



# COMMUNICATING THE GREEN TRANSITION

Practices and Competencies for Engineers

**ECO**GT

Engineers Communicating & Collaborating  
Internationally for the Green Transition



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## Abstract

The green transition is driving demand for engineering expertise in sectors such as renewable energy, construction, transport, and industrial decarbonisation. Projects are complex and interdisciplinary, and communication plays a central role. This report presents findings from 20 focus groups with 103 engineers across Europe examining how engineers communicate in green transition project contexts. Participants described a wide range of communicative tasks involving coordination, documentation, stakeholder engagement, and public communication. Engineers work across spoken, written, and digital modes, shifting between formal and informal styles, and adapting to varied audiences. They must navigate fragmented tools and workflows, unclear goals and roles, jargon pitfalls, conflicting stakeholder agendas, and interpersonal and cross-cultural frictions—especially in multilingual, distributed teams.

The report identifies a broad, interconnected framework of competencies required for effective communication in green transition engineering. These include digital fluency, audience-centred message design, emotional and social intelligence, negotiation and crisis communication, interdisciplinary and inclusive collaboration, strategic advocacy, and communication governance. Each competency is described within a broader ecosystem of communicative practice, linked to specific means, contexts, and core skills rather than treated in isolation. This integrated structure supports a holistic approach to instructional design, enabling educators to derive context-specific learning outcomes and “can-do” statements tailored to professional realities.

While grounded in real-world practice, the findings reflect local interpretations and methodological constraints. Further research should build on this work through lifecycle analysis, communication mapping, and relevant theoretically informed approaches. The growing influence of generative AI on engineering tasks also adds urgency to this agenda, as communication demands continue to evolve.

# Table of Contents

Executive Summary .....	1
1. Introduction.....	3
1.1. Purpose of the Report .....	4
1.2. Pedagogical Rationale .....	5
1.3. Outline of the Report .....	6
2. Method.....	8
2.1. Data Collection.....	8
2.2. Participants.....	12
2.3. Data Analysis.....	15
3. Broad Overview of “Green” Technologies .....	25
4. ‘Communicative Interactions’ in Green Transition Engineering .....	28
4.1. Project Related Interactions .....	28
4.2. Workplace and Organisational Interactions .....	37
4.3. External and Public-Facing Interactions.....	39
5. Means of Communication .....	44
5.1. Spoken Communication .....	44
5.2. General Written Communication .....	49
5.3. Specific Written Genres .....	51
6. Communication Networks .....	61
6.1. Technical Communication Partners .....	61
6.2. Business and Commercial Communication Partners.....	65
6.3. Administrative and Managerial Communication Partners.....	67
6.4. Legal and Regulatory Communication Partners.....	71
6.5. Academic and Research Communication Partners .....	73
6.6. Public Communication Partners.....	76
7. Common Communication Challenges.....	82
7.1. Failure to Achieve Common Understanding .....	82
7.2. Interpersonal Communication Challenges.....	85
7.3. Language, Culture and Contextual Barriers .....	88
7.4. Information and Information Gaps .....	89
8. Communication-Related Competencies.....	93
8.1. Communication Means.....	93
8.2. Communication Contexts & Applications .....	109
8.3. Underlying Language and Communication Competencies.....	137
9. Conclusion.....	163
9.1. Summary of Report Findings.....	163
9.2. Limitations and Further Research.....	164
Bibliography.....	167

## Executive Summary

The global transition toward sustainable, low-carbon technologies has increased demand for engineering expertise across renewable energy, construction, transport, and industrial decarbonisation. These complex, interdisciplinary projects require not only technical capability but also advanced communication skills. Engineers must coordinate across professional boundaries, engage with regulators and communities, and convey technical knowledge in ways that influence decisions, align stakeholders, and build trust. Despite growing awareness, communication training in engineering education remains limited, often lacking relevance to real-world practice.

This report presents findings from a multinational study exploring how engineers communicate in green-transition projects. Twenty focus groups involving 103 participants were conducted across Austria, Finland, Ireland, Poland, Portugal, Romania, and Türkiye, as well as with transnational R&D consortia. The research examined the communicative interactions, networks, tools, and challenges encountered in practice, with the aim of developing an evidence-based framework for communication competencies in engineering education.

### Key Findings

Communication was found to underpin every phase of engineering work—from strategic planning and stakeholder negotiation to on-site coordination and public outreach. Engineers use a wide mix of communication modes, including meetings, phone calls, video conferencing, email, digital collaboration platforms, and formal documentation. Spoken interaction remains essential for decision-making and problem-solving, while written and digital tools ensure traceability and compliance. The study identified communication networks that span internal teams, contractors, suppliers, clients, regulators, researchers, financiers, and the public. Effective communication across these interfaces allows engineers to align technical objectives with broader social, political, and institutional realities, clearly underlining how communication is not ancillary to engineering practice but a strategic function that shapes project outcomes and stakeholder relations.

However, inconsistent terminology, fragmented digital channels, and insufficient attention to interpersonal dynamics such as listening, empathy, and trust were identified as recurring challenges. Multinational teams also reported difficulties linked to language proficiency, cultural norms, and generational differences.

### Skills and Competencies in Green Transition Engineering

Analysis of the findings led to the development of a structured framework comprising 90 communication-related competencies, grouped across communication means, communication

contexts and applications, and underlying language and communication competencies. The communication demands identified in this study require a broad set of competencies that go beyond technical writing or presentation skills. Engineers must communicate clearly, strategically, and adaptively across spoken, written, and digital formats. This includes, for example, explaining complex ideas to non-specialists, distilling key messages for decision-makers, adjusting tone and structure to suit diverse stakeholders in a range of very specific settings, negotiating and persuading effectively, and managing interaction across languages, cultures, and digital environments. It also requires a conscious focus on designing and structuring project-wide communication, selecting the appropriate tools and platforms, and establishing guidelines and mechanisms for effective exchange and collaboration.

The findings have direct pedagogical implications for engineering education. They support a task-based, context-driven approach that mirrors authentic professional interactions and allows students to practise the communicative activities that occur in real projects. By designing learning tasks around realistic engineering scenarios—such as design briefings, site problem-solving, stakeholder consultations, or crisis communications—educators can better connect communication instruction to disciplinary practice. Emphasis should also be placed on genre awareness, audience adaptation, intercultural competence, and the management of digital communication environments, ensuring that graduates are prepared for both traditional and hybrid modes of professional interaction.

## Limitations and Further Research

While the study provides grounded and practice-oriented insights, it also has limitations. The findings reflect the contexts and interpretations of participants within specific national and sectoral environments. Further research should refine these results through systematic lifecycle analysis, quantitative mapping of communication networks, and qualitative approaches such as genre analysis and Activity Theory. Importantly, the dataset predates the widespread integration of generative AI into professional workflows. Future studies should therefore explore how AI-assisted writing, translation, and documentation tools are reshaping communication practices, competencies, and ethical considerations within engineering contexts.

Overall, the report demonstrates that effective communication is not a peripheral skill but a central determinant of success in green-transition engineering. As the technical challenges of decarbonisation intersect with social, regulatory, and environmental complexities, engineers must combine precision with adaptability, empathy, and strategic awareness. The competency framework presented here offers educators and professional trainers a foundation for designing learning activities that reflect these realities—equipping future engineers to lead the transition not only with technical expertise but also with communicative competence, clarity, and confidence.

# 1. Introduction

Green-transition engineering projects are emerging across diverse contexts. The shift to renewable energy sources like solar, wind, and hydropower is essential for reducing greenhouse gas emissions and achieving sustainable development goals (Paraschiv & Paraschiv, 2023), whilst other technologies relating to urban mobility (Tsavachidis & Petit, 2022), sustainable urban water management systems (Liu & Jensen, 2018), the development of low-carbon materials and energy-efficient buildings (Chen et al., 2023) as well as the low-carbon retrofitting of existing buildings (Liu et al., 2020) are also key to achieving long-term climate goals. These are truly “wicked problems” that require not only technical expertise but diverse social and communication skills (Lönngren, 2019) and intercultural competence (Handford et al., 2019). Indeed, Nielsen and Heymann (2015), in their study of the history of wind power technology, found that effective communication by engineers, including building networks and acting as public spokespersons, was key to the success of wind power technology in Denmark, while, in contrast, early failures to develop wind power capacity in Germany could be attributed to the lack of such communication (Nielsen & Heymann, 2015).

Research consistently highlights the critical importance of effective communication skills for engineers in the workplace. Effective communication is essential for professional success, team collaboration, and employability (Sumaiya et al., 2022), and engineers need to be adept at interpersonal, small group, and formal communication, as well as skills like translation, clarity, negotiation, and listening (Darling & Dannels, 2003; Vest et al., 1995). These are skills which are essential for collaboration, networking, and cultural understanding in increasingly interdisciplinary and globalised work environments (Lappalainen, 2009). The range of roles within engineering also reflects a corresponding diversity in required competencies. For instance, in terms of broader social and personal skills, Craps et al. (2021) highlight that innovation-focused roles require perseverance and creativity, while optimisation roles prioritise critical thinking and stress management (Craps et al., 2021). Given this variation in job profiles, it is reasonable to assume that the scope of communication activities and the competencies needed to carry them out also differ accordingly. Engineering communication, as Nielsen and Heymann (2015) argue, takes various forms, employs different modes, and involves a range of tasks, engaging diverse actors to meet different needs and objectives (Nielsen & Heymann, 2015).

While engineering education has made efforts to incorporate communication training, new graduates still face challenges in transferring these skills to the workplace due to the complex and situated nature of professional communication (Ford et al., 2021; Paretti, 2008). A contributing factor here may be that engineering educators face challenges in teaching communication skills, including inadequate methods and insufficient knowledge (Petrovic & Pale, 2021), while language and communication educators often lack the technical expertise

or subject knowledge to sufficiently situate the communication skills within the engineering context (Spector-Cohen et al., 2001). At the same time, students may underestimate the importance of language and communication skills (Petrovic & Pale, 2021) and may lack motivation to develop these skills if course content is not perceived as relevant to their primary field of study or future career (Jafari Pazoki & Alemi, 2020). There remains, therefore, a need for continued improvement in teaching and assessing these skills to better prepare engineering students for the demands of their future careers (Petrovic & Pale, 2021). Incorporating communication courses and authentic activities that aim to develop verbal and non-verbal communication skills, and intercultural competence (Baskakova et al., 2024; Verzella et al., 2021), as well as developing targeted resources and adopting flexible, context-specific approaches (Ye, 2020), may help improve language and communication skills education in engineering programs.

A clearer understanding of these authentic contexts—the communicative events and interactions, the networks of communication partners, and the forms of communication that occur in these contexts—can provide teachers from both language/communications backgrounds (cf. Spector-Cohen et al., 2001) and technical disciplines (cf. Paretto et al., 2019) with tools and resources to develop relevant, context-specific, learning activities that can be integrated into the engineering curriculum (Smith Diaz, 2014).

The objectives of this research were framed over four research questions:

- 1) What communicative events or interactions take place within the scope of green transition engineering projects?
- 2) With whom do engineers communicate within the scope of green transition engineering projects?
- 3) What means of communication do engineers use when communicating within the scope of green transition engineering projects?
- 4) What communication-related challenges do engineers face when communicating within the scope of green transition engineering projects?

In answering these questions, this research set out to develop an evidence-based competency framework that can help inform the design and implementation of communications-related learning activities within the context of higher education engineering curricula.

## 1.1. Purpose of the Report

The present report compiles insights from focus groups conducted by partner institutions in seven countries (Poland, Austria, Ireland, Finland, Portugal, Türkiye, and Romania), each of which investigated how engineers communicate across engineering projects in green transition contexts. By bringing together research and industry practitioners from diverse ‘green’ engineering contexts—including sustainable construction, low-carbon infrastructure, industrial

decarbonisation, renewable energy, circular economy, and eco-design—each partner captured a multi-angled perspective on the real-world, situated communication practices needed to steer sustainability projects from concept to execution—practices which may be integrated into engineering curricula.

This report outlines the core task-oriented interactions, communication partners and means of communication that emerged from the focus group findings, as well as the challenges faced and the competencies and mindsets required to navigate these challenges. This report provides a synthesis and thematic analysis of data provided in 7 individual country-level reports, with findings illustrated with data from each of these individual partner reports, showcasing the “on-the-ground” realities engineers face and highlighting the common experiences felt by engineers across both a broad geographical area and a widely cross-disciplinary landscape.

## 1.2. Pedagogical Rationale

The information gleaned from this research is expected to provide relevant context for the design of communication courses within engineering education.

Information on green transition project contexts helps to ensure that our understanding of “green engineering” in the ECO-GT project is closely aligned with the understanding and experiences of the focus group participants, who themselves represented a large pool of experts from industry and academic engineering contexts. This knowledge may be useful in helping teachers to contextualise learning activities, which has been shown to enhance student engagement, performance, and knowledge retention across various educational settings, including materials science (Krause et al., 2016), mathematics (Masita, 2012) and molecular biology (Belen & Caballes, 2020). By extending our knowledge of the context of green technologies, we are better able to design communication-related material that can address a broader range of green engineering interests, encouraging students to connect new information with their professional interests, their existing knowledge and personal experiences (cf. Hudson & Whisler, 2007). On a more practical level, though, the understanding of context extends to the communicative interactions that take place within these types of projects, the means of communication employed, and the communication partners that engineers potentially engage with in the course of their work.

The value of these communicative interactions lies in their potential for designing task-based communication courses. In the field of language pedagogy, task-based learning (TBL) has long been touted for offering a richer exposure to language use and motivation for students to build on their existing language repertoire (Ellis, 2003). Research on task-based learning suggests that educational designers can incorporate key characteristics of workplace communication into the design of tasks for professional communication courses for adult

learners, particularly in fields such as Business English (Evans, 2013), but also in English for engineering communication (Rahman, 2010). It follows the assumption that “people of all ages learn languages best, inside or outside a classroom, by not treating the languages as an object of study, but by experiencing them as a medium of communication’ (Long & Robinson, 1998, p. 18). Although this current research report—and by extension the objectives of the ECO-GT project—are not exclusively grounded in language pedagogy but in broader communication skills of which language competency is only a part, we assume that the principles of task-based learning are transferable to this broader, pragmatic application of language and communication and that by understanding the situations in which communication occurs, teachers have better resources for designing programmes that are grounded in real-world engineering interactions regardless of the language being used.

Finally, by exploring the specific communication skills that underpin these interactions and the associated challenges that engineers face when communicating in these contexts, this report provides evidence-based insights into the very specific learning communication-centred learning outcomes that engineers ideally need to acquire within the scope of their studies and professional development. It is by combining these skills with the situated interactions and the engineering-based contexts above that educators may be able to better prepare—and better motivate—engineering students for the communication challenges that they are likely to face in their careers.

### 1.3. Outline of the Report

Chapter 2 of this report outlines the methods applied to generate and analyse the data, including the structure and implementation of the research focus groups, the reporting of data at a country level and the AI-assisted analysis and synthesis of data from across these reports.

Chapters 0 to 6 report the data from the focus group. Chapter 0 provides a general overview of the kinds of technologies that focus group participants raised as integral to the “green transition”, whether or not they were directly involved in these technologies themselves. The purpose of this is to offer broader context as to the overall green transition landscape, providing non-technical teachers and lecturers (for example those focused on language and communication skills within an engineering context) with background on some of the applied technologies that students in this field are likely to be exposed to, whether in their studies or their future careers, thus enabling them to design more context-rich learning activities.

Chapter 0 deals with the specific communication-related tasks—the communicative interactions or events—that focus group participants alluded to, explicitly or implicitly, during the group discussions or follow-up interviews. Here, we sought to understand ‘why’ engineers communicate in the context of their projects. The findings in this chapter, which derive from a qualitative content analysis of the country level reports, rather than a purely systematic

synthesis of country level report findings, offer insights into the applied communicative tasks that occur in the context of a range of “green transition” engineering projects (defined as such by the focus group participants themselves), thus providing a framework for designing task-based communications training activities.

Chapter 5 focuses on the means of communication—the 'how' of interactions. These findings, also drawn from qualitative analysis of the country reports, identify specific means—tools or channels—of communication that are used by engineers to achieve their communicative objectives. This data can be used to help focus on mastering the specific tools, means, genres, and discourses engineers use in their communication—whether written or spoken. There may be certain similarities and crossovers with respect to the 'how' described in this chapter and the 'why' in Chapter 0. Broadly speaking, this is to do with viewing the same activity through different lenses, particularly for the purpose of integrating it into different teaching contexts. This is explained in more detail within the introduction to Chapter 5.

Chapter 6 completes the three-way perspective on engineers' communication activities by analysing the data through the lens of stakeholder communication networks within these projects, representing the 'who' of the interaction. The findings, as with Chapters 0 and 5, reflect a qualitative content analysis of the country reports, identifying references to differences between stakeholders or communication partners and the context of these interactions. This data is expected to be useful in supporting students in designing target group-specific communication plans and strategies and in learning how to adapt communication styles to a range of specific relevant audiences.

Chapter 7 addresses the communication challenges and skills required to navigate these projects, communicative interactions and stakeholder exchanges. The findings reflect, to a greater extent, a direct synthesis of the pre-categorised data presented in the individual country reports, largely as a result of the focus group discussions focusing more directly on these skills and challenges. This includes the particular means of communication that engineers need to master, as well as the more social and interpersonal competencies that are foundational for effective communication in this professional setting. The findings here will be useful for teachers and trainers in being aware of some of the potential skills gaps that students may potentially exhibit and to strengthen their focus on particular communication skills that may need integrating into the curriculum.

Finally, Chapter 8 of the report summarises the overall report findings and draws conclusions and recommendations as to how these findings may be effectively implemented in higher education and professional engineering education contexts. Limitations of the research are outlined, and future directions for research in this area are elaborated.

## 2. Method

### 2.1. Data Collection

All project partners employed a qualitative focus-group methodology to explore how engineers communicate during green transition projects. The core design of these focus groups followed a shared protocol—detailed in the “Focus Group Instructions” (Appendix 1)—ensuring consistency across the consortium. Each partner gathered professionals from engineering disciplines working in both industry and research and development (R&D) contexts. Participants were purposively sampled on the basis of their likely involvement in green transition technologies and their professional experience engaging with a balanced range of stakeholder categories (e.g., installers, manufacturers, operators, researchers, policymakers, end-users). Convenience sampling also played a role, as recruiting busy professionals during working hours posed challenges of motivation and incentive. As a result, the samples may also have been biased toward individuals with a pre-existing interest in communication topics. However, this was unlikely to negatively influence the study; on the contrary, heightened awareness of communication issues contributed to richer data. Collectively, the project partners held 20 focus group sessions between 13 February and 11 June 2024, involving a total of 103 participants.

The sessions included a pre-workshop questionnaire to orient participants around “green transition” concepts, as well as group activities to visualise the innovation or product life cycle. For this, we provided an illustrative example of the lifecycle of toast (see Figure 1), following Tom Wujec’s (n.d.) *DrawToast* method as a way of visualising complex systems (see <http://www.drawtoast.com>). Afterwards, participants worked in small teams or individually to map out typical communication tasks, partners, and challenges at each project stage, after being provided an example from the toast-making process (see Figure 2). In some cases, partners also conducted follow-up interviews to deepen the analysis of specific challenges or practices.

This structured, task-oriented approach enabled meaningful cross-country comparisons while remaining sensitive to the specificities of engineering work in different sectors and national contexts. It allowed each partner to gather parallel data on communication practices, analysed through the lens of Lasswell’s model of communication—who says what, in which channel, to whom, and with what effect? (Sapienza et al., 2015) but was pedagogically informed by task-based needs analysis, following Long’s (2005) model from the field of English for Specific Purposes (ESP). While ESP traditionally centres on learner needs in specific professional contexts (Hutchinson & Waters, 1987), Long’s emphasis on identifying authentic workplace tasks and deriving communicative goals from them offered a methodological fit with ECO-GT’s aim to explore communication as situated, purposeful activity. Task-based

needs analysis was selected specifically for its ability to reveal not only linguistic demands, but also the ways in which communication is shaped by the tools, roles, and goals that define engineering work. Pedagogically, this aligns with task-based language teaching (TBLT), which prioritises the completion of meaningful, real-world tasks as the foundation for developing communicative competence.

Figure 1: Illustration of a technical lifecycle using the principle of how to make toast

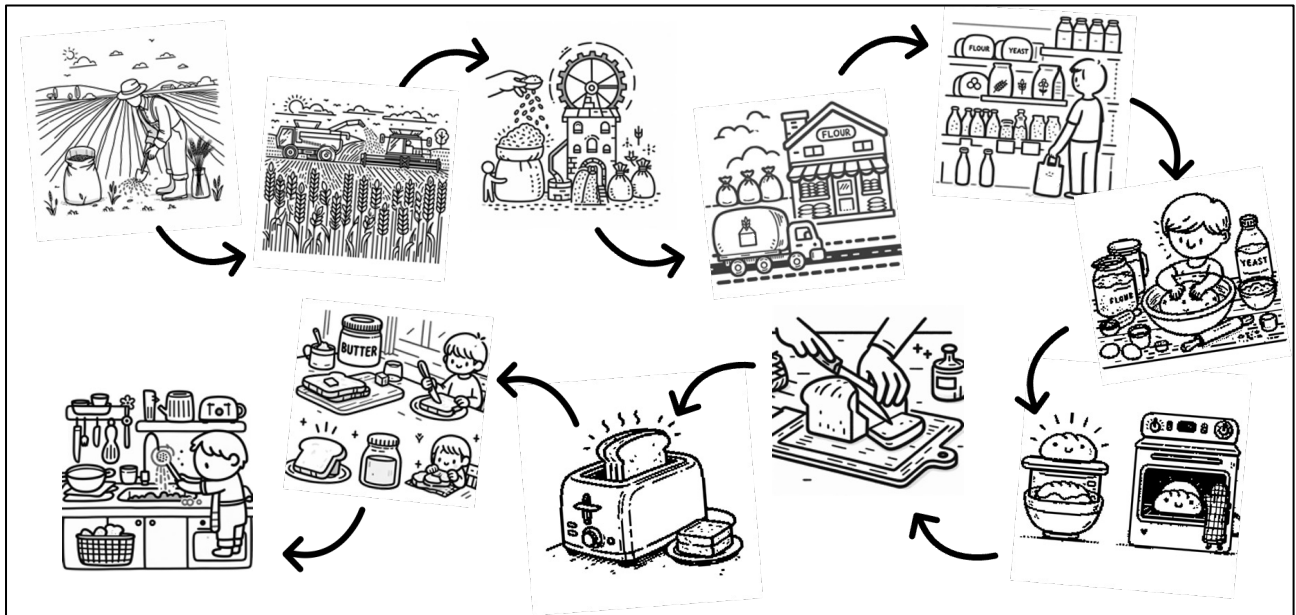



Figure 2: Example of communicative interactions at a specific stage of the toast lifecycle



**Processing Wheat into Flour**

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**Who?** Millers communicate with farmers, transporters, quality control inspectors, and buyers.

**Why?** To coordinate the receipt of wheat, discuss specifications, ensure quality, and arrange for subsequent sale and distribution.

**How?** Through contracts, phone calls, emails, and in-person meetings.

**What?** Conversations may include the timing of wheat delivery, the quality and type of wheat, the specific milling processes required, and the types of flour needed by different customers.

### 2.1.1. Focus Group Composition and Differences

Although a uniform research approach was developed for all partner institutions, individual contexts inevitably led to some variation between focus groups (Table 1 details the focus group composition and context in each country). Several partners conducted focus groups

entirely online (e.g., UAS Lapland, Istanbul University) using platforms like Teams or Zoom, whereas others (e.g., TU Dublin, University of Transylvania of Braşov) organised sessions in person, leveraging physical post-it notes or whiteboard exercises. Technikum Wien, in addition to holding face-to-face workshops with local industry perspectives, also held focus groups with transnational R&D consortia participating in EU Horizon Europe projects in diverse green technology fields. These transnational focus groups incorporated team members from across multiple countries and took place via Zoom. This approach ensured that the research addressed not only country-specific experiences but also those where virtual, intercultural and translanguaging activities played a central role.

The common exercises included the physical mapping of a process to illustrate the project or product lifecycle (as per Figures 1-2 above), and most focus groups took a traditional brainstorming approach with flip charts in face-to-face sessions. Where focus groups were conducted online, additional software (e.g., Miro or Padlet) was used to facilitate remote collaboration.

Table 1: Focus group composition and context ordered by date

Date	Location	Type of Organization	No.	Gender	Roles & Expertise
13.02.24	Ireland	Engineering Consultants (mainly structural)	11	4 women, 7 men	2 x civil engineers (1 consultant, 1 contractor); 9 x structural engineering consultants
21.02.24	Ireland	Engineering consultants and environmental scientists	5	2 women, 3 men	2 x transportation engineers; 1 x civil engineer; 2 x environmental scientists, all consultants
06.03.24	Ireland	Engineering consultants (mainly water/civil) working within a government department	3	2 men, 1 woman	1 x ecologist; 1 x environmental/water and wastewater treatment project manager; 1 x senior design engineer (process-water and wastewater)
12.03.24	Austria	Civil Engineering / Structural Engineering Company	4	3 men, 1 woman	2 x energy & environmental engineers; 1 x civil engineer; 1 x building physicist
19.03.24	Europe-Wide (Horizon Europe Projects; Online)	R&D Project Participants (Universities)	2	2 women	1 x associate professor in mechanochemistry; 1 x associate professor in electrical engineering (power electronics)
26.03.24	Finland	Engineers (Steel, Mining, Circular Economy)	5	1 woman, 4 men	2 x steel industry engineers; 1 x mining engineer; 1 x circular economy centre expert; 1 x researcher
28.03.24	Europe-Wide (Horizon Europe Projects; Online)	R&D Project Participants (University & Tech Start-Up)	2	1 man, 1 woman	1 x postdoctoral researcher in physics/material science; 1 x chief technology officer in green hydrogen field
04.04.24	Finland	Engineering Consultancy & Research	3	2 women, 1 man	1 x consultant engineer (design office); 2 x researchers

25.04.24	Romania	Engineering consultants (industrial and mechanical)	6	2 women, 4 men	5 x industrial and mechanical engineers (2 x plant directors, 3 x design engineers); 1 x human resources manager
29.04.24	Austria	Innovations & Technology Solutions Company	2	2 women	1 x innovation & intellectual property manager; 1 x head of product security, standardization, environmental sustainability
06.05.24	Portugal	Engineering consultants and researchers	6	3 men, 3 women	1 x Company CEO (Renewables); 1 x CEO of an Hi-Tec Company (ICT); 1 x Product Designer; 1 x Project Manager; 2 x Researcher (water and renewable energy optimization)
15.05.24	Türkiye	Scientific Community	7	5 women, 2 men	3 x professors; 3 x assistant professors; 1 x research assistant (PhD); Fields: 4 x environmental engineer, 1 x biologist, 1 x chemist, 1 x aquaculture engineer
22.05.24	Poland	Construction and Design Disciplines	5	3 women, 2 men	1 x building project manager; 1 x consultant engineer (design office); 3 x researchers
22.05.24	Romania	Engineering consultants (industrial /mechanical) + local administration rep	4	1 woman, 3 men	2 x industrial and mechanical engineers; 1 x forestry engineer (local administration); 1 x psychologist (HR manager)
23.05.24	Türkiye	Industry (Installers)	9	2 women, 7 men	3 x aquaculture engineer; 2 x environmental engineer; 3 x mechanical engineer; 1 x material engineer
28.05.24	Portugal	Engineering consultant, project manager and researchers	6	6 men	1 x Company CEO (Renewables); 1 x Engineer at architecture company; 1 x Civil Engineer; 1 x Project Manager; 2 x PhD students (Electrical Mobility and ICT)
28.05.24	Romania	Engineering consultants (industrial /mechanical) + local administration + organisational psychologist	5	2 women, 3 men	1 x ecologist/local administration rep; 1 x psychologist (organisational); 3 x design engineers (process-water and wastewater)
29.05.24	Portugal	Engineering consultants, journalists, end users and researchers	6	3 men, 3 women	1 x Journalist; 1 x CEO of a Construction Company; 1 x Farm Owner; 1 x PhD student; 1 x MSc student; 1 x End User
30.05.24	Türkiye	Public Authorities (Water & Sewerage Sector)	7	1 woman, 6 men	3 x aquaculture engineer; 3 x environmental engineer; 1 x mechanical engineer; 1 x chemical engineer; 1 x electrical and electronic engineer
11.06.24	Poland	Mixed Engineering Roles	5	Not specified	1 x project assistant; 1 x sanitary systems engineer; 1 x construction engineer and design assistant; 1 x inspector; 1 x external communication specialist

## 2.1.2. Follow-Up Interviews

Certain partners (e.g., TU Dublin, Technikum Wien, UTAD) were able to arrange post-session interviews with individual focus group participants to elicit more detailed qualitative insights, whereas others (e.g., Gdansk Tech) relied exclusively on in-group discussions.

## 2.2. Participants

This section outlines the professional fields represented by the focus group participants in each country. It is important to note that while the focus groups were organised by project partners in these countries and the participants are employed as engineers there, this does not imply that the participants themselves are nationals of those countries. When focus groups or individuals are referred to under a country label—within this or any other section of the report—this should be understood as describing the national context rather than personal nationality; for example, “Polish engineers” or “Polish focus groups” refers to engineers working in Poland, who may not necessarily identify as Polish.

For focus groups held by Technikum Wien (Austria), a clear distinction has been made between “Austrian” data, drawn from focus groups conducted in Austrian companies, and “Horizon European (R&D)” data, which derives from transnational focus groups. In the latter case, neither the nationalities nor the national working context of the participants were recorded.

### 2.2.1. Gdansk Tech (Poland)

At Gdansk Tech in Poland, the project’s focus groups brought together a group of engineers, project managers, and researchers working mainly in construction and design disciplines. Among the participants were building project managers, consultant engineers from design offices, young structural engineers, inspectors, and a specialist focused on external communications.

Their discussions centred on wide-ranging projects aimed at meeting sustainability goals in building and urban environments. Participants described thermal-modernisation initiatives that retrofit existing buildings to enhance energy efficiency, as well as the use of recognised green standards like BREEAM and LEED in new construction. Researchers and consultants alike highlighted the importance of reclaiming materials during the construction process, reflecting an emerging drive to integrate circular-economy principles into building practices. Beyond construction, the focus groups also featured conversations about urban greening, from reducing deforestation in surrounding areas to integrating green roofs and natural habitats within city spaces. Engineers involved in waste management and recycling projects contributed perspectives on implementing 3R (Reduce, Reuse, Recycle) policies, developing car tyre recycling operations, and tailoring solutions for municipal waste. In the field of renewable energy, participants described efforts to install wind, hydropower, and photovoltaic systems, as well as to incorporate electromobility infrastructure in transport networks.

### **2.2.2. Technikum Wien (Austria)**

In Austria, Technikum Wien's focus groups were split between local industry professionals and international R&D project representatives involved in Horizon Europe programs. On the local side, participants included civil engineers, building physicists, and specialists in innovation and technology management who collaborate closely with industry partner organisations. They described an array of green-transition work, most prominently in energy and environmental engineering. For example, structural engineers and building physicists explored both the technical and regulatory sides of designing resource-efficient and environmentally friendly buildings. They described integrating innovative materials, performing complex thermal analyses, and contributing to standardisation and product security initiatives.

The international R&D representatives came from multiple European countries, working on Horizon Europe initiatives in fields such as mechanochemistry, advanced power electronics, and green hydrogen technologies. One postdoctoral researcher discussed her experience in developing next-generation materials to support cleaner manufacturing. Another participant, the chief technology officer of a green hydrogen start-up, highlighted the need for cross-border collaboration in scaling up renewable hydrogen production.

### **2.2.3. TU Dublin (Ireland)**

TU Dublin's focus groups primarily involved civil, structural, and environmental engineering consultants and contractors, with representation from those with significant experience in transport and water infrastructure. They addressed how engineers adapt to new sustainability mandates in their day-to-day practice, specifically focusing on designing low-carbon buildings, optimising public transportation networks, and delivering water supply and wastewater treatment solutions for rural communities.

Some participants highlighted the growing need for life-cycle assessments in structural projects. Others, particularly in transportation engineering, spoke about retrofitting roads to incorporate active travel designs for cyclists and pedestrians, as well as electrifying existing infrastructure to reduce dependence on fossil fuels. Regarding water management, participants emphasised that their work often involves nature-based solutions, such as constructed wetlands or retention basins, that can mitigate flooding and support biodiversity.

### **2.2.4. UAS Lapland (Finland)**

In Finland, UAS Lapland's focus groups convened engineers and researchers from several carbon-intensive industries, notably steel and mining, as well as professionals in the circular economy sector. Many participants were directly involved in high-impact industrial projects, including developing carbon-neutral approaches to steel manufacturing and exploring how waste-heat recovery systems can trim emissions in large-scale processes.

Mining- and steel-industry sector participants described strategies for reducing and reusing by-products, underscoring how digital technology, such as real-time condition monitoring, can optimise production while minimising environmental footprints. Others, particularly those from the circular economy centre, stressed a systemic view of industrial symbiosis—where waste streams from one process can serve as raw materials for another. Hydrogen production and power-to-X technologies are also featured in the discussions, particularly as pathways to decarbonise process industries.

### **2.2.5. UTAD (Portugal)**

At UTAD in Portugal, focus group participants included engineering consultants, researchers, a journalist, farm owners, and students of engineering at various levels. As a result, the discussions offered a diverse look at how sustainability plays out in everything from civil engineering and renewable energy to farming and media communication.

One focus group participant working on municipal lighting projects described a successful transition from outdated systems to LED technology, which improved both energy efficiency and lighting quality in a large municipal stadium. Another participant recounted experiences building a solar park in Kenya, underscoring the international dimension of green-transition engineering. Conversations also encompassed smaller-scale but no less important projects, such as shifting to paperless communications within an organisation, which reduced waste and streamlined workflows.

### **2.2.6. Istanbul University (Türkiye)**

Istanbul University's focus groups assembled members of the scientific community, industrial installers, product manufacturers, and operators in the water and sewerage sector. Their work often sits at the intersection of environmental engineering, aquaculture, mechanical systems, and material sciences. Researchers specialising in aquaponics and recirculating aquaculture systems explained how they are pushing the boundaries of more sustainable fisheries and land-based seafood production, while industrial participants discussed harnessing digital twins and AI systems for more efficient waste and water management.

The concept of zero waste—a major national priority—permeated the discussions, with participants explaining how they apply industrial symbiosis frameworks to repurpose by-products for new uses. Hydro and solar projects surfaced as well, along with wave, wind, and biogas installations, each requiring regular interaction with local authorities, consultants, and sometimes international partners.

## 2.2.7. University of Transylvania of Braşov (Romania)

The University of Transylvania of Braşov (Romania) approached its focus groups primarily through the lens of industrial, mechanical, and renewable energy engineering. This involved participants from plant management and design engineering backgrounds, as well as representatives from local government administrations and psychology, particularly organisational psychologists. In many of their projects, the participants explored manufacturing process efficiency, product design initiatives with eco-design principles, and the rollout of solar-module installations for private and public clients.

Local administration representatives described how issues such as urban mobility, municipal waste management, and forestry conservation shape their own approach to green-transition projects, often in collaboration with industry. Meanwhile, organisational psychologists emphasised the role that corporate culture and communication style play in making any transition viable. Participants recounted their experiences designing mechanical transmissions more efficiently, rethinking packaging materials, or adopting lean manufacturing methods to reduce energy use and waste.

## 2.3. Data Analysis

### 2.3.1. Individual country reports

Each partner was responsible for compiling a country-level report, which then fed into the overall consortium-wide analysis. This decentralised approach was necessary for several reasons. Firstly, due to research ethics and data protection constraints, some institutions could not obtain approval to share raw data externally, making a centralised analysis of all transcripts unfeasible. Secondly, raw transcripts alone would have lacked the critical contextual insights provided by local observers who facilitated the focus groups. Since data collection occurred in local languages and was later translated into English, key nuances could have been lost without interpretation by those present during the sessions. To support consistency, all partners completed a standard reporting template with prompts for analysis, though the level of detail varied. As a result, the consortium-wide findings in this report are based on secondary, qualitative content analysis of these reports, relying on the scientific rigour and contextual accuracy embedded in each country-level interpretation and subsequent translation into English. The final combined analysis was validated by individual partners to ensure that the results and interpretations were in line with both their experiences of the original focus groups and interviews and in how these were presented—and intended—in their respective country-level reports.

### 2.3.2. Qualitative Content Analysis using OpenAI o1 ‘Temporary Chat’

Recent studies explore the potential of large language models (LLMs) such as ChatGPT in qualitative research. LLMs show promise in assisting with various research tasks, including data analysis and theme identification (Bijker et al., 2024; Turobov et al., 2024; Wachinger et al., 2024; Zhang et al., 2024) and can efficiently process large amounts of data and generate human-like text, potentially saving time and resources (Kantor, 2024). Bijker et al. (2024) find that ChatGPT “could prove useful as a tool to assist in each phase of qualitative content analysis” but highlight that “multiple iterations are required to determine the reliability of each stage of analysis” (p.1). The speed at which the technology behind LLMs is evolving does put any studies of their research application somewhat into context. At the time of writing this report, no studies could be found that specifically evaluated OpenAI’s o1 model—supposedly the most advanced large language model available through the ChatGPT interface at the time of the study—as a research tool, although in applied (non-research) contexts, (see, for example, Mondillo et al., 2024 for a (non peer reviewed) study of the o1 model in applied clinical case management) it has been suggested that the model utilizes chain-of-thought reasoning to reduce ‘hallucinations’ and improve response coherence and that it demonstrates improved structured reasoning and accuracy compared to the previous GPT-4 model. Taking into account this ongoing debate on LLMs in qualitative research, this current report cautiously exploits some of the emerging opportunities for AI-assisted qualitative analysis using OpenAI’s o1 model to iteratively analyse selected sections of ECO-GT’s seven country-specific focus group reports.

The “temporary chat” function within the ChatGPT interface was used throughout. This mode ensures that interactions are not stored in history, used to train models, or retained beyond a safety-assurance period of 30 days (<https://chatgpt.com/?temporary-chat=true>). This helped ensure that each iteration of qualitative analysis was independently conducted without the model carrying over previous responses from its memory, thus strengthening the rigour of the analytical process as each iteration was a fresh start influenced only by the author’s conscious iterative prompting. This approach also had the benefit of mitigating potential ethical or intellectual property concerns by ensuring that no data or text is saved on any external server or used to train (and potentially influence) other LLMs in the future. This said, the country reports themselves contained no confidential or personally identifiable data and the reports were intended for public release in accordance with funding requirements—practically speaking, once a report is in the public domain, it may be extremely difficult to prevent it, eventually, from finding its way into LLM training data.

#### **Phase 1: Initial Analysis and Category Development (Communicative Events; Chapter 4)**

The first objective of the analysis was to answer the first research question: What communicative events or interactions take place within the scope of green transition engineering projects? The first report to be uploaded for analysis was the Austria report,

since the lead author (the Austrian partner) was already intimately familiar with the report content and could quickly evaluate the accuracy of the results. Various prompts were used, producing a range of results that did not align with the explicit research intentions. After numerous iterations (each time in a fresh temporary chat to avoid interference from previous iterations; see above), the text was provided to the large language model together with the following prompt:

### *Prompt 1*

```
Task: Analyse the following excerpt from a report on communication in engineering contexts. Identify all types of interaction or communicative events mentioned in the text.
```

```
Important Guidelines: Focus only on types of interaction or communicative events. Ignore means of communication, communication skills, or communication challenges.
```

```
For each identified type of interaction or communicative event, provide supporting evidence, including relevant citations from the report. Provide a single sentence contextual justification of each item.
```

```
Report Excerpt: [pasted as plain text below]
```

This resulted in an inductively generated initial list of communicative events which aligned well with both the qualitative content of the initial country report and with the author's own subjective experience of the focus groups in question. The evidence (citations from the report) was cross-referenced with the original report for accuracy and context. This list of categories was recorded in the first column of a Microsoft Excel spreadsheet with the supporting evidence in a second column labelled "Austria".

The next step was to test these emerging categories against the content of a second country report (Ireland) to identify any data from this report which aligned with the existing list, as well as any additional interactions that did not emerge from the analysis of the first country report. To start with, a fresh temporary chat was initiated, and the existing list of categories was provided together with the following prompt:

### *Prompt 2*

```
Below is a list of types of interaction or communicative events derived from an original report on communication in engineering contexts. Please review the list and confirm that you understand the categories.
```

```
List of Types of Interaction / Communicative Events: [pasted as plain text below]
```

The model reported back a correct interpretation of the instruction and a list of categories of interaction commensurate with those uploaded. At this point, the text from the second report could be processed, for which the following prompt was used:

### **Prompt 3**

Task: I will now provide an excerpt from a different report. Analyse this new report and identify any types of interaction or communicative events that match the categories in the list above.

Important Guidelines: Identify and align examples from the new report with the existing categories. If you find new types of interaction or communicative events that are not covered in the list, create additional categories. Ignore means of communication, communication skills, or communication challenges.

For each identified type of interaction or communicative event, provide supporting evidence, including relevant citations from the report. Provide a single sentence contextual explanation of each item.

Report Excerpt: [pasted as plain text below]

This resulted in the presentation of the full original list of categories. For those categories where corresponding data were identified in the report excerpt, the supporting evidence and contextual justification were provided. For categories where no data was found, the model indicated as such with the wording “no further evidence of this category” or text to this effect. The data was again cross-referenced with the original report for accuracy and context and transferred to the Excel spreadsheet, together with the additional new categories.

This process was repeated until all seven reports had been processed. Each time, the new extended list of categories was used to provide a provisional category framework for the next report. Each iteration required human oversight to verify accuracy, refine categories, and remove any misaligned examples. This sometimes led to certain categories or certain ‘examples’ being excluded as they either did not fit the criteria of an interaction or communicative event, or the examples given were entirely absent in the original report. As the category list became longer and more complex, similar or overlapping categories were consolidated manually to maintain a streamlined structure.

### **Phase 2: Saturation Testing and Final Verification**

After completing the initial round of analysis for all seven reports, a second phase was undertaken to verify whether any of the later-identified categories applied to earlier reports. This involved reprocessing each report using the final category list, but with a refined focus: only categories that had not been previously identified in any respective report were tested. By narrowing the scope in this way, the model was directed to search specifically for instances of these missing categories rather than re-identifying existing ones.

To conduct this verification, the same structured approach was followed. A fresh temporary chat was opened for each report, ensuring that prior interactions did not influence the results. The model was first asked to confirm its understanding of the final category list (using Prompt 2, above), ensuring alignment with the intended framework. Once this was established,

excerpts from each report were reanalysed (using an adaptation of Prompt 4, see below) to determine whether any of the missing categories could now be found within the data.

#### *Prompt 4*

Task: I will now provide an excerpt from a different report. Analyse this new report and identify any types of interaction or communicative events that match the categories in the list above.

Important Guidelines: Identify and align examples from the new report with the existing categories. Do not create any additional categories. Ignore means of communication, communication skills, or communication challenges.

For each identified type of interaction or communicative event, provide supporting evidence, including relevant citations from the report. Provide a single sentence contextual explanation of each item.

Report Excerpt: [pasted as plain text below]

Despite this structured and iterative approach, the second round of analysis did not yield any new valuable insights. The model frequently misclassified examples, providing evidence that was either inconsistent with the intended category or focused on aspects explicitly excluded from the analysis, such as communication skills or challenges, rather than communicative events. This suggested that the analysis had reached a point of theoretical saturation—at least in terms of what OpenAI’s o1 model was capable of achieving—and was now going through the process of forcing themes into categories rather than generating novel insights, similar to the experiences reported by Wachinger et al. (2024).

Phases 1 and 2 were then repeated for each of the remaining three research questions with prompts adapted to instruct the model to identify communication partners, means of communication, and references to communication challenges, respectively.

### **Phase 3: Synthesis of Categorised Findings across Country Reports**

The LLM-generated output was collected in an Excel table (see Figure 3, below, for a snapshot of this during the iterative process). The content in each cell was textual in nature, combining excerpts from the country-level reports together with a brief LLM-generated contextualisation of the data in relation to its respective category.

Figure 3: Snapshot of cross-country-level category development for communicative interactions

	Austria	Ireland	Poland	Portugal	Finland	Romania	Turkey
<b>Developing and Maintaining Relationships</b>	Customer relationship building through informal interactions (e.g., CEO meetings at conferences). Establishing relationships with partners before formal collaborations.  "You can start with the like, um, customer relationship by two CEOs meeting somewhere in the conference and they discuss something, you know, they pass down the team and the team starts to talk, and then you have this kind of account managers involved, some senior management or like just a project manager."	Developing and Maintaining Relationships. A key theme discussed in the focus groups was the development of relationships between team members on a project... These relationships were developed by open communication between participants, most often verbally rather than in email form. "Developing and keeping those relationships were key to a successful outcome." "For me, I was taught when I started... the most important relationship to get right is between the design engineer and the contracts engineer on site."  The report emphasizes the value of informal conversations in maintaining positive working relationships, particularly between site engineers and design engineers. Evidence: "Well over the years you've worked with people, you get to know them, you pick up the phone to X and say what's the story here?"	Engineers must build and sustain professional relationships to foster collaboration and ensure smooth project execution. This is whether it is a project partner or an internal colleague.  "Many engineers emphasized the importance of direct contact, even in the digital communication era, personal interactions are crucial for building trust and understanding within teams."		Engineers exchange ideas in informal networking settings.  "Think tank at the gas station coffee table (casual meetings with stakeholders)."	Engineers need to build strong working relationships within their teams and with external stakeholders to ensure smooth project execution: Communication plays a vital role in the engineering industry, facilitating collaboration, conveying complex ideas, and ensuring the successful completion of projects.	Some teams maintain personal relationships outside work, while others limit interactions to work hours. Evidence: "Focus Group 1 emphasized their close-knit bond by frequently meeting outside of work, portraying themselves as a family that spends quality time together. In contrast, the other two groups, particularly Focus Group 2, expressed a preference against meeting outside of work due to the constant interaction they already have during work hours."
<b>Resolving Design and Construction Issues</b>	Addressing architectural concerns versus technical constraints. Reconciling artistic design with engineering requirements. "So now I have the architect, for example, which will have to communicate with all those involved, because they ultimately collate the information and mix it in a plan. But now I also have, for example, a marginal planner, a certifier such as klimaaktiv. For them, the architecture is only marginally important. What is important for them is how much material goes in, how is it heated, what comes out at the end? Are my requirements met and is the goal that I'm aiming for achieved?"	Resolving Design and Construction Issues. "If you can have a good working relationship between the two of you, you can sort most problems out... pick up the phone... you get to the point where you resolve it before it becomes an issue and you can say 'I missed this' on a drawing or they might miss something on site and you can have it sorted out between you." "If you picked up the phone for a two-minute conversation, you could probably save 10 emails going back and forth."	Engineers must clarify design details and align project expectations with stakeholders to ensure feasibility and compliance. Examples: "Road designers - Support in design process" "Company employee - Design requirements with client and designer" Excerpt: "Company employee - Design requirements Client, 'designer - Dostosowanie projektu do potrzeb klienta"	NO DATA	Engineers communicate to solve design and construction setbacks. "Engineers - Problem-solving (how we have this setback)."	NO DATA	NO DATA
<b>Planning Proposals</b>	Submitting project proposals to funding agencies. Collaborating with industry partners before submission. "And we had a project where we must involve an industry or a company before submission of the proposal. So in that case, we had a company, in that case, like we mailed them and one of the companies, not everyone accepts it. And, further, they give their agreement letter to us, like a collaboration letter, and we submitted that."	Planning Proposals. One participant highlighted that depending on the discipline of engineering one worked in, they may be exposed only to very technical reports, and others would be required to write reports in a persuasive way to convince a planning authority to proceed with a scheme. "These reports are very important because they have to be persuasive in terms of, you know, convincing a planning authority to grant permission or convincing a funding authority to provide funding."	NO DATA	Communication is crucial for project approval, budgeting, and coordination across multiple stakeholders. Evidence: "To discuss the budget plan." "To ask for money for the investment." "If you don't communicate with stakeholders, they will not understand for what the project is going to save, and so it is compromised right in the beginning."	NO DATA	NO DATA	Communication in project planning involves feasibility discussions and technology transfer office consultations. Evidence: "Technology Transfer Office: Project preparation" "Finance: Discussing the feasibility and originality of the project"
<b>Implementation, Installation and Start of Operation</b>	NO DATA	NO DATA	Engineers oversee final installation and ensure a smooth start-up process for clients. Example: "Installation ready for calibration": "Producer employee - Installation ready for calibration Customer, company employee - Start of operation face-to-face meeting"	NO DATA	NO DATA	NO DATA	Engineers and technical staff communicate to ensure proper system installation and operation. Evidence: "Technical personnel: In order to install the system completely, explaining the system to the technician."

The horizontal cross-country category data was then input into OpenAI's o1 model, one category at a time, following the same 'temporary chat' processes as outlined above. The model was asked to synthesise the data provided. ChatGPT has been shown to be effective in generating nuanced summaries of data when structured information is provided as input—described as "hybrid summarization" (H. Liu et al., 2023). The category column (column A) was not included so as not to provide any undue influence or force the model to support specific hypotheses. The following prompt was used:

### Prompt 5

Task: I will provide citations and contextual explanations from focus group data across seven countries. Based on this input, generate a synthesis of the data.

Important Guidelines: Synthesise the information by themes or ideas, not by listing countries individually. Use only the citations and explanations provided—do not add any new information or interpretations. Accurately represent each data point in the synthesis, reflecting the original wording and context. If a country has no data, omit it entirely from the synthesis. Maintain a clear, cohesive narrative that reflects the thematic content of the citations. Do not add additional interpretations.

Data Excerpt: [pasted as table]

The output at this stage was not considered as final report text, but rather as semi-processed data, which, although presented in convincing narrative form, still required validation (see 2.3.4 below for a more detailed discussion on the use of LLM narrative structures in the report).

## **Phase 5: Validation**

The final data was compiled into a draft narrative report, with each country report contribution highlighted in a specific colour. The respective country report authors then confirmed the accuracy, authenticity and interpretation of the examples and citations based on the content of their individual reports and their subjective interpretations of the original focus group discussions and interviews. Despite these efforts, potential problems of groupthink and “the desire to achieve consensus and uniformity” with other report writers may potentially impact the reliability of the final results (Resnik & Smith, 2020, p. 99).

## **Methodological Reflections**

Although the AI-assisted process was methodically controlled to ensure rigour and objectivity, the limitations of the model became apparent both in the “hallucination” of evidence and in the attempts to fill predefined gaps with non-relevant content. This highlights an important consideration for AI-assisted qualitative research: while AI can facilitate categorisation and pattern recognition, human oversight remains essential to filter out misclassifications and refine emerging frameworks. In this case, the structured use of fresh temporary chats contributed to maintaining analytical rigour, as each iteration was independently conducted without the model carrying over previous responses. The human validation process helped confirm the accuracy and interpretation of the results, but may not have been sufficient to evaluate the completeness of the findings. To ensure absolute theoretical saturation, additional human analysts would be required to cross-check and further validate the findings. The results must therefore be viewed as provisional. Nevertheless, while they cannot yet be regarded as a basis for theory building without further validation, they do provide a solid practical foundation for the design of relevant learning materials, in line with the purpose of the ECO-GT project. These materials can be refined and strengthened through iterative feedback loops, ensuring their continued relevance and effectiveness even as the underlying theoretical claims remain tentative.

## **Further use of AI in the Country-Report Analysis**

The process outlined above describes how OpenAI’s o1 model in ChatGPT was used to perform qualitative content analysis of the communicative events or interactions, the means of communication, communication partners and communication challenges alluded to in the country reports. The process was used to a somewhat lesser extent for the Broad Overview of “Green Technologies” (see Chapter 3); in this case, the LLM model was used to simply extract and categorise all mentions of green technologies from across all reports. Since this chapter is purely descriptive (what technologies are there?) rather than interpretive or analytical, the process of identification and categorization was more rudimentary with no iterative processes or systematic validation, and the results can only be taken as useful background context rather than the product of rigorous research; it was none the less

important to manually verify that this information was indeed drawn from the country reports and not a result of model hallucination.

### 2.3.3. Identifying and Cross-Referencing Competencies using OpenAI o1 'Temporary Chat'

Following the thematic analyses presented in Chapters 4 through 7, a final analytical stage was conducted to identify communication skills either explicitly or implicitly referenced in the qualitative content analysis. This step aimed to consolidate the findings into a structured framework of communicative competencies relevant to engineering contexts. It is important to note here that the analysis took a broader approach to identifying competencies beyond simply reporting focus groups' responses to this question. This takes into account the problems associated with the self-reporting of learning needs (see e.g., Carter & Dunning, 2008). Instead, the analysis explored how competencies were inferred from reports on activities, means, communication partners and challenges.

For each completed chapter, the full chapter text was input into a temporary session of OpenAI's o1 model, and the model was prompted to identify what engineers need to be able to do based on the situations described. We began with Chapter 4 (Communicative Events):

#### *Prompt 6*

Task: I will provide you with an excerpt from a report on engineering communication. Identify what engineers need to be able to do based on the communicative activities described in the following report section.

Important Guidelines: Focus on actions or abilities which can be framed as "can-do" statements

Instructions: For each identified ability, provide a brief justification and cite the relevant section number from the report.

Report Excerpt: [pasted as plain text below]

Each item was linked to its corresponding section number in the report to ensure traceability. The same process was repeated for Chapters 5 through 7, each in a new session to ensure interpretive independence and consistency across chapters. The outputs were compiled into a master list of draft 90 unique "can do" statements.

This complete list was then input into a new session, where the model was prompted to suggest organisational structures.

#### *Prompt 7*

Task: You are given a list of 90 communication competencies relevant to engineering contexts. Propose and justify several possible frameworks for organising these competencies into meaningful categories.

**Important Guidelines:** The framework should be useful for training design and curriculum development. Provide brief rationales for each framework you suggest.

List: [pasted in CSV format]

Several alternatives were generated and assessed manually. A final framework was selected based on practitioner judgment—critically discussed in the conclusion of this report and in Hamann & Kosmützky (2021)—that balanced pedagogical relevance (communication skills) with contextual applicability (means and tasks). This chosen structure allowed competencies to be embedded flexibly across different learning and professional environments, aligning with the pedagogical aims of the ECO-GT project.

In a new temporary chat, the model was then prompted to categorise the 90 “can-do” statements within this structure. After several rounds of manual refinement, the competencies were grouped across these three main categories and assigned manually to subcategories.

These 90 statements, structured into categories and subcategories, were then re-input into a fresh session, and each chapter was reanalysed. The model was prompted to identify which of the statements were evident or inferred in each chapter, referencing specific section numbers. For each identified instance, a further, more detailed, context-specific “can-do” statement was generated, articulating what was required of engineers in more specific, practical terms.

### *Prompt 8*

**Task:** Review the following report excerpt. Identify which of the listed competencies are evident or can be reasonably inferred from the text.

**Important Guidelines:** Focus on actions or abilities that can be framed as “can-do” statements. Do not introduce new competencies. For each identified competency, generate a clear, context-specific “can-do” statement that describes what an engineer is able to do in the situation described.

**Instructions:** Link each statement to the corresponding section number in the report. Use concise, practical language suitable for curriculum design or training objectives.

List of Competencies: [pasted in CSV format]

Report Excerpt: [pasted as plain text]

Where multiple can-do statements emerged for a single competency, these were synthesised into unified descriptors in an attempt to preserve the breadth of the source data while offering concise, pedagogically useful representations. Each descriptor remained traceable to its original context, allowing for cross-verification of source alignment and relevance. These descriptors are outlined in Chapter 8 of this report

#### 2.3.4. Structuring the Report Narrative

The process described above—particularly during the analysis and category development phase and the synthesis of categorised findings across country reports (see 2.3.2)—resulted in narrative outputs that became an integral part of the data processing workflow. The use of the large language model enabled qualitative data to be reorganised and presented back to the researcher in a structured narrative form. However, this output was not treated as a final product. Instead, it served as a provisional scaffold within an iterative interpretive process. Each synthesis was critically reviewed and edited by the report author, drawing on knowledge of the research objectives, familiarity with the emerging data, the evolving analytical framework and the author’s personal authorial intentions. This was particularly evident during the validation phase, when country partners reviewed thematic findings and identified instances where paraphrased text from country reports could be misread as direct focus group citations. These were manually corrected to ensure representational accuracy.

This approach is consistent with emerging literature that positions large language models not as autonomous analysts, but as iterative drafting tools whose outputs are subject to critical scrutiny, restructuring, and authorial control (e.g., Bijker et al., 2024; Turobov et al., 2024; Wachinger et al., 2024). In this sense, AI-generated text acts as an intermediary in the sense-making process—a scaffold for interpretation rather than a source of conclusions. The process can be understood, to some extent, as a digital extension of the tradition described by Richardson (2000), who argues that “writing is not just a mopping-up activity at the end of a research project,” but “a way of ‘knowing’—a method of discovery and analysis” (p. 923). In this sense, LLM-assisted writing served not as a post-hoc reporting device, but as part of the analytic process through which the researcher actively constructed and refined understanding.

Elements of this writing invariably find their way into the final narrative, and while much of the final report text was rewritten or restructured by the author, some passages retain LLM-generated wording where it effectively captured the intended meaning and met the required tone. These instances were carefully reviewed and integrated as part of the broader authorial process—for example, prompting reordering of ideas to foreground themes, requesting re-synthesis to avoid country-by-country listings, and refining language for clarity, coherence, and academic tone. Overall, the integration of LLM-supported synthesis with human interpretive oversight streamlined the analytic, writing, and validation phases without displacing the author’s critical role. The LLM was thus used not as an alternative to the author’s thinking, but as an extension of it: a responsive tool that supported but did not direct the writing process (for a philosophical discussion on Generative AI as just the latest in a series of extensions of the human mind, see Clark, 2025).

This chapter has described the methodological approaches to generating, interpreting and presenting the data in this study. The following chapters provide a discussion of the findings.

### 3. Broad Overview of “Green” Technologies

Participants in the focus groups identified a wide range of technologies that they consider to fall under their definition of “the green transition”. This list covers all “green transition” technologies that they are aware of, rather than only the specific technological fields in which the participants themselves work, although, naturally, in some cases, there may be overlap. The data was collected in part during the pre-focus group questionnaires and in part during the focus groups and/or interviews themselves.

This information is purely descriptive and bears no interpretive or analytical value. However, it was relevant to collect because it ensures that our understanding of “green engineering” in the ECO-GT project is closely aligned with the understanding and experiences of the focus group participants, who themselves represented a large and diverse pool of experts from industry and academic engineering contexts.

#### 3.1.1. Renewable Energy Production and Storage

Technologies in renewable energy and storage included solar photovoltaic systems, ranging from rooftop installations to utility-scale facilities, with reference to lifecycle performance, costs, and grid connection. Wind, wave, and tidal approaches were also noted, spanning offshore and onshore wind farms as well as devices designed to capture ocean energy. Hydroelectric and small-scale hydro systems were described, involving dams or turbines used to generate electricity in both large and local contexts. Green hydrogen and related “Power-to-X” approaches were identified in relation to converting surplus renewable electricity into hydrogen or other energy carriers, sometimes combined with carbon capture and synthetic fuel production. Energy storage technologies were also discussed, including battery systems and thermal storage, with reference to their role in managing variability in renewable energy supply and integration with grids or industrial processes.

#### 3.1.2. Sustainable Buildings and Construction

In sustainable buildings and construction, energy-efficient design and retrofits were mentioned, including insulation, passive design features, LED lighting, and advanced HVAC systems, often linked to performance standards and certifications such as LEED or BREEAM. Low-carbon materials and techniques were also identified, such as the use of cement substitutes like GGBS, the reuse of construction waste, green roofs, and modular construction. Structural innovation and life-cycle assessment (LCA) were described in relation to modelling tools used to assess material use, building durability, and embodied carbon.

### **3.1.3. Infrastructure and Transportation**

Technologies in infrastructure and transportation included the electrification of rail and bus systems, as well as active-travel infrastructure such as cycling lanes and pedestrian-friendly street design. Digital solutions for traffic management were also noted. For large-scale infrastructure projects, flood mitigation systems, rainwater treatment, and the use of recycled materials in major transport corridors were described. Urban mobility and public transport innovations were identified, including redesigned bus networks, e-bikes, shared mobility services, and policy-based incentives for low-emission travel.

### **3.1.4. Water and Wastewater Management**

Water and wastewater management technologies included treatment and reuse approaches such as constructed wetlands, greywater recycling, advanced process monitoring, and decentralised treatment systems for rural contexts. In the area of stormwater and flood control, retention basins, green roofs, and sustainable urban drainage systems (SUDS) were noted for managing water runoff. Aquaculture and aquaponics technologies were also described, including recirculating aquaculture systems (RAS), integrated multi-trophic aquaculture, and sensor-based aquaponics, with reference to improving energy and water efficiency in fish and plant production.

### **3.1.5. Circular Economy and Waste Management**

Technologies in circular economy and waste management included recycling, composting, and zero-waste strategies, ranging from municipal to industrial-scale programs focused on reducing waste streams and promoting materials reuse in line with the 3R principles of reduce, reuse, and recycle. Industrial symbiosis was also noted, referring to networks where by-products from one process are used as resources in another, such as waste heat recovery or biomass conversion. Product lifecycle and ecodesign approaches were described in relation to redesigning consumer and industrial products—such as packaging and electronics—to minimise material use, enhance recyclability, and reduce emissions throughout the supply chain.

### **3.1.6. Decarbonising Heavy Industry**

Technologies related to heavy industry decarbonisation included approaches in steel, mining, and manufacturing, such as carbon-neutral steel production, emission reduction in mining operations, and optimisation of process flows to minimise energy use. Waste-heat recovery systems were also noted, capturing excess heat from industrial processes for use in auxiliary systems or district heating networks. Advanced robotics and lean production techniques were described in relation to automation for improved precision and reduced resource waste.

Continuous improvement methodologies, including Lean and Six Sigma, were identified as further tools to streamline operations and lower emissions.

### **3.1.7. Agriculture and Land-Use**

Technologies related to sustainable farming included precision irrigation, organic waste composting, and nature-based approaches aimed at supporting soil health and resource efficiency. Digital tools and sensor networks were also noted in relation to livestock activity monitoring, with applications in optimising grazing, reducing emissions, and improving farm management. Reforestation and biodiversity projects were described, including strategies to enhance local ecosystems, preserve greenfield spaces, and offset carbon through forest management practices.

### **3.1.8. Digital/ICT-Enhanced Sustainability**

Alongside technologies focused directly on carbon reduction and environmental sustainability, a range of digital tools and ICT applications were identified as playing a facilitative role in green transition developments across multiple engineering sectors. AI, digital twins, and remote monitoring were noted for enabling real-time analytics and sensor networks in manufacturing, water treatment, and energy systems, supporting process optimisation and resource management. Paperless systems and digital communication platforms were also described, reducing the need for physical documentation and streamlining organisational workflows. Smart grid and grid management technologies were highlighted for their use of ICT tools to integrate renewable energy sources, electric vehicles, and storage solutions while balancing supply and demand. Despite it not being a typical “green technology”, the role that ICT, AI and digitalisation play—and will undoubtedly play in the future—should remain central to our understanding of green transition engineering.

This chapter has provided a brief overview of some of the technologies and types of engineering projects that our research participants identified as contributing to the green transition. This is by no means a comprehensive list of all technical solutions in this field, but it does provide for contextual framing for potential language and communication-related activities within an engineering curriculum. The nature of these language and communication-related activities is outlined and described in the following three chapters, looking at communicative interactions, means of communication and communication networks, respectively.

## 4. ‘Communicative Interactions’ in Green Transition Engineering

Beyond the broader identification of “green transition” initiatives or technologies, the research sought to explore some of the specific communication-relevant tasks and activities—the communicative events or interactions—that focus group participants deemed relevant in the lifecycle of the projects they themselves have experience of. This section is concerned with where communicative interactions occur, whilst providing some context for the relevance of communication in each of the cases.

The process of the focus group implementation—the identification of activities along the lifecycle of a particular project or technology—provided a framework for participants to consider the various tasks relevant to their work. However, it did not, in most cases, lead to a systematic or coherent reporting of processes from start to finish. Furthermore, the collation of data from across the seven different partners did not lend itself to a clearly defined life cycle in which to locate specific activities. This was not surprising given the variety of ways in which engineering projects can be managed (Timinger et al., 2024) and the diversity in project characteristics and the tasks and roles that these projects demand (Bentahar & Ika, 2020). Therefore, while some activities *do* perhaps lend themselves to clearly defined stages of a process, the activity descriptions below do not and cannot claim to represent a coherent process. Instead, these activities can be broken up into three broad categories: project-related interactions, workplace and organisational interactions, and external and public-facing interactions.

A summary of all communicative interactions detailed in this research is provided in Table 2 at the end of this chapter.

### 4.1. Project Related Interactions

#### 4.1.1. Strategic communication and communication planning activities

Strategic communication and communication planning in engineering projects often revolve around establishing clear procedures, assigning roles, and selecting appropriate channels for information exchange. In some organisations (as noted in the Austrian data), this might include creating project-specific email addresses and distribution lists so that every participant is kept up to date. Compliance with predefined guidelines and the use of Enterprise Resource Planning (ERP) systems can also help maintain consistency: project proposals are developed in accordance with established rules, and structured processes ensure that information is stored centrally and shared transparently. These steps ensure that everyone is “on the same page” and can access relevant materials when needed.

Another aspect is defining a formal communication plan that outlines specific goals, target audiences, and channels—an approach highlighted in Finland, where clear responsibilities help mitigate confusion. Meanwhile, in Türkiye, engineering teams may adapt their planning to different institutional cultures. Official letters are used in public institutions, while academics often rely on more informal interpersonal skills. Regardless of the format, these planned communication activities—creating distribution lists, delineating responsibilities, and choosing suitable communication styles—help coordinate engineering efforts and keep complex projects running smoothly.

#### **4.1.2. Planning Proposals**

Planning proposals represent a key communication task in engineering projects, encompassing the preparation of documents and discussions aimed at securing funding, approvals, or partnerships. The Austrian data shows how this can involve collaborating with industry partners in advance, with engineers emailing potential companies and obtaining formal letters of agreement to strengthen a proposal before it is submitted to funding agencies. The Irish data highlights that proposals may need to be more persuasive than purely technical, depending on the project's nature—some reports must convince planning authorities or funding bodies of their viability. The Portuguese data underscores the importance of communicating budgetary needs and project objectives early on, suggesting that a failure to engage stakeholders “right in the beginning” can compromise the proposal's success. Similarly, in Türkiye, feasibility discussions with technology transfer offices and financiers serve as a crucial step in validating a project's originality before it moves forward. These interactions—whether through email, meetings, or formal documentation—highlight the collaborative efforts needed to align technical feasibility with persuasive rationale in order to secure a project's successful launch.

#### **4.1.3. Relationship-Building Interactions**

Developing and maintaining relationships in engineering projects typically involves informal and direct interactions that foster trust and collaboration. In Ireland, for example, team members place a strong emphasis on verbal conversations—rather than long email threads—to “develop and keep those relationships”. A frequent practice involves picking up the phone to quickly address concerns or share updates, particularly between key roles such as the design engineer and the on-site contracts engineer—although this is frequently seen as a challenge, especially for younger engineers (see Chapter 7).

Beyond immediate project teams, initial relationship-building often occurs well before any formal agreements are in place. In the Horizon Europe (R&D) data, we see how CEOs may meet at a conference and begin discussing potential collaborations, passing relevant information down to their respective account managers or project managers. Meanwhile, Polish engineers highlight “direct contact” in building trust, even in an era of digital

communication. In Finland, this may manifest as informal networking sessions—a “think tank at the gas station coffee table”—where stakeholders casually exchange ideas. Romania similarly points out the necessity of cultivating strong professional ties among both internal and external partners to ensure smooth project execution, and in Türkiye, some teams extend these interactions beyond the workplace, frequently meeting outside of work, whereas others prefer to limit face-to-face contact to work hours.

#### **4.1.4. Stakeholder Engagement in Projects**

Stakeholder Engagement in Projects represents a set of interactions aimed at securing buy-in, aligning interests, and addressing concerns among diverse groups. The Austrian data illustrates how including top management in structured email communications can help create accountability and encourage timely delivery. The Irish data highlights that engagement strategies may vary depending on whether one is speaking with national government ministers—who are more difficult to access—or local politicians, who can offer insights into community priorities. Meanwhile, the Polish data stresses that engineers must negotiate and clarify objectives with an array of stakeholders, from building users to central policymakers, to reach consensus on project activities. The Portuguese data underscores the importance of well-targeted messaging and solid justification through facts and figures, especially in large infrastructure projects like dam construction, where minimising opposition is key. Lastly, the Finnish data shows how collecting input from municipal residents and other end users can refine project implementation to better meet local needs.

#### **4.1.5. Recognising and Responding to Customer or Market Needs**

Recognising and responding to customer or market needs involves gathering user requirements, understanding market demands, and translating these insights into practical solutions. Data from the Polish and Turkish focus groups revealed the importance of pinpointing client needs so that engineers can propose suitable technical solutions that align with these requirements, ensuring the project remains both feasible and responsive to user demands. The Austrian data, similarly, highlights the importance of identifying customer expectations at the outset—whether it’s meeting specific standards or exploring how an emerging idea might “stir customer desires.” Taking a macro-level view, the Portuguese data focuses on broader market signals, from understanding consumer interest in green products to recognising the growing demand for electric bicycles.

#### **4.1.6. Negotiating Financial and Business Agreements**

Negotiating financial and business agreements helps to ensure that all parties align on budgets, costs, and contractual terms. The Polish data points to “financial negotiations,” where engineers discuss prices and finalise contract details with clients and other stakeholders. The Portuguese data stresses that clear, timely communication about investment needs and

payment terms can prevent delays—especially in large projects where hesitation or poor timing can lead to misunderstandings. The Finnish data also emphasises reporting to financiers on costs and schedules, highlighting the importance of transparency and agreement on project expenditures. Meanwhile, the Turkish data describes the role of financial discussions in cost assessments and feasibility evaluations, underlining the importance of dialogue among project managers, financiers, and engineers.

#### **4.1.7. Contractor-Engineer Coordination**

When working with contractors, the primary communication task involves ensuring that on-site activities align with project specifications and quality standards. The Polish data indicates that “financial negotiations” and supervisory processes help keep contractor responsibilities clear, while the Portuguese data focuses on meeting agreed-upon expectations through collaborative dialogue. According to the Finnish data, coordination also extends to subcontractors and suppliers, who must be informed of resource and product needs in a timely manner. The Irish data underscores the value of maintaining positive relationships with site personnel, partly through flexibility and goodwill, so future cooperation remains strong. Taken together, these points highlight the importance of open, respectful communication between engineers and contractors.

#### **4.1.8. Resolving design and construction issues**

Engineers need to communicate to resolve design and construction issues, and the data illustrates this in several ways. The Austrian data shows how communication can serve a coordinating function, involving multiple perspectives—such as architectural, technical, and environmental. Here, the architect acts as a central hub, gathering requirements from various specialists to ensure that materials, heating needs, and sustainability goals align with the overall project vision. The Polish data highlights the role of clarification, where engineers actively check design details with different stakeholders (e.g., road designers, clients, company employees) to ensure feasibility and compliance. These conversations often revolve around adjusting the project to meet client needs while remaining consistent with technical standards. The Finnish data points to problem-solving, emphasising a pattern of focused, solution-oriented communication when setbacks or unexpected challenges arise. Open dialogue in such cases is key to navigating problems and keeping design plans on track. Finally, the Irish data draws attention to efficiency, suggesting that this kind of communication benefits from direct, real-time interaction—for example, picking up the phone to address discrepancies in drawings or on-site conditions before they escalate. Such exchanges can bypass lengthy email chains and keep design and construction teams in sync.

#### 4.1.9. Cross-Disciplinary Team Collaboration

Instances of cross-disciplinary team collaboration represent a crucial type of interaction in green engineering and related research projects, where diverse expertise converges to drive project success. In the Horizon Europe (R&D) groups, participants highlighted the importance of interdisciplinary collaboration and the sharing of knowledge across multiple fields, where a combination of disciplines such as chemistry, material science, and engineering is vital for the success of project outcomes: "Interdisciplinary collaborations we definitely want to have because I'm basically from a physics background, and basically what I'm working on is electrochemistry. So, in that case, we need to collaborate with other disciplines like chemistry, material science, and engineering." At the same time, participants emphasised the challenge of ensuring that data provided is relevant to collaborators, even when its significance is not immediately clear: "So they went through the documents, and they picked up the info they needed for their calculation. But we don't know what they need in terms of data. So we need them to tell us the way we need to perform a synthesis or collect the specific data that we are not used to collecting."

In Türkiye, collaboration was described in terms of knowledge exchange between researchers, technical managers, and experts. As one participant explained: "Researchers, technical managers, and experts engage in project knowledge exchange," ensuring that specialised technical content is shared among team members. This exchange also extended beyond the scientific community. Among the Horizon Europe (R&D) groups, data pointed to collaboration between legal and scientific expertise, particularly in developing patents from research and development outcomes. As one participant put it: "A lawyer cannot understand the impact of an invention, and a chemist is not able to know all the rules and laws that bring to the patent."

Effective information flow across multiple professional disciplines was also highlighted in the industry context. The Austrian data revealed how the architect must act as a key communicator, consolidating input from all parties and mapping it into a plan: "So now I have the architect, for example, who will have to communicate with all those involved, because they ultimately collate the information and map it in a plan." According to the Irish data, collaboration required communication to be adapted to the specific needs of different professional groups. As one participant noted, "It's your method of getting your idea across. You need to be able to tailor that because if you're talking to another engineer, or if you're talking to a contractor, or if you're talking to an architect... You may have to use different ways for a different person." The ability to adjust style and approach was therefore seen as central to ensuring that all participants, regardless of role, could contribute effectively.

#### **4.1.10. On-Site Problem-Solving Discussions**

In the on-site environment, communicative events often focus on real-time issue resolution. The Austrian data shows engineers attending both formal and informal meetings to address technical concerns as they arise, preventing smaller issues from escalating into larger delays. The Irish data similarly highlights direct conversations with site teams—such as rebar-fixers—to ensure designs remain practical and buildable. In the Finnish and Romanian data, immediate, face-to-face exchanges and on-site inspections were described as ways of troubleshooting setbacks quickly, while the Turkish data pointed to coordination with department heads and managers to resolve operational challenges. Across these contexts, on-site communication is characterised by direct, timely dialogue among technical experts to maintain project progress.

#### **4.1.11. Project Conflict Resolution**

Conflict resolution is a communicative event within engineering projects that involves addressing misunderstandings, competing interests, or interpersonal tensions. Misunderstandings and breakdowns in dialogue emerged as a source of conflict. The Austrian data describes situations where communication between engineers and architects deteriorated, sometimes leading to a complete halt in discussion. The Finnish data highlights that escalation often occurs when participants resort to “shouting at each other” rather than listening. The Portuguese data points to unclear messaging or delayed dialogue as further triggers of disagreement, especially in large or financially sensitive projects. Conflicts also arise from divergent priorities, with the Polish data referring to tensions around cost and quality expectations, requiring engineers to balance these competing demands to maintain project feasibility. Some of these issues may come down to the role of relationships and communication style. The Irish data indicate that pre-existing positive relationships can help to defuse hostile exchanges, with phone calls often preferred over confrontational emails to maintain a constructive tone. The Turkish data similarly shows that direct interaction—through phone calls or face-to-face meetings—can build trust and clarify misunderstandings in ways that, for example, digital communication often cannot.

#### **4.1.12. Keeping Written Records of Communication**

Maintaining written documentation is a communicative event within engineering projects that supports accountability, prevents disputes, and clarifies decisions. In the Austrian data, participants described the practice of producing a “jointly written protocol,” where the outcomes of phone calls and meetings are recorded and shared to verify mutual understanding. As one participant explained, sending a short summary after each interaction makes it possible to confirm whether it “matches what [the other party] think[s],” thereby ensuring alignment. These records are also circulated to “top management executives in CC [carbon copy email recipients]” to keep higher-level stakeholders informed and to “create

pressure on the stakeholders to deliver.” Turkish participants similarly described the importance of “tangible records of agreements, decisions, and directives” in serving as a shared reference point for all parties.

The Irish data presents a slightly different angle, describing a related practice framed as “cover yourself,” where emails are copied to multiple recipients to ensure a digital trail exists if disagreements arise. Portuguese participants similarly emphasised the role of meeting minutes as a tool for accountability.

#### **4.1.13. Legal Documentation and Clarification of Contractual Obligations**

In engineering projects, formalising roles, responsibilities, and legal obligations through clear documentation helps mitigate risks and maintain project momentum. The Portuguese data highlights the role of clearly defined terms “to ensure contractual obligations,” ensuring that all parties understand their responsibilities and the scope of work. The Finnish data points to different forms of contractual relationships, such as “employer → employees” or “forest owner → the logger,” illustrating how legal agreements underpin aspects of project operations, from labour arrangements to resource use. However, when it comes to legal and contractual issues, a balance may be sought between spoken and written communication. The Irish data shows how more experienced engineers often advise resolving delicate or contentious matters verbally first—typically by phone—before putting the agreed outcome in writing. As one participant explained, “for anything contentious, written communication is very dangerous,” with a call helping to resolve confusion before a potentially misleading email is sent.

#### **4.1.14. Compliance and Regulatory Communication**

Many engineering projects operate under strict legal and environmental regulations, making communication with regulatory bodies an integral part of project work. The Austrian data describes a structured approach to tracking new legislation: an EU Affairs expert monitors relevant laws and informs the project lead whenever significant changes occur. One participant explained the process of obtaining the “last stable draft from the legislation” and then analysing which teams and deliverables are affected.

The Polish data refers to revising contracts when legal amendments arise, while the Portuguese data highlights how licensing authorities and oversight bodies require “good compliance” to grant permission for certain activities. Turkish participants noted that public institutions and “controllers” engage in dialogues with engineers for “permits, education, and regulations.” Finnish and Romanian data similarly point to the influence of environmental impact calculations, permits, and professional standards on engineering decisions. In Romania, the mainstreaming of software and tools “to help calculate the environmental impact of a product or process,” including their integration into university curricula, training programmes,

professional accreditation assessments, and award criteria, was said to highlight “the influence of professional bodies in moving the profession to focus on this aspect.”

Other compliance-related exchanges were also described. Irish participants mentioned responding to Freedom of Information (FOI) requests, where the project team was “absolutely bombarded” for records ranging from site photos to any mention of specific individuals, showing how public accountability can shape documentation practices.

#### **4.1.15. Implementation, Installation and Start of Operation**

Implementation, installation, and the start of operation require clear, hands-on communication to ensure that new systems function as intended. The Polish data describes engineers overseeing the final installation phase, including equipment calibration and on-site meetings with producers and clients to support a smooth start-up process. The Turkish data highlights step-by-step explanations by engineers and technical personnel, who guide technicians through the setup and operation procedure. Demonstrating and clarifying system requirements in real time helps minimise errors and gives stakeholders confidence as the project moves into active use.

#### **4.1.16. Ongoing Support, Maintenance, and Troubleshooting**

Beyond initial implementation, projects often require continued communication to address malfunctions or changing needs. The Turkish data points to the importance of prompt feedback and confirmation for resolving issues quickly and minimising downtime. Clarifying terminology and responsibilities allows engineers and municipal staff to coordinate maintenance tasks effectively, helping to ensure the reliability of systems or infrastructure. This dialogue addresses immediate problems while also supporting proactive maintenance and ongoing improvement.

#### **4.1.17. Technology Transfer and Commercialisation**

Engineering teams may need to bridge the gap between research and market applications, requiring clear dialogue to promote the adoption of new technologies. The Horizon Europe (R&D) data provides an example of researchers transferring a product to industry partners, who then test how the innovation compares to existing technologies and feed the results back to the research team. Maintaining this feedback loop allows the product’s performance and commercial potential to be refined. However, Portuguese data highlights the challenge of communicating unfamiliar technologies, both internally among engineers and externally to potential users, noting that such communication can “bring more effective solutions” if decision-makers fully understand the benefits. Finnish data illustrates the range of stakeholders involved, from “industry experts” who specify what they need to “equipment manufacturers” who deliver products to end users.

In Türkiye, the reference to a “Technology Transfer Office: Project preparation” points to structured pathways for discussing commercialisation strategies, ensuring that knowledge transfer is managed systematically. The Horizon Europe (R&D) data refers to the patenting process as a form of technology transfer: “If you think that you can patent, then what we write is something called the declaration of invention, where you describe the state of the art, and you describe what your patent, what your invention is bringing to the state of the art that is different and innovative.”

#### **4.1.18. Confronting Resistance**

This category of interaction centres on persuading or influencing stakeholders who may be reluctant to accept certain project measures. The Irish data highlights the importance of first listening carefully to landowners or community members and understanding their perspectives before raising proposals such as compulsory purchase orders. By acknowledging concerns at the outset, engineers can build rapport and negotiate terms that are more likely to be accepted. Portuguese data reinforces this point by showing how well-targeted, context-sensitive communication can reduce opposition—particularly in large-scale initiatives like dam projects—when changes are explained clearly and at the right time. Such practices foster transparency and help to prevent misunderstandings that could otherwise delay or derail a project.

#### **4.1.19. Crisis Communication and Damage Control**

Swift, transparent communication is especially critical when urgent or unexpected problems arise—ranging from technical failures to public relations challenges. The Portuguese data tells of a dam project where “inconsistent and hesitant communication” fueled local mistrust and opposition. In another instance, “a lack of clear communication about the conditions of the land” caused difficulties, illustrating how misunderstandings can quickly escalate if not addressed head-on. The Turkish data echoes this sentiment, with one focus group discussing the importance of “confirmation and ongoing communication” to tackle immediate malfunctions in the city’s water supply. Ensuring that all responsible parties share information promptly can make the difference between a minor setback and a full-scale crisis. By being proactive—whether through press releases, direct stakeholder briefings, or rapid response teams—project managers and engineers can mitigate public alarm and keep projects on track.

#### **4.1.20. Project Progress Monitoring and Reporting**

Ongoing monitoring and reporting help maintain momentum in engineering projects by keeping milestones, budgets, and goals visible to all involved. Internal monitoring is reflected in the Austrian data, where participants described “regular meetings for every major project where minutes are taken,” with records then shared with product managers, production teams,

and logistics staff. Such updates allow team members to track progress and address potential issues—such as design flaws or supply chain bottlenecks—before they escalate.

Portuguese participants noted that meeting deadlines and achieving objectives depend on consistent stakeholder engagement and transparent communication. Finnish participants added that financiers must be kept updated on “financial usage” and project schedules, underscoring the need for regular reviews of both cost and timeline, while Romanian data highlights the importance of design specifications, project plans, and progress reports in keeping both internal teams and external partners aligned. Finally, dissemination to broader audiences appears in the Turkish data, where “regular reporting” was described as essential for keeping managers, students, and other interested parties informed of project developments.

## 4.2. Workplace and Organisational Interactions

### 4.2.1. Informal Interactions

Not all engineering communication takes place in scheduled meetings or formal channels. Casual discussions and unplanned meetings form another important mode of interaction. The Austrian data highlights that “even employees send us things that they’ve noticed,” suggesting a culture where spontaneous input is welcomed. One example involved a wind power operator’s staff informally exchanging updates in “coffee kitchens,” leading to fresh project ideas. The Finnish data similarly describes a “think tank at the gas station coffee table,” referring to casual gatherings with stakeholders, as well as “stand-up meetings in the hallway.” These less formal get-togethers allow teams to share insights quickly and support flexible decision-making.

Closely connected to this is the transfer of engineering knowledge that comes from proximity-based learning in many offices. In open-plan environments or closely knit teams, professionals—particularly junior ones—may “pick up” communication habits, technical terminology, and troubleshooting approaches simply by being near more experienced colleagues. The Irish data refers to an “open plan” environment in consultancy offices, where “you just learned by osmosis” from overhearing phone calls to architects or clients. This kind of real-time exposure helps new engineers understand workplace norms and problem-solving tactics. The Polish data similarly notes that engineers often learn by observing senior staff, though it can also introduce inconsistencies if each senior employee has distinct habits or idiosyncrasies. As participants noted, “communication in the engineering field is often shaped by individual methods of senior employees.” Despite its limitations, proximity remains an important factor in skill development and the day-to-day transmission of engineering knowledge.

#### **4.2.2. Training and Knowledge Transfer**

Retaining and passing on institutional knowledge is critical in engineering projects, particularly in R&D environments where employees may leave mid-project for new opportunities. The Horizon Europe (R&D) data notes that “when people get some other opportunities, they just go on,” creating the need for systematic handovers to maintain continuity. In such settings, senior staff often mentor junior colleagues to ensure that expertise is not lost. As one participant explained, in an R&D lab, it sometimes requires existing team members “to train the other person from the beginning. So, there can happen some delays.” While this process can slow progress, it helps mitigate the disruptions caused by staff turnover and allows new members to integrate more quickly.

Documentation also plays a role in preserving organisational expertise. The Polish data highlights the importance of written records such as meeting notes and emails: “Written communication helps document agreements and supports project continuity, even as team members change.”

#### **4.2.3. Internal Data Sharing Across Departments**

Large projects often require close coordination among multiple divisions—design, production, logistics, and others—making cross-departmental data exchange a key form of interaction. Polish participants described “reporting progress” and clarifying objectives within the project team through structured updates, including reports and emails. Finnish data likewise emphasised the role of “internal communication” via reports and emails in coordinating tasks and maintaining alignment on deliverables. Turkish participants highlighted how “different units within the institution” share resources and assessments, reinforcing the importance of effective inter-departmental channels.

#### **4.2.4. Remote Work-Related Interaction and Supervision**

Supervision and mentoring through digital channels have become an important form of interaction in engineering as remote and hybrid work models expand. The Finnish data notes that “meetings are held mostly online,” often through platforms such as Teams, replacing in-person oversight. Turkish participants likewise recognised the practicality of virtual meetings for geographically dispersed teams, though they also criticised them for reducing interpersonal connection. As one focus group observed, “this mode of communication often results in diminished connection among team members.” These limitations are particularly evident for junior engineers. The Irish data describes how those working from home may hesitate to seek guidance, lacking the ease of physical proximity to supervisors. Some reported worrying about “bothering” their supervisors when remote, noting they might more easily approach someone “who’s sitting beside them” than initiate a call.

#### **4.2.5. Clarifying Team Goals and Aligning Project Objectives**

Even when projects are well defined, teams can drift apart if they do not regularly revisit and align on objectives. The Austrian data emphasises “meetings and discussions” to synchronise on project goals, with one participant noting that “one of the key central issues is always to check the other person’s expectations.” Polish participants similarly pointed to the need to “develop, strengthen, realise our actions/goals,” reflecting open dialogue about how individual tasks fit into the broader picture. Finnish data highlights the responsibility of “project leaders” to clarify the common goal, helping participants remain motivated and on track. Turkish participants described the role of “kickoff meetings,” where the project team and target group set objectives, timelines, and scope together, providing a clear foundation for collaboration.

### **4.3. External and Public-Facing Interactions**

#### **4.3.1. Scientific and Technical Community Interactions**

Sharing research and development insights with peers in academia, industry, and other professional domains is important for advancing engineering knowledge and fostering innovation. The Horizon Europe (R&D) data highlights the importance of presenting findings at a range of events—“conferences, workshops,” both national and international—and of making results “exploitable” through publications, patents, or demonstrations “for students.” One participant explained that such publications should be “informative or pedagogic” and accessible to a wide audience—including chemists, pharmacists, technologists, and engineers—rather than confined to a single discipline.

Polish participants described engineers “engaging in knowledge-sharing within academic and professional communities,” giving examples such as “lecturers and students—transmitting information/collecting information.” Portuguese data adds that this communication varies depending on the audience, noting that “it’s very different when you talk with first-year students or when you give classes to PhD students.”

#### **4.3.2. Professional Networking, Industry Conferences and Technical Seminars**

Beyond the scientific community described above, regular engagement with industry partners and professional networks at conferences and seminars enables engineers to exchange breakthroughs, establish partnerships, and stay aligned with market trends. The Finnish data highlights that engineers often use these forums to update “industry experts” on project findings, noting the importance of tailoring presentations to “what they want to hear.”

### 4.3.3. Educating the Public and External Communication

Beyond professional circles, engineering teams engage with broader communities to raise awareness, secure support, and promote new technologies or initiatives. In Austria, participants referred to public “celebration announcements” when an innovation moved from design and development into commercial production. For research and development projects, communication often took the form of “public demonstrations,” “outreach programs,” and appearances at events such as the European Researchers’ Night. Participants noted that “we cannot bring scientific terms” in some outreach settings, as these would “be boring” for a general audience, showing the need to adjust language when addressing lay audiences.

In Finland, digital platforms—from social media to specialised websites—were used to “communicate project details,” with project operators learning to use “the right hashtags to receive as much audience as possible.” Portuguese participants referred to “targeted messaging” to build “public acceptance.” One explained that “the concept of strategic communication helps to position the organisation in the public mind,” while another remarked that “strategic communication in the green transition is fundamental.”

### Key Takeaways

This chapter set out to examine where communicative interactions occur within engineering project contexts. It identified a wide range of interaction settings, spanning strategic planning, everyday workplace exchanges, external engagements, and public-facing communication. The findings demonstrate that:

- Strategic and planning interactions (e.g., communication plans, proposals, funding negotiations) provide structure and direction, aligning goals, responsibilities, and resources.
- Relationship-building exchanges—from informal conversations to trust-based networking—help establish collaboration before and during projects.
- Stakeholder engagement involves negotiating with managers, regulators, clients, financiers, and local communities to align technical objectives with social, political, and financial realities.
- On-site communication (e.g., problem-solving, design clarifications, contractor coordination) is characterised by immediacy, real-time dialogue, and solution-oriented exchanges.
- Cross-disciplinary collaboration requires tailoring communication styles to bridge gaps between engineers, scientists, lawyers, managers, and other professional groups.
- Conflict resolution and crisis communication demand proactive, clear, and often verbal exchanges to defuse tensions, address misunderstandings, and maintain project momentum.

- Documentation and record-keeping (e.g., protocols, contracts, compliance records) underpin accountability, transparency, and regulatory adherence.
- Workplace and organisational settings—such as informal office talk, proximity-based learning, training, and inter-departmental reporting—form important channels for everyday knowledge transfer.
- Remote and digital interactions (e.g., online meetings, virtual supervision) enable dispersed teams to collaborate but risk weakening interpersonal connections, especially for junior staff.
- External professional interactions occur through conferences, seminars, and industry forums, supporting knowledge exchange, networking, and technology transfer.
- Public and outreach communication involves adapting technical language for non-specialists, building acceptance, and promoting trust through events, announcements, and media engagement.

Table 2: Summary of Communicative Interactions Experienced by Engineers Working in the Field of “Green Transition” Technologies

<b>PROJECT-RELATED INTERACTIONS</b>	<b>Stakeholder Engagement in Projects</b>	<b>Compliance &amp; Regulatory Communication</b>	<b>Confronting Resistance</b>
<p><b>Strategic Communication &amp; Communication Planning Activities</b></p> <ul style="list-style-type: none"> <li>• Creating project-specific email addresses and distribution lists</li> <li>• Compliance with predefined guidelines and ERP systems</li> <li>• Developing structured project proposals</li> <li>• Establishing formal communication plans with goals, audiences, and channels</li> <li>• Adapting communication styles to different institutional cultures</li> </ul> <p><b>Planning Proposals</b></p> <ul style="list-style-type: none"> <li>• Emailing potential industry partners to secure letters of agreement</li> <li>• Preparing persuasive and budget-oriented proposals for funding and approvals</li> <li>• Conducting feasibility discussions with technology transfer offices and financiers</li> </ul> <p><b>Relationship-Building Interactions</b></p> <ul style="list-style-type: none"> <li>• Using phone calls instead of emails for quick updates</li> <li>• Informal networking (e.g., conference meetings, coffee-table discussions)</li> <li>• Direct in-person contact to build trust</li> <li>• Social gatherings beyond work to strengthen professional ties</li> </ul>	<p><b>Recognising &amp; Responding to Customer or Market Needs</b></p> <ul style="list-style-type: none"> <li>• Identifying customer expectations through early discussions</li> <li>• Conducting site visits for face-to-face meetings with clients</li> <li>• Analysing market trends</li> <li>• Translating customer needs into formal project plans</li> </ul> <p><b>Negotiating Financial &amp; Business Agreements</b></p> <ul style="list-style-type: none"> <li>• Financial negotiations with clients and stakeholders</li> <li>• Communicating investment needs and payment terms</li> <li>• Reporting to financiers on costs and schedules</li> </ul>	<ul style="list-style-type: none"> <li>• Monitoring and communicating legislative changes (e.g., EU Affairs expert tracking regulations)</li> <li>• Revising contracts in response to legal amendments</li> <li>• Engaging with regulatory bodies for permits and compliance</li> </ul> <p><b>Implementation, Installation, &amp; Start of Operation</b></p> <ul style="list-style-type: none"> <li>• Overseeing final installation phases (e.g., equipment calibration)</li> <li>• Providing step-by-step guidance to technicians</li> </ul> <p><b>Ongoing Support, Maintenance, and Troubleshooting</b></p> <ul style="list-style-type: none"> <li>• Coordinating with municipal staff to maintain infrastructure reliability</li> <li>• Ensuring timely feedback and issue resolution</li> </ul> <p><b>Technology Transfer and Commercialisation</b></p> <ul style="list-style-type: none"> <li>• Transferring innovations to industry partners for testing and refinement</li> <li>• Communicating new technologies effectively to decision-makers</li> <li>• Drafting invention declarations for patent applications</li> </ul>	<ul style="list-style-type: none"> <li>• Listening to stakeholders (e.g., landowners) before proposing changes</li> <li>• Providing targeted, context-sensitive communication to reduce opposition</li> </ul> <p><b>Crisis Communication and Damage Control</b></p> <ul style="list-style-type: none"> <li>• Providing transparent, immediate communication to prevent misinformation</li> <li>• Using confirmation and ongoing communication to manage urgent technical failures</li> </ul> <p><b>Project Progress Monitoring &amp; Reporting</b></p> <ul style="list-style-type: none"> <li>• Holding regular project meetings and sharing documented updates</li> <li>• Reporting financial and timeline progress to financiers and stakeholders</li> <li>• Using clear documentation to keep team members aligned.</li> <li>• Conducting feasibility evaluations for financial viability</li> </ul> <p><b>Contractor-Engineer Coordination</b></p> <ul style="list-style-type: none"> <li>• Maintaining positive relationships with site personnel</li> <li>• Supervising contractor activities and ensuring clarity of responsibilities</li> <li>• Coordinating subcontractors and suppliers on resource needs</li> </ul>

<p><b>Resolving Design &amp; Construction Issues</b></p> <ul style="list-style-type: none"> <li>• Coordinating multiple specialist perspectives (architectural, technical, environmental)</li> <li>• Clarifying design details with stakeholder: (e.g., road designers, clients)</li> <li>• Using direct, real-time interactions (e.g., phone calls) to resolve discrepancies</li> </ul> <p><b>Cross-Disciplinary Team Collaboration</b></p> <ul style="list-style-type: none"> <li>• Sharing knowledge across disciplines (e.g. physics, electrochemistry, material science)</li> <li>• Adapting communication styles for different professional disciplines</li> <li>• Collaborating with legal experts on patents and regulatory matters</li> </ul> <p><b>On-Site Problem-Solving Discussions</b></p> <ul style="list-style-type: none"> <li>• Attending formal and informal site meetings to address issues</li> <li>• Speaking directly with site teams (e.g., rebar-fixers) to ensure practicality</li> <li>• Conducting on-site inspections for real-time troubleshooting</li> </ul> <p><b>Project Conflict Resolution</b></p> <ul style="list-style-type: none"> <li>• Using phone calls instead of emails to defuse tensions</li> <li>• Balancing cost and quality expectations in negotiations</li> <li>• Addressing disputes caused by unclear messaging or delayed communication</li> </ul>	<p><b>Keeping Written Records of Communication</b></p> <ul style="list-style-type: none"> <li>• Documenting meeting outcomes in jointly written protocols</li> <li>• Using emails to create digital trails for accountability</li> <li>• Recording agreements through official letters</li> </ul> <p><b>Legal Documentation &amp; Clarification of Contractual Obligations</b></p> <ul style="list-style-type: none"> <li>• Using phone calls before written communication for sensitive matters</li> <li>• Ensuring explicit contractual terms to clarify responsibilities</li> <li>• Managing different forms of contractual relationships</li> </ul> <p><b>WORKPLACE AND ORGANISATIONAL INTERACTIONS</b></p> <hr/> <p><b>Informal Interactions</b></p> <ul style="list-style-type: none"> <li>• Unplanned discussions in workplace settings (e.g., “coffee kitchens”)</li> <li>• Knowledge transfer through workplace proximity and observation</li> <li>• Learning communication habits from senior engineers</li> </ul> <p><b>Training and Knowledge Transfer</b></p> <ul style="list-style-type: none"> <li>• Mentorship from senior to junior staff</li> <li>• Maintaining written records to document project continuity</li> </ul>	<p><b>Internal Data Sharing Across Departments</b></p> <ul style="list-style-type: none"> <li>• Reporting project progress via structured reports and email updates</li> <li>• Coordinating resources and assessments between departments</li> </ul> <p><b>Remote Work-Related Interaction and Supervision</b></p> <ul style="list-style-type: none"> <li>• Conducting virtual meetings for supervision and mentoring</li> <li>• Addressing challenges of remote work (e.g., lack of casual face-to-face interactions)</li> </ul> <p><b>Clarifying Team Goals and Aligning Project Objectives</b></p> <ul style="list-style-type: none"> <li>• Holding meetings and discussions to align on objectives</li> <li>• Using kickoff meetings to define project scope, timeline, and roles</li> </ul> <p><b>EXTERNAL AND PUBLIC-FACING INTERACTIONS</b></p> <hr/> <p><b>Scientific and Technical Community Interactions</b></p> <ul style="list-style-type: none"> <li>• Presenting research findings at conferences and workshops</li> <li>• Publishing research in accessible formats for different audiences</li> <li>• Engaging in knowledge-sharing within academic and professional communities</li> </ul>	<p><b>Professional Networking, Industry Conferences, and Technical Seminars</b></p> <ul style="list-style-type: none"> <li>• Updating industry experts on project findings at professional events</li> <li>• Tailoring presentations to audience expectations</li> </ul> <p><b>Educating the Public and External Communication</b></p> <ul style="list-style-type: none"> <li>• Announcing innovations through public celebrations and demonstrations</li> <li>• Conducting outreach programs and simplifying scientific language</li> <li>• Using social media and targeted messaging to increase public acceptance</li> <li>• Engaging with communities to reduce opposition to project.</li> </ul>
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## 5. Means of Communication

To get a fuller picture of these communicative interactions requires an understanding of the means of communication itself—what particular text types, or channels, tools or media do engineers engage with in the process of these interactions. Research shows that engineering workplaces value different types of texts and communication practices (Winsor, 2003) and that engineers of all levels must be able to utilise various modalities, including face-to-face, written, and technological means (Almeida et al., 2021). Studies highlight the importance of different forms of oral communication, including presentations and small group interactions (Darling & Dannels, 2003; Vest et al., 1995) as well as written communication and the use of online tools (Howard et al., 2017), while instructional textbooks such as House et al.'s (2017) *The Engineering Communication Manual* emphasises the importance of mastering real-world engineering genres (House et al., 2017). This part of the report details the range of communication means employed by engineers in the course of their work and how these relate to their project objectives.

The items reported here are connected—sometimes very closely—to those in Chapter 0 (Communicative Interactions). However, for the purpose of this report and its subsequent contribution to the development of task-based learning activities, it is important to recognise that, while these may represent overlapping concepts, they do so through different lenses. It is clear that certain communicative interactions will be strongly associated with specific means of communication (for example note taking, record keeping or informal discussions), but whether, in a teaching setting, this activity is seen through the lens of an engineering task or through the lens of a language or communication-focused task will depend largely on the teaching context, and this will influence the way it is introduced and implemented as a classroom activity.

A summary of all means of communication detailed in this research is provided in Table 3 at the end of this chapter.

### 5.1. Spoken Communication

#### 5.1.1. Meetings (Face-to-Face, Online, Site Meetings, Interviews)

Meetings, whether face-to-face or online, are used as a means of communication, coordination, and decision-making across different contexts. The data indicate that the format of meetings is shaped by both practical considerations and the type of communication involved.

Structured and routine meetings support ongoing communication and coordination. Data from engineers in Austria describes *jour fixe* meetings as a scheduled opportunity for stakeholder engagement: “So I have regular *jour fixes* with everyone anyway, and depending on when

the Ecodesign regulatory work was timely again, I would then mention it at the next possible appointment.” Similarly, engineers in Poland referred to structured meetings as useful for addressing complex issues, building relationships, and facilitating quick information exchange.

Smaller and more flexible meetings are used when immediate action or detailed discussion is required. Participants working in Austria explained that one-on-one or small-group meetings help maintain progress and address delays: “If it still takes longer or the progress is not sufficient to be ready on time, I set up individual meetings.” Engineers in Portugal also described meetings as opportunities for clarification and reinforcement: “In the end, any conversation or meeting is an opportunity to clarify doubts. When people have a safe space to ask questions, we can adjust and reinforce the message.”

Online meetings are described as efficient and accessible, particularly for geographically dispersed teams. Engineers in Finland reported that “meetings are held mostly online, for example in Teams,” reflecting the normalisation of digital platforms. Yet, despite the growing use of online meetings, many accounts emphasise that some aspects of communication remain difficult to achieve online. Data from Ireland indicates the unique value of face-to-face engagement, particularly for trust-building and negotiations, asserting that “this is not the sort of engagement you can do by email or by Teams. This is something you need to do in person.” Engineers in Türkiye similarly remarked that while virtual meetings improve accessibility, they can also reduce interpersonal connections. Participants underscored the unparalleled efficacy of face-to-face meetings, with in-person interactions associated with clearer communication and stronger connections.

Context-specific meetings such as site visits and interviews also feature in the data. These are described as important opportunities for communication with clients and contractors, showing that, alongside structured and online formats, in-person encounters remain embedded in project practice.

### **5.1.2. Phone Calls**

Phone calls appear across the data as a means of communication valued for immediacy, efficiency, and direct, real-time engagement. They are described as effective in resolving issues quickly, coordinating projects, and reducing the inefficiencies of lengthy email exchanges. Phone calls are cited as a primary means of verbal communication alongside email. The Finnish report notes their prevalence in project-based work: “In projects, communication is often made by phone calls or email.”

More specifically, however, the value of phone calls was reported to lie in their capacity for quick clarification. The Horizon Europe (R&D) data highlights the importance of accessibility for quick problem-solving: “Yeah, but otherwise you can call him any time of the day on the

phone to clarify.” This suggests that phone communication serves as an informal yet efficient way to address questions as they arise. Similarly, the Irish data underscores the advantage of phone calls over email, particularly in situations where back-and-forth messaging can be time-consuming. One account states, “Many problems can often be resolved with a call, rather than a long chain of email correspondence with many participants copied in.” Another participant reinforces this by emphasising the efficiency of a quick call: “If you picked up the phone for a two-minute conversation, you could probably save 10 emails going back and forth.” Participants in Türkiye similarly highlighted their invaluable role in facilitating direct and immediate communication. These accounts indicate that phone calls are used to resolve questions rapidly and to avoid extended written exchanges, streamlining communication.

### **5.1.3. Informal Discussions**

Informal discussions are described in the data as a means of communication that facilitates relationship-building, trust development, and information exchange. These spontaneous conversations take place in workplace settings, casual social spaces, and unplanned interactions outside formal meetings, contributing to both collaboration and problem-solving.

One reported function of informal discussions is workplace feedback and early-stage idea-sharing. Austrian participants referred to casual workplace interactions “in coffee kitchens or something like that” as a way of identifying problems. Informal exchanges were also described as suitable for non-binding, exploratory conversations: “...it’s a pitch, it’s generally a non-binding exchange, I say...” Portuguese participants likewise acknowledged “informal talks” as a key communication channel alongside formal meetings, showing that unstructured discussions are recognised as part of professional practice. These accounts suggest that spontaneous conversations provide a low-pressure setting for generating and refining ideas.

Informal discussions are also associated with relationship-building and trust. Data from Ireland noted that professional relationships were developed by open communication between participants, most often verbally rather than by email. Polish data similarly emphasised the importance of personal interactions, with participants emphasising the importance of direct contact and personal interactions for building trust and understanding within teams, even in the digital communication era. Together, these accounts point to the role of informal discussions in strengthening networks and supporting complex exchanges.

In addition, informal discussions are reported in non-traditional settings. Finnish participants described “think tank at the gas station coffee table” as an example of an unconventional but effective space for stakeholder engagement. This illustrates that informal discussions are not confined to offices but can emerge in everyday locations where participants feel comfortable exchanging ideas.

Finally, the data also points to the need for balance and efficiency. Turkish participants noted the importance of keeping conversations concise and focused, particularly when discussing work-related matters outside of formal meeting settings. This suggests that while spontaneity and openness are valued, efficiency remains an important consideration.

#### **5.1.4. Presentations and Pitches**

Presentations and pitches are described in the data as verbal communication tools that support technical demonstrations, public engagement, and structured information sharing. They range from informal pitches and interactive demonstrations to formal PowerPoint presentations, oral hearings, and town hall meetings.

Presentations are frequently viewed as a structured means of communication. Austrian participants described the use of PowerPoint as a tool positioned alongside other formal channels for internal communication: “We have PowerPoints just like Intranet, articles, or small videos”, while Horizon Europe (R&D) data also referred to structured result-sharing meetings where presentations were linked to industry technology transfer: “We email [industry representatives], and those who find [our innovation] satisfactory, they reply to us, and they host some meetings with us [where] we present our results.” These accounts suggest that presentations contribute directly to decision-making processes. Presentations may also be used for public engagement. Finnish participants referred to oral hearings as a recognised communication method in engineering, while Romanian participants mentioned town hall presentations as a way of addressing larger audiences. These examples show that spoken presentations extend beyond workplace contexts to include stakeholder engagement and community outreach.

Beyond slide-based presentations, demonstrations were described as an important form of technical communication. Austrian participants referred, for example, to trade fairs as presentation settings, or to the use of test sites to provide hands-on demonstrations: “We have our own test site, also where we can do demos for customers and make it tangible.”

Presentations may also take on an informal, exploratory, pitch-like tone, suitable for early-stage discussions to introduce ideas before committing to further work. One Austrian participant described this form as “...it’s interactive, it’s verbal, it’s a pitch, it’s generally a non-binding exchange.”

Finally, the data points to the skill dimension of presentations. Polish participants emphasised that presentation skills include speaking to different audiences and situations and making comprehensible PowerPoint presentations. Audience adaptation is an important related consideration, with Austrian participants noting that tailoring technical detail is necessary

depending on the expertise of the presentation audience: “If there's a simple client sitting opposite who is sometimes overwhelmed by the overly detailed content.”

#### **5.1.5. Scientific Conferences and Symposia**

Scientific conferences, symposia, and related events are described in the data as formal communication channels for presenting research, engaging with academic and industry professionals, and disseminating project findings. These include national and international conferences, workshops, seminars, and poster sessions, which provide structured platforms for exchanging knowledge, promoting ongoing work, and connecting with peers in their disciplines.

One key function of these events is the dissemination of project-related information. Horizon Europe (R&D) data explicitly highlighted conferences as a medium for presenting research findings: “We have conferences of national interest. We have international conferences. And we have a task to talk about that project.” These events also incorporate multiple presentation formats to enable targeted discussion. Horizon Europe (R&D) participants described the inclusion of workshops, poster sessions, and special sessions: “And every conference we have some workshops or posters [or] special sessions with similar projects or things like that.” Turkish participants emphasised the role of symposia, congresses, workshops, and seminars, describing these as spaces for networking, knowledge-sharing, and the exchange of expertise between academic and industry professionals.

#### **5.1.6. Lectures and Classes**

Lectures and classes serve as structured communication settings for instructional presentations, academic teaching, and knowledge dissemination. These formalised environments facilitate the transfer of specialised knowledge, requiring tailored communication strategies to engage students at different levels of expertise.

One function of lectures and classes is their role in higher education and research communication. Horizon Europe (R&D) participants noted their significance within the research field: “Because people in the research field [...] will be having some teaching sessions, especially for bachelor's or master's students.” These structured instructional presentations serve as a mechanism for educating future researchers or practising engineers.

The data also emphasises the importance of adaptation in teaching contexts. Portuguese participants referred to informative lectures as an established academic communication channel and highlighted the need to adjust communication depending on the audience: “...it's very different when you talk with first-year students or when you give classes to PhD students. So, the way that you communicate [is important] when you start to talk with people that don't know anything about what you are talking about.”

## 5.2. General Written Communication

### 5.2.1. Email

Email serves as a fundamental written communication channel for outreach, formal documentation, stakeholder coordination, and project-related exchanges. It appears as a primary written tool in projects and a formal business channel, albeit alongside other channels. Finnish respondents reported: “In projects, communication is often made by phone calls or email”, and both the Turkish and Polish data positioned it alongside telephone, email, social media platforms like LinkedIn, and team-specific WhatsApp groups, indicating that while it remains dominant, it is increasingly integrated with other platforms.

Specific examples of email use include outreach, client communication, and formal project processes. Horizon Europe (R&D) participants described email as a primary outreach tool for engaging stakeholders. Polish participants noted its role in structured client interactions. An Austrian participant emphasised its use for communicating requests and deadlines: “And then write an email to the affected stakeholders with what the impact is if you don’t do it? What do I need from you? By when do I need it?” Email further functions as a means of accountability and documentation. Irish participants raised concerns about overuse and excessive copying practices, linking this to a “cover yourself” type of attitude so that in case a problem arose, the email could be brought out in case of a claim.”

At the same time, email communication was recognised as vulnerable to misinterpretation. As noted in the Finnish data, “Emails, for example, are at big risk of being misunderstood. The sender must define clearly what he/she wants the receiver to do.” This highlights the importance of precision and clarity in order to avoid confusion and misalignment.

### 5.2.2. Media Messaging and Communication Platforms

Digital communication platforms are described in the data as tools for project coordination, information exchange, and remote collaboration, integrating structured documentation systems with real-time messaging and virtual meetings.

A central role is remote collaboration, encompassing both synchronous and asynchronous interaction. Participants in the Turkish study identified online platforms such as WhatsApp, Zoom, or Google Meets as the most commonly used communication tools, while Irish participants identified Microsoft Teams (MS Teams) as dominant. The Finnish data referred to efficiency for geographically dispersed teams: “Meetings are held mostly online, for example in Teams, because it’s more efficient when participants are on different sides of the country.” Portuguese participants referred to “discussion forums” as a structured online medium. WhatsApp was mentioned in both Polish and Finnish data as a channel for quick project updates and small-

team coordination. Digital platforms also provide means for structured documentation and task tracking. Austrian participants reported: “As for what we use for documentation, internally it's Confluence and SharePoint. For external communication and for tracking work packages or tasks, we use Jira.”

Digital platforms form part of a multi-channel approach. The Polish study found that emails and reports provide formal documentation, while online meetings, phone calls, and communication groups like WhatsApp allow for quick information exchange. However, concerns about risks and limitations were raised. The Turkish focus groups referred to “the phenomenon of information pollution stemming from the utilisation of multiple platforms for communication concerning the same task or topic.” This suggests that while digital tools streamline communication, excessive reliance on multiple platforms can lead to inefficiencies and information fragmentation. Some Irish participants commented on the impact of digital communication, expressing a preference for verbal interaction over digital messaging.

### **5.2.3. Online Social Media**

Social media and online platforms are increasingly integrated into professional communication strategies, playing a role in public outreach, professional networking, and project visibility. Tools such as LinkedIn, company websites, and other channels enable real-time interaction, content sharing, and audience engagement.

Social media platforms are used for audience engagement and public communication. Portuguese participants described social media as both a communication tool and a medium for engaging with broader audiences. Romanian participants explicitly listed “Social Media and website posts” as formal communication tools in engineering contexts.

The data highlighted the importance of LinkedIn, in particular, as a professional communication tool. In Turkey, LinkedIn was positioned alongside traditional communication tools such as telephone and email, while in Finland, one respondent described how LinkedIn “has become a very popular communication channel” and emphasised its ability to reach wider audiences.

The data also pointed to the growing relevance of social media management skills. Finnish participants noted: “Nowadays it has become more and more important to manage social media and have skills for that. For example, project operators have to know the right hashtags to receive as much audience as possible.” This indicates that effective social media communication requires a strategic approach, leveraging platform-specific techniques to maximise visibility and engagement.

#### **5.2.4. Written Notes, Summaries, and Records**

Written documentation helps ensure clarity, accountability, and project continuity. From meeting notes and summaries to official confirmations, written records provide structure, serve as reference points for decision-making, and support legal and regulatory requirements. While documentation enhances transparency, the data also shows that written records must often be balanced with verbal discussion in complex situations.

A key function of written documentation is to confirm agreements and maintain alignment among participants. The Austrian data illustrate how real-time documentation during discussions helps secure consensus: “So we have that quite often. Just in Teams, it's practical because you can share your screen. Yes, and there's usually one, either for everyone or just for himself, writing down and says, ‘So are we agreed on that.’” This highlights that immediate written confirmation can enhance clarity and prevent misinterpretation. Meeting minutes and memos are commonly used to summarise discussions and capture outcomes. The Portuguese data referenced meeting minutes as a structured documentation method, while the Finnish data highlighted workplace meeting memos as essential records, ensuring that decisions and discussions are formally documented for future reference.

Written records are also central for project continuity and tracking agreements. The Polish data noted: “Written communication—such as meeting notes, reports, and emails—helps to document agreements and supports project continuity.” This illustrates how documentation functions as a stable reference point across ongoing projects. The importance of careful documentation in sensitive or legal contexts was emphasised in the Irish data: “Get it worked out before it goes in writing with anything legal or contentious. Make sure everyone's clear on what's going in writing before you put it in writing.” This highlights the need for precision and shared understanding before committing sensitive matters to record.

At the same time, one Austrian account acknowledged the limitations of formal records: “You make a long protocol and write a lot of things in it... But communication, which is necessary... can't be depicted in any protocol. But it's about saying what are the facts, what are my opinions, and how do I get to the heart of the matter?” This underscores that while documentation secures essential facts, it cannot replace the depth of verbal discussion.

### **5.3. Specific Written Genres**

#### **5.3.1. Reports**

Reports serve as essential written communication tools across professional, regulatory, and academic contexts, ensuring project documentation, compliance verification, funding

applications, and regulatory approval. They include project reports, compliance reports, progress updates, site inspection records, and persuasive technical documents.

One function of reports is to document project progress and share lessons learned. The Finnish and Romanian data cited progress reports as primary forms of written communication, while site inspection reports were identified as a means of formally recording project conditions and assessments. The Austrian data highlights project reports as a key output that not only records achievements but also influences stakeholders: “Lessons learned, project reports—yes, and if others then see this success, then they also want to jump on this train.” This highlights that well-documented successes can encourage the adoption of best practices and inform decision-making in similar projects.

Compliance reporting is another function of formal documentation. The Austrian data describes the parallel processes involved in compliance and progress reporting: “So I have this report monitoring or progress monitoring, in principle, and in parallel, I create and complete this compliance report for each product.” Another account confirms the submission process: “When the Compliance Report is completely ready, then it gets sent to the appointed authority, i.e., Certification Body.” These examples illustrate that compliance reports serve as an official requirement for regulatory approval and reinforce adherence to industry standards.

Reports are also used to persuade planning and funding authorities. The Irish data highlights the contrast between academic and professional report writing, emphasising the need for structured, persuasive communication: “The reports we wrote in college were just two-line paragraphs, very factual. There was nothing. There was no storytelling, and I think that was very much something I ended up learning on the job reading other reports.” Another account stated: “We’re... trying to get people who can write reports to the extent that... convincing a planning authority to grant permission or convincing a funding authority to provide funding.” These insights highlight that professional engineering reports must go beyond factual reporting to include strategic framing and argumentation.

### **5.3.2. Formal Letters**

Formal letters play a role in formalising agreements, documenting project commitments, and structuring official correspondence. They are used, for example, for collaboration agreements and letters of intention, ensuring clarity and accountability, even if they may not carry the legal status of contracts and formal agreements discussed below.

A central function of formal letters is to establish and confirm professional agreements. The Horizon Europe (R&D) data explicitly referenced collaboration letters as a formalised means of securing project partnerships, serving as official records of mutual commitments within structured project documentation. The Romanian data similarly highlighted the use of letters of

intention, showing that formal letters function as recognised and structured methods of communication in engineering and business interactions. These letters act as preliminary agreements that outline intent before a contract is finalised, ensuring that key stakeholders are aligned before formally committing to a project.

### **5.3.3. Legal and Regulatory Texts**

Legal and regulatory texts play a role in project execution, compliance, and governance, providing the framework within which professionals must operate. These documents—including legislation, permits, Freedom of Information (FOI) requests, and regulatory documentation—serve as binding guidelines that must be reviewed, adhered to, and in some cases, acted upon.

A key function of legal texts is their role in shaping industry regulations and ensuring compliance. The Austrian data highlights the iterative process of reviewing and adapting to legislation before it becomes law: “And in the last meeting—I also regularly ask [our EU affairs expert] about this topic—he told me that we were already informed years ago that [a specific EU regulation] was coming, and he assured me that by the end of April the final draft text would most likely be available, which will then also be enacted into law.” This underscores how regulatory developments require long-term monitoring and adaptation. The same respondent emphasised the need for professionals to interpret legislative texts according to their own expertise: “I then look at the legislative text, since [our EU affairs expert] can't fully assess its full impact on my field. So, he only looks at it in broad terms, but I go through it in detail and examine what the exact impact on our portfolio is.” This highlights that while broad guidance exists, detailed professional interpretation is often necessary.

Legal and regulatory compliance may also involve securing permits and certification before project execution. The Turkish data explicitly referenced permits as part of regulatory documentation: “Controller – Permits,” while the importance of meeting official compliance certification requirements was mentioned across both Austrian focus groups. This highlights that working with official documents pertaining to certification and authorisation is a fundamental step in ensuring that projects meet legal standards.

Compliance also extends to public transparency and record-keeping. The Irish data emphasised the significance of Freedom of Information (FOI) requests: “The other thing... was the extent of Freedom of Information requests, and we were absolutely bombarded with FOI requests in one location where every piece of correspondence, every site photo, every mention of their name, their location, anything had to be provided by us.” This illustrates the need for careful documentation, with records potentially being subject to public disclosure in the future.

#### 5.3.4. Contracts and Formal Agreements

Contracts and formal agreements are central written tools in professional and engineering settings, providing clarity, accountability, and legal protection in collaborations. While they share similarities with legal and regulatory texts in their formal status and binding authority, they differ in that they are drafted to regulate relations and obligations between parties rather than to enforce statutory requirements. These documents—ranging from tender materials and technology agreements to nondisclosure agreements (NDAs), official letters, and formal contracts—structure communication between stakeholders, define responsibilities, and record commitments.

A key communicative function of contracts lies in structuring procurement exchanges and documenting requirements. The Austrian data described how competitive bidding involves formal written requests and responses: “We have contact with several companies, and typically I proceed like this: I write them an email, please give me a quote, that's the order, and the one with the best price-performance ratio gets the contract and is commissioned.” Another Austrian account emphasised the role of tender materials in specifying customer requirements: “Or we have a lot of tender material, which states what we need to fulfil, which customer wishes.” These examples show how procurement depends on written exchanges—such as quotations and tenders—that both document expectations and lead to contracts as the formalised outcome of these communications. Tenders in particular serve as binding documents that ensure project deliverables align with contractual obligations.

Contracts also function as instruments of confidentiality and information security. The Horizon Europe (R&D) data referenced the selective use of NDAs, stating: “Uh, because you cannot sign an NDA with everyone you work with, it's impossible.” NDAs are recognised as legal communication tools but are applied selectively, balancing confidentiality with practical collaboration.

In engineering and technology collaborations, contracts and agreements also formalise partnerships. The Polish data referenced technology agreements as structured documents governing engineering collaborations, particularly in civil engineering projects. Similarly, the Romanian data cited contracts as a key form of written communication in engineering, confirming their role in documenting professional commitments.

#### 5.3.5. Project Proposals

Project proposals serve as formal documents used to justify approval, establish partnerships, secure funding, and align stakeholders on objectives and feasibility. Contracting authorities and potential industry project sponsors were identified in the data as key stakeholders in project acquisition, with written proposals described as central to securing support.

These submissions require clear justifications, supporting data, and well-defined milestones. The Portuguese data emphasised the need for detailed documentation to gain stakeholder agreement: “...but in the beginning, the stakeholders needed a lot of justifications in order to agree with a certain project in a certain area. They needed numbers, they needed milestones. Now we also need these milestones in order to apply to the project...” A participant from the Irish focus groups described the importance of persuasive writing when “convincing a funding authority to provide funding.” Proposals may also draw on input from project sponsors. The Horizon Europe (R&D) data explicitly referenced the presentation and submission of draft proposals to potential industry partners: “So we presented our proposal, which we are planning to apply to the committee, and they gave their own suggestions.” These accounts show that proposals operate within structured approval processes and often involve both written and oral presentations to decision-making bodies.

### **5.3.6. Scientific Papers and Articles**

Scientific papers and articles serve as a key medium for disseminating research findings, technical knowledge, and academic insights to both specialised and interdisciplinary audiences. These publications, including peer-reviewed papers, technical reports, and academic studies, contribute to knowledge dissemination, professional development, and cross-disciplinary engagement.

A central function of scientific articles is their role in structured knowledge sharing. The Austrian data explicitly highlights these publications as primary channels for communicating and for gaining insights into research findings. One account from an innovation manager described how technology screening—keeping up to date with technological developments for the purpose of potentially integrating these technologies into industrial and commercial products—“happens through articles, through studies, scientific works, and the like.” This confirms the continued role of formal written outputs in ensuring that research findings remain accessible to both scientific and professional communities.

Scientific publications were also described as pedagogical tools for a diverse readership. One Horizon Europe (R&D) account emphasised the importance of writing for interdisciplinary audiences: “Writing a publication is more like informative or pedagogic because that should be read by not only the chemist, maybe pharmacists, maybe, I don’t know, technologists, engineers, doctors, physicists.” This highlights the expectation that scientific writing should be clear and adaptable enough to reach across disciplinary boundaries.

However, in describing the decision-making process behind publishing research, one Horizon Europe (R&D) participant portrayed publishing research findings as a back-up option in the event that a particular scientific innovation cannot be patented. “we can say ‘this is not so innovative’, so we publish, but if you think that you can patent, then what we write is something

called the declaration of invention” suggesting that, at least in R&D circles, ideas may be shared openly through scientific publication only when not being pursued for patenting.

### **5.3.7. Declaration of Invention**

A declaration of invention serves as a formal document used to identify and evaluate potentially patentable innovations, ensuring they are officially recorded within the patenting process. This document plays a crucial role in intellectual property protection by providing a structured mechanism for assessing the novelty and commercial viability of new inventions.

The Horizon Europe (R&D) data explicitly described the declaration of invention as a required step in patent evaluation: “For me, every time that I have something that is potentially patentable, ... then what we write is something called the declaration of invention.” This shows that before a patent application can be pursued, innovations must first be formally documented and reviewed to determine their eligibility. Declarations of invention, therefore, function both as legal safeguards and as decision-making tools, helping researchers and organisations assess whether an innovation should proceed to patenting or instead be shared through other channels, such as scientific publications.

### **5.3.8. Marketing Materials**

Marketing materials play a role in external communication, publicising initiatives, and promoting products or services through formats such as advertisements, articles, company websites, and targeted campaigns. These materials extend beyond technical publications, functioning as strategic tools to engage broader audiences, enhance visibility, and support sales and outreach efforts.

The Austrian data acknowledged advertising as part of sales and external engagement: “And that is I still believe also the task of sales, but then also the communication again with, with articles, with advertising, with not necessarily scientific works.” This highlights the distinction between scientific publications, which focus on knowledge dissemination, and marketing outputs, which are oriented toward promotional outreach.

Targeted marketing was also emphasised as a key approach. The Portuguese data referenced advertising and tailored efforts as essential channels for promoting initiatives and reaching specific audiences. This suggests that marketing strategies are not limited to broad public engagement but also include focused messaging for specific stakeholder groups.

Digital platforms are increasingly central to marketing communication. The Finnish data highlighted direct marketing strategies, particularly through company websites: “Marketing directly to customers / generally. For example, company website ...” Company websites and

digital platforms therefore serve as primary channels for customer engagement, promotional content, and organisational visibility.

While the design of marketing materials may not be a direct task for all engineers, maintaining effective communication with sales and marketing colleagues—and the ability to frame scientific or technical knowledge for use in promotional contexts—was described as an important boundary-crossing competency.

## Key Takeaways

This chapter set out to examine the main means of communication used by engineers and researchers in the context of green transition projects. It identified a broad range of spoken and written forms, from everyday workplace talk to formal documents, each serving distinct functions in coordination, decision-making, knowledge-sharing, compliance, and public engagement. The findings demonstrate that:

- Spoken communication remains central, with meetings, phone calls, and informal discussions facilitating coordination, trust-building, and rapid problem-solving.
- Meetings—both face-to-face and online—serve as structured forums for updates, negotiations, and decision-making, with in-person formats particularly valued for trust-building and sensitive exchanges.
- Phone calls and informal conversations complement formal channels, providing quick clarification, relationship-building, and early-stage idea sharing.
- Presentations, pitches, and demonstrations translate technical content for different audiences and contexts, from industry stakeholders to the general public.
- Conferences, symposia, and lectures provide formal platforms for disseminating research, engaging peers, and supporting teaching and knowledge transfer.
- Written communication ensures accountability and continuity, with email as a dominant tool for coordination, though risks of overload and misinterpretation were noted.
- Digital platforms (e.g., MS Teams, WhatsApp, Confluence, Jira) integrate real-time interaction with documentation, supporting remote collaboration but also risking fragmentation when multiple channels overlap.
- Social media, especially LinkedIn, has become a standard professional tool, used for visibility, networking, and outreach to wider audiences.
- Written records (notes, summaries, minutes, memos) secure agreements and support project continuity, balancing immediacy with the limitations of formal records.
- Specialised written genres—such as reports, proposals, scientific papers, and invention disclosures—play critical roles in documenting progress, securing approvals and funding, disseminating knowledge, and managing intellectual property.

- Legal and contractual texts (contracts, formal letters, permits, regulatory documents) underpin project governance, formalising obligations, commitments, and compliance requirements.
- Marketing materials provide a complementary channel, reframing technical and scientific content into accessible formats for public and commercial audiences.

Table 3: Summary of Means of Communication Employed by Engineers Working in the Field of “Green Transition” Technologies

<p><b>SPOKEN COMMUNICATION</b></p> <p><b>Meetings</b></p> <ul style="list-style-type: none"> <li>• Face-to-face meetings (preferred for relationship-building, trust, and complex discussions)</li> <li>• Online meetings (efficient for geographically dispersed teams, commonly held via Microsoft Teams)</li> <li>• Jour fixe meetings (routine stakeholder engagement meetings in Austria)</li> <li>• One-on-one or small-group meetings (for quick resolution of project issues and progress monitoring)</li> <li>• Site meetings (discussions held on-site with contractors, technicians, and project teams)</li> <li>• Client interviews (face-to-face discussions with clients)</li> </ul> <p><b>Phone Calls</b></p> <ul style="list-style-type: none"> <li>• Direct phone calls (preferred for quick problem resolution and coordination)</li> <li>• Project coordination calls (with engineers, contractors, project partners)</li> <li>• Emergency/urgent calls (used when immediate attention is needed)</li> <li>• Follow-up calls (clarifying doubts or reinforcing agreements)</li> </ul> <p><b>Informal Discussions</b></p> <ul style="list-style-type: none"> <li>• Spontaneous office discussions (e.g., "coffee kitchen" conversations)</li> </ul>	<ul style="list-style-type: none"> <li>• Hallway or workplace stand-up meetings (quick exchanges on project progress)</li> <li>• Casual networking settings (e.g., "think tank at the gas station coffee table")</li> <li>• On-site informal discussions (engineers discussing issues directly with contractors)</li> </ul> <p><b>Presentations and Pitches</b></p> <ul style="list-style-type: none"> <li>• Informal pitches (interactive and non-binding discussions of ideas)</li> <li>• PowerPoint presentations (used in structured business / technical meetings)</li> <li>• Client result-sharing meetings (structured discussions presenting project outcomes)</li> <li>• Technical demonstrations (test sites for hands-on customer demos)</li> <li>• Trade fair presentations (showcasing new technologies)</li> <li>• Town hall presentations (for stakeholder engagement)</li> </ul> <p><b>Scientific Conferences and Symposia</b></p> <ul style="list-style-type: none"> <li>• National and international conferences (formal presentation of research findings)</li> <li>• Workshops and poster sessions (interactive academic discussions)</li> <li>• Industry symposia, congresses, and seminars (structured forums for knowledge-sharing)</li> </ul>	<p><b>Lectures and Classes</b></p> <ul style="list-style-type: none"> <li>• University lectures and teaching sessions (for Bachelor's, Master's, and PhD students)</li> <li>• Workshops for professional development (teaching specialised engineering knowledge)</li> <li>• Guest lectures in industry or academia (knowledge exchange across sectors)</li> </ul> <p><b>GENERAL WRITTEN COMMUNICATION</b></p> <p><b>Email</b></p> <ul style="list-style-type: none"> <li>• Stakeholder outreach emails (engaging industry partners and clients)</li> <li>• Request and deadline emails (clarifying expectations and due dates)</li> <li>• Compliance review emails (structured communication for regulatory reporting)</li> <li>• Accountability emails (used in "cover yourself" practices to document agreements)</li> <li>• Project coordination emails (with project partners, engineers, and clients)</li> </ul> <p><b>Media Messaging and Communication Platforms</b></p> <ul style="list-style-type: none"> <li>• Microsoft Teams (MS Teams) (common for online meetings and internal chats)</li> <li>• WhatsApp (used for quick project updates)</li> <li>• Jira (for tracking work packages and tasks)</li> </ul>	<ul style="list-style-type: none"> <li>• Confluence and SharePoint (internal documentation platforms)</li> <li>• Discussion forums (structured online discussion platforms for professional collaboration)</li> <li>• Zoom, Google Meet, and LinkedIn Messaging (commonly used for digital interactions)</li> </ul> <p><b>Online Social Media</b></p> <ul style="list-style-type: none"> <li>• LinkedIn (professional networking, company updates, project visibility)</li> <li>• Company websites (used for direct marketing and customer engagement)</li> <li>• Social media engagement (promoting initiatives using targeted messaging)</li> <li>• Hashtag-based outreach (leveraging social media algorithms for visibility)</li> </ul> <p><b>Written Notes, Summaries, and Records</b></p> <ul style="list-style-type: none"> <li>• Meeting notes and minutes (formal documentation of discussions and agreements)</li> <li>• Decision confirmation notes (real-time written agreements in Teams)</li> <li>• Project tracking memos (internal updates on progress)</li> <li>• Legal documentation summaries (ensuring clarity in contentious matters)</li> <li>• Public infrastructure records (official letters and compliance documentation)</li> </ul>
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<b>SPECIFIC WRITTEN GENRES</b>			
<p><b>Reports</b></p> <ul style="list-style-type: none"> <li>• Project reports (documenting lessons learned and progress updates)</li> <li>• Compliance reports (submitted to certification bodies for approval)</li> <li>• Funding applications and planning reports (for convincing planning authorities)</li> <li>• Progress reports and site inspection reports (documenting on-the-ground project status)</li> <li>• Research and technical reports (structured documentation of engineering findings)</li> </ul> <p><b>Formal Letters</b></p> <ul style="list-style-type: none"> <li>• Collaboration letters (formalising project partnerships)</li> </ul>	<ul style="list-style-type: none"> <li>• Letters of intention (preliminary agreements before formal contracts)</li> <li>• Official letters (tangible records of agreements and project commitments)</li> </ul> <p><b>Legal and Regulatory Texts</b></p> <ul style="list-style-type: none"> <li>• Legislative documents (tracking new industry regulations)</li> <li>• Freedom of Information (FOI) requests (handling public inquiries about project records)</li> <li>• Permits and compliance documentation (ensuring regulatory approval)</li> </ul> <p><b>Contracts and Formal Agreements</b></p> <ul style="list-style-type: none"> <li>• Procurement contracts (formalised selection of suppliers)</li> <li>• Non-disclosure agreements (NDAs) (securing confidentiality in business agreements)</li> </ul>	<ul style="list-style-type: none"> <li>• Tender materials (outlining project specifications and client requirements)</li> <li>• Technology agreements (formalising engineering collaborations)</li> </ul> <p><b>Project Proposals</b></p> <ul style="list-style-type: none"> <li>• Funding applications (submitted to financial institutions and committees)</li> <li>• Stakeholder approval proposals (detailed justifications and milestone-based planning)</li> <li>• Scientific Papers and Articles</li> </ul> <p><b>Peer-reviewed research papers (disseminating scientific findings)</b></p> <ul style="list-style-type: none"> <li>• Technical articles (explaining engineering and technological advancements)</li> <li>• Innovation and technology screening reports (documenting market-relevant technologies)</li> </ul>	<p><b>Declaration of Invention</b></p> <ul style="list-style-type: none"> <li>• Patent documentation (formalising potentially patentable innovations)</li> <li>• Innovation records (used in internal review before deciding on publication or patenting)</li> </ul> <p><b>Marketing Materials</b></p> <ul style="list-style-type: none"> <li>• Company advertisements (promoting engineering services and products)</li> <li>• Website articles (publicising technological advancements)</li> <li>• Targeted marketing efforts (tailoring messaging for industry and public engagement)</li> </ul>

## 6. Communication Networks

Engineering projects in any area rarely rely on a single “source–recipient” exchange of information. Instead, they operate through communication networks in which engineers connect with—and navigate between—multitudes of stakeholders, each bringing distinct priorities, knowledge levels, and decision-making power (See, for example, Wright, 2015). These networks extend internally, where design engineers, project managers, and technicians exchange specialised technical data, and externally, as they interface with regulators, local communities, funding agencies, or end users. The diversity of communication partners—ranging from subcontractors on a building site to policymakers who shape legal frameworks—demonstrates that the success of any green innovation hinges on well-structured communication linkages rather than isolated conversations. When these networks function effectively, engineers can reconcile complex environmental standards with on-the-ground realities, ensuring projects are not only technically feasible but also socially and politically supported.

This chapter does not seek to perform a complete communication network analysis (cf. Rogers & Kincaid, 1981), but it does recognise the importance of communication networks and seeks at the least to identify who the key players are within the communication network(s) of “green transition” engineering and to ascertain how engineers engage with these actors.

A summary of all communication partners detailed in this research is provided in Table 4 at the end of this chapter.

### 6.1. Technical Communication Partners

#### 6.1.1. Design Teams

The engineers in our focus groups communicate with a range of design team members who consolidate information and translate project requirements between different parties. In the Austrian data, architects are described as central figures in design communication: “The architect has to communicate with all those involved because they ultimately collate the information and map it in a plan.” This indicates the architect’s role in coordinating inputs from different actors and mapping them into a coherent design plan. Architects also manage differing priorities, as illustrated by one account: “The client expresses his wishes, and then the specialist planner certainly sees the quality from a completely different perspective.” Here, the architect is positioned between client expectations and technical constraints, mediating across perspectives.

Intermediary figures such as architects working in translation roles and system designers also appear as communication partners. One account explained: “We actually have a crew that

translates these customer wishes into technology language,” indicating how customer expectations are reformulated into structured engineering requirements. The Irish data reinforces the architect’s role as an external point of contact for professionals navigating interactions beyond their immediate teams and also refers to design engineers as part of this communication landscape, highlighting that communication extends across both design and technical roles.

Specialist technical experts are another group with whom engineers interact during project design and planning. The Austrian data mentions specialist planners, who bring a perspective distinct from that of clients by focusing on feasibility and technical constraints. The Polish and Portuguese data refer to civil engineers and road designers in defining infrastructural requirements, indicating how communication extends to sector-specific expertise. The Finnish and Romanian data mention environmental and mechanical engineering consultants as figures involved in assessing sustainability, environmental impacts, and system feasibility. In Romania, consultants are specifically described as responsible for needs assessment, showing how their input shapes project decisions before implementation begins.

### **6.1.2. Technical Suppliers**

The data showed that engineers communicate with technical suppliers across several stages of project delivery. Procurement is one key area, with the Polish data referencing a “Chairman request for product quotation” and the Finnish data pointing to “subscribers and suppliers” involved in contractual arrangements. The Turkish data similarly records “Supplier Sales representatives” as communication partners, highlighting the commercial side of procurement discussions.

Suppliers are also present during delivery and installation. Mentions in the Polish data of “producer, supplier” in relation to installations indicate that engineers work with suppliers to integrate technical components into projects and ensure compatibility with design requirements. This extends beyond physical equipment, as the Finnish data also refers to software suppliers, showing that engineers engage with providers of digital products and services alongside hardware.

In some cases, engineers must clarify how products are to be applied. The Horizon Europe (R&D) data describes situations where suppliers did not initially recognise the relevance of their equipment: “But this happened to me also when I talk to companies that produce equipment for my field, sometimes they don’t see the interest of their equipment.” Such accounts suggest that engineers may need to explain technical applications and align supplier understanding with project needs.

### 6.1.3. Technical Implementation Roles and Subcontractors

The data identifies site engineers, contractors, subcontractors, technicians, and other on-site personnel as key communication partners in project implementation. Their role involves coordinating with architects, designers, and clients to ensure that construction, installation, and technical processes meet project requirements.

One area of interaction concerns the transition from design to execution. The Austrian data places executors in the bidding phase, noting: “I have now taken the design phase, I would also have executors in there. So, so to speak, when they submit an offer... they will then go to the architect, to the client.” This indicates that implementers engage in dialogue not only when carrying out work but also at earlier stages, aligning their responsibilities with design specifications and client expectations.

Another recurring theme is on-site coordination. The Irish data emphasises the importance of direct communication with site personnel: “I like to maintain positive relationships with anyone that I'm dealing with on site because the people that I deal with on site, they're not always the higher ups....like you're dealing with site engineers, they're on the ground every day.” Mentions of survey and site investigation contractors, MEP subcontractors, and other specialists reinforce that project execution often involves multiple teams working in parallel, requiring engineers to sustain communication across different technical groups.

Contractors also appear as partners in supervision and process execution. In the Polish data, contractors are recorded as part of construction oversight: “Supervision of construction processes... contractor.” Another account links contractors directly with designers: “Implementation of the process... contractor, designer.” These examples suggest that contractors communicate laterally with engineers and designers, ensuring that project plans are carried out as intended.

References from Portugal, Finland, and Türkiye expand this picture, pointing to “implementing entities,” “loggers,” “other subcontractors,” “technicians,” and “field engineers” as additional partners in execution. These accounts highlight the breadth of technical specialists with whom engineers interact during implementation and illustrate the hands-on nature of communication at this stage of project delivery.

### 6.1.4. Production Facilities

The data identifies production facilities and their personnel as communication partners in engineering projects. These interactions focus on coordinating manufacturing processes and ensuring that engineering specifications are translated effectively into production.

The Austrian data refers to direct engagement with production staff, noting: “And then you have like a discussion with production line.” Similarly, the Romanian data records that “an engineer, at work, has to communicate with: ... production facility persons.” Both accounts point to engineers working closely with manufacturing personnel, suggesting that communication at this interface addresses the practical implementation of designs within production environments.

While not extensively represented across all datasets, these references suggest that production facilities form part of the wider communicative environment of green transition engineering. Dialogue with manufacturing staff allows engineers to address technical aspects of production, align processes with design requirements, and ensure that project outputs can be delivered effectively.

### **6.1.5. Industry Partners**

The data identifies industry partners as communication stakeholders in engineering projects, particularly in the contexts of research application, product commercialisation, and technical collaboration. These interactions link research and development to practical implementation, while also providing opportunities for funding, joint work, and process optimisation.

One recurring theme concerns the transition from research to application. The Horizon Europe (R&D) data notes: “Industry is, of course, an application of that research. For the application, they need industry because of funds... the industry can make this research to be applied.” This suggests that researchers and engineers depend on industry partners to move ideas from laboratory development into large-scale testing and eventual commercialisation.

A second set of examples highlights knowledge exchange and project monitoring. Horizon Europe (R&D) accounts describe engineers supplying materials or components for integration into industrial processes, with companies testing and assembling outputs. Communication in this context takes the form of structured meetings, such as one participant’s description of “meeting with the company, we present before them” at each stage of project progress. Another reference to “scientific officers” or “research officers” indicates that industrial partners may also provide oversight during technology adoption.

Beyond the R&D setting, sector-specific partnerships are also recorded. Portuguese data lists “Manufacturer” as an industry partner, while Finnish accounts mention a “Wind power company” and “Factories (purchasing timber from logging activities).” These references suggest that communication with industry extends across manufacturing, energy, and resource-based sectors, with interactions linked to procurement, collaboration, or process integration.

### 6.1.6. Technical and R&D Experts

The data records technical and research experts as communication partners in engineering projects, with exchanges focusing on data sharing, model development, and specialist discussions. These interactions support the refinement of technical processes, the adaptation of research findings, and the alignment of project outputs with expert knowledge.

The Horizon Europe (R&D) data describes collaboration with experts in process optimisation and modelling: “So it’s important for us that we always share the data with the colleagues, and from our data they build models, or they tell us, okay, your synthesis probably needs to be changed in this way.” This shows how technical discussions allow for iterative adjustments to methods and outputs.

Portuguese accounts point to communication among engineers in specialised areas such as energy transition, where a technical approach is sufficient within expert groups but needs to be adapted when engaging a more diverse audience: “If we’re talking among engineers, a technical approach is sufficient. But in energy transition projects, for example, where the audience can be diverse, we have to adapt the communication.” Another participant noted the ease of interaction when all members share the same disciplinary background: “Because if you are in a group of scientists that everybody speaks the same language and everybody studies the same subjects, it’s not difficult.”

Other references indicate the broader involvement of technical specialists. The Finnish data mentions industry experts, designers, and engineers, while the Turkish data refers to “Researchers” involved in “Information sharing” and “Experts” contributing to “Project technical content.” These examples indicate that technical specialists participate both in research-focused exchanges and in project-specific coordination, ensuring accuracy and feasibility in technical decision-making.

## 6.2. Business and Commercial Communication Partners

### 6.2.1. External Industry and Commercial Stakeholders

Engineers communicate with a range of external business actors, including representatives of companies, distributors, and carriers. These exchanges are described as focusing on decision-making, business development, and logistical coordination.

The Horizon Europe (R&D) data highlights engagement between technical experts and business representatives. As one participant explained, “the business guys, they seek for more like, ‘let’s connect more’.” This indicates that interactions with commercial stakeholders may emphasise networking and relationship-building in addition to technical collaboration.

In the Polish data, external companies are recorded as communication partners in project-related decision-making, including in “Establishing the scope of activities.” The Portuguese material lists “Companies, Distributors, Carrier” as partners, pointing to roles in procurement, distribution, or supply chain coordination. Similarly, the Finnish data refers to “Transportation companies” involved in “logistical aspects, such as schedules and deliveries,” indicating their contribution to operational workflows.

### **6.2.2. Sales, Marketing & Product Strategy**

Project accounts highlight the involvement of sales, marketing, and product strategy personnel in both technical and commercial contexts. Their participation is described in relation to market assessment, customer engagement, product promotion, and the alignment of technical developments with market requirements.

The Austrian data emphasises the role of marketing experts in assessing market viability. One participant explained: “We can roughly give a little estimation, but then of course it is needed to have experts making marketing inquiries.” This positions sales and marketing colleagues, or external partners, as responsible for market research to evaluate investment potential and commercial feasibility. Sales representatives are also identified as partners in commercial discussions. As one account noted: “So in, in, uh, in our case, uh, like one of the examples would be, you know, sales rep is taught to say some, some overall things, not understanding the physics itself.” This illustrates that while sales staff contribute to communication about products, their role does not always include technical expertise.

Coordination between sales and technical teams is further underscored in descriptions of regular information exchange. One engineer explained: “Again, parallel, I see then also the stream from sales. He must work towards the customer. I must always present the intermediate status to him.” Marketing and communications professionals are mentioned in connection with product launches and early customer engagement: “And to maybe still build in, when Marketing and Communications comes into play, typically when there is the first friendly customer who has accepted it.” These accounts suggest that marketing teams become involved once a product gains initial customer acceptance.

The Polish material records the “Marketing Director” as a communication partner when there is a “New product on the market,” with a need to communicate with “potential customers” to “solve the customer’s problem.” This positions marketing personnel in product positioning and direct customer interaction. Similarly, the Turkish data references “Supplier Sales Representatives” as actors in commercial communication related to product strategy and supply coordination, reinforcing the role of sales staff in business negotiations.

### 6.2.3. Customers / Clients / Commissioning Entities

Customers and clients are described as central communication partners in engineering projects, shaping priorities, influencing design decisions, and engaging with engineers to address technical challenges. Their involvement extends from the identification of needs to the final implementation, with communication directed at aligning technical solutions with user expectations.

Several accounts emphasise how clients define requirements with an emphasis on usability and functionality, often differing from the technical perspective of engineers and planners. As one Austrian participant noted: “On the one hand, [the architect] has a client who expresses his wishes and then a specialist planner who certainly sees the quality from a completely different perspective than the client.” Another added: “And that's what I sold to the customer... It's based on the fact that the client trusts that the architect knows what he's doing.” These accounts position clients as decision-makers who also depend on technical professionals to interpret and deliver their requirements.

Beyond goal definition, customers and commissioning entities feature as direct partners in technical problem-solving. The Horizon Europe (R&D) data records: “For me as a scientist or the engineers behind, usually if we work with customers, like for me, the main idea is to solve the problem, to achieve the solution.” Another participant explained: “One is, um, what are the customer requirements? How can I now, with this idea, with this potential that I see, fulfil or maybe even stir customer desires?” These descriptions highlight both responsiveness to client needs and the role of engineers in anticipating or shaping future demand.

Accounts also point to the settings in which client communication takes place. The Polish material mentions site visits as a way of recognising customer needs, while other entries describe face-to-face meetings for introducing new products or resolving technical issues. Portuguese and Romanian reports confirm that engineers interact routinely with final consumers, project owners, and clients. In the Turkish data, customers are described as recipients of project plans, underscoring their role in reviewing and approving technical documentation.

## 6.3. Administrative and Managerial Communication Partners

### 6.3.1. Project Management

Project managers are described as central figures in project coordination, acting as intermediaries between different stakeholders. Their role extends beyond logistical oversight to structuring communication, ensuring efficient execution, and addressing financial and strategic considerations.

Accounts describe project managers as communication interfaces rather than direct implementers. One Austrian participant explained: “Yes, usually a project manager is then added, who is also used here as a communication interface, so to speak.” Similarly, Irish data contrasts communication with project managers and on-site staff: “I’d say I definitely would have a different kind of communication with the project manager as I would to, like, someone who’s physically down on site tying rebar.” Finnish data emphasises the role of project managers in planning effective discussions: “The project manager should also plan the meetings, so that they would be the most effective, and not waste others’ time.” References to “Project management and personnel” and “Project leaders” further underscore their responsibility for structuring workflows and communication channels. The Turkish material adds a financial dimension, noting “Project Manager – Project costs” as a communication partner, which situates project managers in exchanges about budgeting and resource allocation.

### **6.3.2. Project Partnerships and Consortia**

Alongside project management, the data highlights project partners and consortia members as important communication counterparts. These exchanges are oriented toward establishing partnerships, coordinating expertise, and addressing project challenges. While often embedded in formal project structures, they are also shaped by informal networking and existing professional ties. Familiarity and trust emerge as foundations for partner selection. Horizon Europe (R&D) data records that partners “didn’t meet for the first time [...] they know each other from before or have very good recommendations for someone who you trust.” This illustrates how established credibility and prior collaboration influence partnership formation.

Communication within consortia is also described as a process of linking expertise to project needs. One Horizon Europe (R&D) participant explained: “So at the end, what I try to do through all the meeting and all the broad picture I have of the project to say to the people, hey, that group had this problem that they could not solve, so maybe your expertise might be functional to solving the problem, so connect with those.” This reflects a coordinating role in which project leaders facilitate connections between different groups. Such exchanges may take on an international dimension, as noted in another account: “We are used to communicating with Japanese and Americans and Swedish and South Africans, all the world.” This highlights the multinational scope of large-scale research and engineering projects.

References are also made to prospective partners. Turkish data identifies “potential partners” as possible collaborators, including “Civil society organisations” involved in project submissions. Formal coordination mechanisms are likewise noted, such as “project kickoff meetings” in the Turkish material and mentions of a “project team and target group” in the Finnish data, both pointing to structured approaches to team formation and communication.

### 6.3.3. Finance, Operations, and Logistics

Finance, operations, and logistics teams are identified as communication partners in engineering and project management, with exchanges centring on production coordination, financial oversight, and logistical efficiency. These interactions help align technical execution with regulatory requirements, operational constraints, and budgetary planning.

Production and logistics personnel are described as important counterparts in compliance and coordination. Austrian data states: “In this case, it's product management. Production and logistics are the relevant stakeholders.” This suggests communication focused on ensuring manufacturing processes meet industry standards while also managing material flow and scheduling. Turkish accounts similarly refer to “logistic units” as communication partners, pointing to the integration of supply chain considerations within project discussions.

Financial stakeholders also appear in the material as participants in planning and oversight. Finnish data mentions “financiers” as a stakeholder group, indicating communication around aligning budgets with project requirements. Romanian data identifies “quantity surveyors” as communication partners, highlighting their role in cost estimation and financial planning to support efficient allocation of resources.

### 6.3.4. Internal Management

The data highlights internal management as a key communication stakeholder in engineering and project contexts, with exchanges centring on decision-making, oversight, and alignment between technical work and organisational priorities. Engineers and project teams interact with different layers of management, including executives, directors, compliance teams, and supervisors, to coordinate execution, maintain accountability, and ensure consistency with company goals.

Communication with senior leadership is highlighted in the Austrian material. One participant explained: “I typically inform the CTO, CEO, and the EVPs (Executive Vice Presidents) of the affected organisational units in advance to inform them something is coming, it will have an impact.” Another described internal reporting as a means of ensuring accountability: “I report this to all stakeholders, including the top management executives in CC, to create pressure on the stakeholders to deliver.” These accounts suggest that communication with upper management both secures strategic alignment and reinforces project responsibility.

Maintaining coherence across departments is also presented as a reason for consulting management. Romanian data reflects the risks of bypassing these channels: “*In the beginning, I made mistakes by being too proactive, responding quickly to requests without consulting management, which sometimes created counter-information.*” This indicates that internal communication structures regulate information flow and prevent conflicting messages.

Mid-level management is described as overseeing both strategic and technical dimensions. Turkish references to “Technical manager/General manager/Senior management – Analysis, measurements” and “Head of Department, manager – Operating the system, performing analyses” show that managers are engaged in supervising technical activities while linking them to broader organisational objectives.

Supervisors and other internal figures are likewise identified. Romanian data explicitly lists “supervisors” as communication partners, while Irish accounts mention senior staff members, project managers, and compliance teams as part of the internal structure. Turkish material further specifies roles such as “Director – Creating the idea of the project / Expressing demands and needs” and “Executive – Schedules,” positioning managers as contributors to both project vision and timeline oversight.

### 6.3.5. Colleagues

Colleagues appear as routine communication partners in engineering and professional settings, with interactions occurring in both informal and structured environments. These exchanges serve multiple purposes, from sharing technical insights to addressing workplace challenges, reflecting the everyday importance of peer-to-peer communication.

Informal settings are described as a frequent context for workplace interaction. Austrian data notes that such exchanges often happen outside formal meetings: “This will probably happen in coffee kitchens or something like that.” Another Austrian account describes informal knowledge-sharing in technology screening: “And it has been shown very well that there are many technicians. Or even our lobbyist. He comes with inputs and will then take it up.” These examples indicate that casual conversations provide space for both problem-solving and contributions to innovation.

Colleagues are also recorded as partners in professional collaboration. The Polish data simply states, “colleagues because we cooperate,” emphasising the centrality of peer communication in project execution. Portuguese material highlights how this communication is shaped by shared technical knowledge, in contrast to external interactions: “I cannot use the language that I use with my colleagues. And this type of focus group is very important because we learn how to communicate.” Similarly, Finnish accounts emphasize the adaptation of language depending on audience: “Furthermore, when talking to colleagues or people in the same field, you can use professional language or business language, but when communicated to an ordinary audience you have to make your language more common style.” The Romanian data reinforces the fundamental role of colleague interactions in engineering work, stating that “an engineer, at work, has to communicate with: ... each other.” This underscores that peer communication is not limited to specific tasks but is a basic feature of daily professional practice, supporting collaboration, troubleshooting, and knowledge exchange.

### **6.3.6. Project Financing and Funding Bodies**

Project funding bodies are identified as important communication partners in engineering and research projects, with exchanges centring on securing financial support, meeting proposal requirements, and demonstrating project feasibility. These interactions help align project goals with funding criteria while addressing both technical and commercial viability.

Horizon Europe (R&D) data underscores the importance of engaging with funding bodies prior to proposal submission: “And we had a project where we must involve an industry or a company before submission of the proposal.” This indicates that approval processes often require partnerships with industry stakeholders, suggesting that communication with funding agencies extends beyond financial negotiation to include strategic alignment with broader research and commercial objectives.

The Polish material similarly identifies “project funding institutions” as partners in “project acquisition,” reflecting discussions focused on securing resources and ensuring eligibility for funding opportunities. Turkish accounts reinforce this by describing the role of “financiers” in assessing feasibility: “Financiers – Discussing the feasibility and originality of the project.” This highlights that communication with funding bodies involves not only financial backing but also evaluation of technical merit, innovation potential, and overall viability.

## **6.4. Legal and Regulatory Communication Partners**

### **6.4.1. Government Regulators & Policymakers**

Government regulators and policymakers emerge in the material as significant communication counterparts in engineering and infrastructure projects. Exchanges with these actors revolve around securing approvals, navigating policy frameworks, and ensuring that project plans comply with regulatory requirements. Stakeholders in this category include planning authorities, local and central governments, and regulatory bodies, whose decisions directly shape project feasibility and implementation.

Securing regulatory approval is described as a key focus of these interactions. Irish data highlights the persuasive dimension of communication with planning authorities: “These reports are very important because they have to be persuasive in terms of, you know, convincing a planning authority to grant permission or convincing a funding authority to provide funding.” This indicates that engineers and project managers must present projects in ways that address compliance, environmental considerations, and societal impact.

Political dynamics also influence these exchanges. As one Irish participant observed: “Now, politicians obviously are vulnerable to electorates... they may, in principle, at a county level,

be in favour of a project. But on a local level... they may have a local community that's entirely opposed to a project." This illustrates how communication with policymakers is shaped not only by technical content but also by political sensitivities and community concerns.

Local and national government entities are similarly noted for their involvement in defining project activities and ensuring regulatory compliance. The Polish material references "local administration" and "central policymakers" as stakeholders engaged in "agreeing on project activities." Finnish accounts mention "municipalities" and "authorities," pointing to their role in approving and overseeing project work.

The Portuguese data illustrate the consequences of unclear communication with government agencies in a dam construction project: "There were many obstacles in the government's mission to build the dam. From the outset, there was a lack of clear communication about the conditions of the land, which caused difficulties." Another Portuguese account highlights inconsistent messaging from municipal authorities: "The council initially denied the possibility of construction, but leaked documents indicated that the landfill could indeed be built." These examples suggest that miscommunication with government stakeholders may generate uncertainty and public opposition, requiring careful management of both regulatory and public relations.

Other accounts further confirm the involvement of public authorities in project oversight. Turkish data lists "municipalities" and "public authorities" as communication partners in infrastructure projects and public services, while Romanian data similarly refers to "local administration" in decision-making processes affecting both public and private sector projects.

#### **6.4.2. Official Certification Bodies (Compliance)**

In connection with government regulation, above, official certification bodies appear in the material as stakeholders responsible for compliance, licensing, material standards, and sustainability requirements in some engineering projects. This category includes certification organisations, licensing authorities, and oversight bodies, which are engaged to verify adherence to technical and environmental criteria.

Austrian accounts illustrate how certification processes emphasise sustainability and material efficiency over architectural design. One participant described the priorities of Klimaaktiv: "For them, the architecture is only marginally important. What is important for them is how much material goes in, how is it heated, what comes out at the end? Are my requirements met and is the goal that I'm aiming for achieved?" Communication with such bodies, therefore, centres on verifying sustainability metrics and compliance with environmental targets. Austrian data also cites TÜV (Technical Inspection Association) and Quality Austria as authorities responsible for certifying technical and quality standards.

Similar roles are recorded in the Portuguese material, which mentions Licensing Authority and Oversight Authority as entities tasked with certification and compliance. These references suggest that engineers and project teams interact with regulatory bodies to secure approvals and confirm that projects conform to legal and operational requirements.

#### **6.4.3. Government Affairs Experts & Lobbyists**

Government affairs experts and lobbyists are identified in the material as communication partners whose responsibilities include advocacy, monitoring legislation, and securing policy support. Interactions with these professionals focus on influencing decision-makers, aligning projects with regulatory frameworks, and positioning initiatives for funding or approval.

Austrian accounts emphasise the need for lobbying alongside technical work. One participant explained: “You cannot think, uh, about the research and solving problems, and then how you will also... find someone to, uh, influence the government... to stand up for your project.” This indicates that engagement with government affairs professionals is considered necessary for advancing projects that depend on political or financial endorsement.

Monitoring legislative developments also appears as a key task. An Austrian interviewee described the role of an EU Affairs expert: “We have an EU Affairs expert on staff who monitors European legislation as part of his role.” Another reference points to a lobbyist based in Brussels: “He is our lobbyist in Brussels and also monitors the legislation as part of his role, and we generally collaborate in various aspects.” These accounts suggest that organisations rely on government affairs staff both for advocacy and for ensuring that projects remain compliant with national and international policy changes.

#### **6.4.4. Intellectual Property Stakeholders (Patent Office)**

The Austrian data suggests that intellectual property (IP) stakeholders, including patent offices and IP experts, play a role in patent writing and the protection of innovations. One account explicitly references communication with patent offices and IP professionals: “Yes, with the patent office or with the cabinet that are experts of IP that are writing your patent.” This indicates engagement with specialised experts responsible for drafting and managing patent applications to secure legal protections for technological developments.

## **6.5. Academic and Research Communication Partners**

### **6.5.1. Interdisciplinary Research & Academic Community Members**

Interdisciplinary researchers and academic community members are identified as communication partners in engineering and scientific work. Their involvement is described in

terms of cross-disciplinary collaboration, knowledge exchange, and the integration of research findings into industry and technological development. Communication in these contexts brings together engineers and industry experts, supporting both innovation and the practical application of scientific discoveries.

Collaboration between academia and industry also emerges as a theme. Horizon Europe (R&D) material describes interactions that cross institutional boundaries: “Be some mix of, uh, some, uh, from the academy and industry.” This suggests that engineers and researchers communicate with both academic and corporate actors in order to connect theoretical knowledge with practical application. Another account emphasises the value of cross-disciplinary data collection: “So working across other disciplines, I know that I need to also record this kind of data that in principle is not useful to an organic chemist, except if you want to go further with other investigations.” Such examples illustrate how interdisciplinary engagement facilitates broader scientific inquiry.

The need for collaboration across fields is made further explicit in the data: “Interdisciplinary collaborations we definitely want to have because I'm basically from a physics background... So in that case, we need to collaborate with other disciplines and various disciplines like chemistry, material science, and engineering.” By contrast, communication within a single discipline is described as more straightforward, as a Portuguese account explains: “Because if you are in a group of scientists that everybody speaks the same language and everybody studies the same subjects, it's not difficult.” Together, these accounts suggest that while disciplinary communities communicate fluidly, interdisciplinary work requires additional adaptation between experts from different fields.

### **6.5.2. Teachers, Students & Early Career Scientists**

Students and early-career researchers are presented in the data as communication partners in academic and research contexts, where exchanges focus on mentoring, knowledge transfer, and collaboration. These interactions take place in both structured teaching environments and informal settings that support professional development and continuity in research.

Academic institutions are described as hubs for structured knowledge-sharing. Polish material refers to “Lecturers and students” engaged in “transmitting information/collecting information,” while Turkish accounts mention “Researcher – Information sharing” as part of academic and research collaboration. Such examples highlight how teaching and scholarly exchanges provide formal avenues for disseminating research and building expertise.

Students themselves are positioned as active contributors in academic communication. Austrian data highlights their involvement in innovation: “Personally, I think that it is crucial that the student, the postdoc, the PhD, that are at the base also of the invention.” Another Austrian

account underscores the obligation to pass research knowledge to the next generation: “Since I’m also part of a European project, we have to, uh, meet some of the criteria of that, and it’s like we have to transfer or communicate our research, uh, skills or ideas to the next generation.” These statements suggest that students and early-career scientists are not only recipients of knowledge but also participants in advancing research.

Teaching and mentoring appear as further contexts for communication. Austrian material describes formal instructional practices: “Because to people in the research field, uh, what we mainly follow is like, we, uh, we will be having some teaching sessions, especially for bachelor's or master's students.” Portuguese accounts add that communication is adapted according to academic level: “... it's very different when you talk about when we talk with first-year students or when you give classes to PhD students.” This points to tailored communication strategies based on the knowledge and experience of the audience.

Different expectations of students’ roles in communication are reflected across the datasets. Polish references position them as passive recipients—“collecting information”—while Turkish accounts describe a more active role in structured oversight: “Students – Regular reporting for progress.” This indicates that students’ communicative involvement ranges from absorbing knowledge to documenting and reflecting on their own academic and research progress.

### **6.5.3. University Administrative Offices**

University administrative offices appear in the data as communication partners in academic and research environments. Their roles are described in terms of evaluating research potential, managing intellectual property, and coordinating public engagement initiatives. These offices support internal decision-making and act as intermediaries between researchers and external actors such as patent offices and industry partners.

In the Horizon Europe (R&D) data, internal university offices are noted as evaluators in the patenting process. One account explained: “This goes to usually to the internal offices in the university, that they consider, they evaluate this, and they say, Okay, this is interesting.” This suggests that before pursuing intellectual property protection, researchers’ work must undergo internal review to assess its viability. Turkish data makes a similar reference to Technology Transfer Offices, which typically oversee project preparation, intellectual property rights, and research commercialisation, reinforcing the administrative role in linking research to external applications.

Administrative offices are also described as organisers of public-facing initiatives. Horizon Europe (R&D) material further highlights institutional efforts to support science communication and outreach: “Our university itself, uh, creates like university open days and European research nights and things like that as well.” These examples suggest that beyond internal

review and management, university offices contribute to connecting academia with wider audiences, facilitating knowledge dissemination and enhancing institutional visibility.

## 6.6. Public Communication Partners

### 6.6.1. General Public Audience

The general public appears in the data as a distinct communication stakeholder in engineering, scientific research, and industry outreach. Interactions with this group focus on raising awareness, simplifying complex topics, and making information accessible to non-specialist audiences. Effective engagement requires adjusting language and presentation styles to reach wider publics while preserving scientific accuracy.

Public awareness is particularly emphasised in Horizon Europe (R&D) accounts. One participant explained the need to introduce emerging technologies: “This green hydrogen is not [very well-known] among the common people. So [...] we have to bring awareness to them.” Another reflected on the challenge of sustaining audience interest: “Because it’s public. We cannot bring in [...] scientific terms. It will be boring for them.” These examples suggest that communication with general audiences combines awareness-raising with efforts to present technical content in accessible and engaging ways.

Corporate and product communication also intersect with public engagement. An Austrian reference highlights the use of public announcements to mark milestones: “Then there is a celebration announcement. Yes, first customer and then it is communicated more widely or regularly on the subject, because then we are sure.” This illustrates how businesses use communication with the public to signal achievements, build trust, and reinforce their presence in the market.

Portuguese material further underscores the adaptation required when addressing general audiences. One account noted: “If I am a scientist and I’m speaking with a journalist and I want to communicate my results to the journalist or to the general public, I cannot use the language that I use with my colleagues.” This indicates that scientists and researchers tailor their communication depending on audience expertise. The mention of “Social Media target groups” also points to the role of digital platforms in extending outreach and ensuring broader dissemination of scientific and industry-related messages.

### 6.6.2. Science Communication & Public Relations Experts

Science communicators and public relations (PR) experts are identified in the data as stakeholders who ensure that technical and scientific content is conveyed effectively to non-

specialist audiences. Their role involves translating complex information into accessible formats, reducing ambiguity, and tailoring communication strategies for public engagement.

Austrian accounts highlight the difficulty of presenting technical content clearly outside specialised fields. One participant explained: “We often have the problem that we see that technical content is communicated, but. The basics that are communicated include general phrases... But it’s precisely in these communications to people who don’t know the details, so to speak, that the questions have to be asked. It has to be communicated to them in such a way that no questions remain unanswered.” This suggests that science communicators structure information to make it both precise and understandable for wider audiences, including policymakers, the public, and industry actors.

Science communication also appears in relation to interdisciplinary knowledge-sharing. A Horizon Europe (R&D) account emphasised how publications are written for multiple fields: “Writing a publication is more like informative or pedagogic because that should be read by not only the chemist, maybe pharmacists, maybe, I don’t know, technologists, engineers, doctors, physicists.” This indicates that communicators, whether based in research institutions or the media, contribute to bridging disciplinary boundaries by framing findings in ways accessible to diverse professional communities.

Portuguese material reinforces the role of communication specialists in shaping public discourse through the media. One participant noted: “... if I am a scientist and I’m speaking with a journalist and I want to communicate my results to the journalist or to the general public, I cannot use the language that I use with my colleagues.” This highlights how journalists, alongside PR professionals, act as intermediaries between scientists and non-specialist audiences, refining messaging strategies so that findings are accurately conveyed while remaining engaging and accessible.

### **6.6.3. Local Community and Landowners**

Local communities and landowners are presented in the data as key communication stakeholders in engineering and infrastructure projects. Interactions with these groups focus on negotiating land use, addressing public concerns, and managing the social impacts of development. Effective communication is framed as necessary for building trust, securing cooperation, and mitigating potential conflicts during project implementation.

Landowners appear explicitly in accounts of project negotiations. Irish data describes a motorway project requiring a compulsory purchase order, where “the importance of first listening to what the other side wanted” was emphasised. This indicates that engineers and project managers must engage directly with property owners, sometimes with the involvement of mediators, to address both legal and personal considerations. The mention of “landowner

liaison officers” points to a formalised approach to maintaining communication, while references to tenants and letting agents—particularly in building refurbishment contexts—show that non-owner stakeholders may also be part of these exchanges.

Community relations are likewise emphasised. Portuguese material highlights the risks of unclear messaging where inconsistent and hesitant communication generated doubts in the population, dividing opinions and fueling mistrust. This illustrates how ineffective communication can undermine public confidence, especially when projects affect local environments or livelihoods. The additional reference to “farmers” suggests that rural communities, whose land use may be directly impacted, require targeted engagement strategies.

Finnish accounts further reinforce the involvement of local stakeholders. References to “municipal residents,” “forest owners” (who sell logging products to factories), and the “surrounding community” illustrate the range of groups engaged in dialogue around land rights, economic concerns, and broader community expectations. These examples suggest that project communication extends beyond technical coordination to include ongoing negotiation with those most directly affected.

## **Key Takeaways**

This chapter set out to understand who the key players are within the communication networks of green transition engineering. It identified a wide range of actors with whom engineers engage, spanning internal team members, commercial and industry partners, regulatory authorities, academic collaborators, and public audiences. The findings demonstrate that:

- Engineers communicate with a wide spectrum of stakeholders across technical, commercial, managerial, regulatory, academic, and public domains.
- Internally, exchanges with colleagues, managers, and project leaders ensure coordination, accountability, and the integration of specialist expertise.
- Externally, engineers interact with clients, contractors, suppliers, financiers, and industry partners, as well as with regulators, certification bodies, policymakers, and funding agencies, whose oversight shapes project feasibility and implementation.
- Academic and research settings add further layers, including students, early-career scientists, university administrators, and interdisciplinary collaborators, all of whom contribute to knowledge exchange and innovation.
- Public-facing communication involves science communicators, journalists, PR experts, local communities, landowners, and wider audiences, requiring the translation of technical content into accessible forms and the management of trust, expectations, and political sensitivities.

- This diversity of communication partners highlights the networked nature of engineering practice. Well-structured communication across these groups enables engineers to align technical solutions with complex social, institutional, and political relationships.

This chapter, together with the two previous chapters, has outlined the nature of language and communication activities situated in the development, deployment and diffusion of green transition technologies. The following chapter describes some of the important challenges felt by engineers when communicating in these contexts.

Table 4: Summary of the Communication Partners and Stakeholders within the Field of “Green Transition” Technologies

<p><b>TECHNICAL COMMUNICATION PARTNERS</b></p> <p><b>Design Teams</b></p> <ul style="list-style-type: none"> <li>Architects (central to design communication, integrating project requirements)</li> <li>System Designers (translating customer expectations into tech. specifications)</li> <li>Design Engineers (coordinating design implementation)</li> <li>Quantity Surveyors (handling cost estimation and financial planning)</li> <li>Specialist Planners (assessing project feasibility and quality)</li> <li>Civil Engineers (defining infrastructural requirements)</li> <li>Road Designers (planning and assessing transportation systems)</li> <li>Environmental Consultants (assessing environmental impact/sustainability)</li> <li>Mechanical Engineering Consultants (evaluating technical feasibility)</li> </ul> <p><b>Technical Suppliers</b></p> <ul style="list-style-type: none"> <li>Industry Representatives (producing and supplying technical equipment)</li> <li>Technology Providers (offering specialised technological solutions)</li> <li>Software Suppliers (providing digital tools and software solutions)</li> <li>Supplier Sales Representatives (sales and procurement discussions)</li> </ul>	<p><b>Technical Implementation Roles and Subcontractors</b></p> <ul style="list-style-type: none"> <li>Site Engineers (managing on-site construction activities)</li> <li>Contractors (overseeing construction execution and supervision)</li> <li>MEP Subcontractors (handling mechanical, electrical, and plumbing installations)</li> <li>Survey / Site Investigation Contractors (assessing project site conditions)</li> <li>Field Engineers (on-site troubleshooting and coordination)</li> <li>Technicians (executing system installations)</li> </ul> <p><b>Production Facilities</b></p> <ul style="list-style-type: none"> <li>Production Line Personnel (ensuring design and manufacturing alignment)</li> <li>Manufacturing Staff (coordinating production processes)</li> </ul> <p><b>Industry Partners</b></p> <ul style="list-style-type: none"> <li>Manufacturers (partners in product commercialisation and industrial applications)</li> <li>Wind Power Companies (involved in renewable energy projects)</li> <li>Factories (processing raw materials for engineering applications)</li> <li>Scientific Officers/Research Officers (managing integration of new technologies)</li> </ul>	<p><b>Technical and R&amp;D Experts</b></p> <ul style="list-style-type: none"> <li>Process Optimisation Experts (refining technical workflows)</li> <li>Model Development Experts (building models for engineering projects)</li> <li>Energy Transition Experts (specialising in sustainable energy projects)</li> <li>Researchers (engaging in knowledge exchange and technical discussions)</li> <li>Engineers in Various Specialisations (collaborating across disciplines)</li> <li>Technical Peers (collaborating on daily work and troubleshooting)</li> <li>Senior Engineering Colleagues (mentoring and guiding junior staff)</li> </ul> <p><b>BUSINESS AND COMMERCIAL COMMUNICATION PARTNERS</b></p> <p><b>External Industry and Commercial Stakeholders</b></p> <ul style="list-style-type: none"> <li>Business Representatives (exploring partnerships and collaborations)</li> <li>External Companies (participating in project decision-making)</li> <li>Distributors (handling product distribution and sales)</li> <li>Carriers/Transportation Companies (managing logistics and deliveries)</li> </ul> <p><b>Sales, Marketing &amp; Product Strategy</b></p> <ul style="list-style-type: none"> <li>Marketing Experts (conducting market viability assessments)</li> </ul>	<ul style="list-style-type: none"> <li>Sales Representatives (coordinating commercial discussions and customer outreach)</li> <li>Marketing Directors (leading product positioning and promotion)</li> <li>Supplier Sales Representatives (managing business negotiations and supply chains)</li> </ul> <p><b>Customers / Clients / Commissioning Entities</b></p> <ul style="list-style-type: none"> <li>Clients (defining project requirements and reviewing solutions)</li> <li>Commissioning Entities (approving project implementation)</li> <li>End-Users (providing feedback on usability and functionality)</li> <li>Project Owners (overseeing project execution and funding)</li> <li>Landowners (negotiating property rights for engineering projects)</li> </ul> <p><b>ADMINISTRATIVE AND MANAGERIAL COMMUNICATION PARTNERS</b></p> <p><b>Project Management</b></p> <ul style="list-style-type: none"> <li>Project Managers (coordinating stakeholders and ensuring project execution)</li> <li>Project Leaders (overseeing team alignment and goal-setting)</li> </ul> <p><b>Project Partnership and Consortia</b></p> <ul style="list-style-type: none"> <li>Project Partners and Consortia Members</li> </ul>
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<ul style="list-style-type: none"> <li>• International Partners (collaborating across countries)</li> <li>• Potential Project Partners (engaged in early-stage networking)</li> <li>• Civil Society Organisations (contributing to research and project development)</li> </ul>	<p><b>Project Financing and Funding Bodies</b></p> <ul style="list-style-type: none"> <li>• Project Funding Institutions (evaluating proposals and securing financing)</li> <li>• Government Financiers (assessing proposal feasibility and originality)</li> </ul>	<p><b>Intellectual Property Stakeholders</b></p> <ul style="list-style-type: none"> <li>• Patent Office Representatives (assessing and granting patents)</li> </ul> <p>IP Experts (guiding engineers through patent application processes)</p>	<p><b>PUBLIC COMMUNICATION PARTNERS</b></p>
<p><b>Finance, Operations, and Logistics</b></p> <ul style="list-style-type: none"> <li>• Logistics Teams (coordinating supply chain and material flow)</li> <li>• Production Management Teams (ensuring compliance and process efficiency)</li> <li>• Financiers (assessing project costs and funding allocations)</li> </ul>	<p><b>LEGAL AND REGULATORY COMMUNICATION PARTNERS</b></p>	<p><b>ACADEMIC AND RESEARCH COMMUNICATION PARTNERS</b></p>	<p><b>General Public Audience</b></p> <ul style="list-style-type: none"> <li>• Citizens and Communities (engaged in awareness campaigns)</li> <li>• Social Media Target Groups (receiving project-related updates)</li> <li>• Media Consumers (accessing engineering and scientific news)</li> </ul>
<p><b>Internal Management</b></p> <ul style="list-style-type: none"> <li>• CEOs, CTOs, EVPs (executives overseeing strategic decisions)</li> <li>• Mid-Level Managers (ensuring technical and financial alignment)</li> <li>• Supervisors (providing direct oversight on operations)</li> <li>• Department Heads (managing specialised teams)</li> <li>• Compliance Teams (ensuring regulatory adherence)</li> </ul>	<p><b>Government Regulators &amp; Policymakers</b></p> <ul style="list-style-type: none"> <li>• Planning Authorities (granting approvals and ensuring compliance)</li> <li>• Local Governments (regulating land use and infrastructure projects)</li> <li>• Central Policymakers (shaping engineering regulations and policies)</li> <li>• Municipal Authorities (overseeing urban and environmental planning)</li> </ul>	<p><b>Interdisciplinary Research &amp; Academic Community Members</b></p> <ul style="list-style-type: none"> <li>• University Researchers (collaborating on technical studies)</li> <li>• Industry Experts (contributing applied knowledge)</li> <li>• Lecturers (facilitating knowledge transfer)</li> <li>• Students (engaging in academic and research activities)</li> </ul>	<p><b>Science Communication &amp; Public Relations Experts</b></p> <ul style="list-style-type: none"> <li>• Science Journalists (translating technical content for public understanding)</li> <li>• PR Experts (shaping public narratives about engineering advancements)</li> <li>• Outreach Coordinators (engaging with communities and media)</li> </ul>
<p><b>Colleagues</b></p> <ul style="list-style-type: none"> <li>• Technical and non-technical peers (collaborating on daily work)</li> </ul>	<p><b>Official Certification Bodies (Compliance)</b></p> <ul style="list-style-type: none"> <li>• Technical Inspection and Industry Standards Associations (verifying technical compliance)</li> <li>• Licensing Authorities (granting necessary project permits)</li> <li>• Environmental Certification Organisations (assessing sustainability compliance)</li> </ul>	<p><b>Teachers, Students &amp; Early Career Scientists</b></p> <ul style="list-style-type: none"> <li>• Undergraduate and Graduate Students (learning and participating in research and development)</li> <li>• Postdocs (contributing to scientific innovation and mentorship)</li> </ul>	<p><b>Local Community and Landowners</b></p> <ul style="list-style-type: none"> <li>• Landowners (negotiating agreements for infrastructure projects)</li> <li>• Tenants and letting agencies</li> <li>• Community Leaders (representing local interests and concerns)</li> <li>• Farmers (affected stakeholders in rural engineering projects)</li> <li>• Municipal Residents (providing feedback on local developments)</li> </ul>
	<p><b>Government Affairs Experts &amp; Lobbyists</b></p> <ul style="list-style-type: none"> <li>• EU Affairs Experts (monitoring European legislation)</li> <li>• Policy Lobbyists (advocating for engineering-related regulations)</li> </ul>	<p><b>University Administrative Offices</b></p> <ul style="list-style-type: none"> <li>• Technology Transfer Offices (assessing patenting and commercialisation potential)</li> <li>• Public Engagement Coordinators (organising outreach initiatives)</li> </ul>	

## 7. Common Communication Challenges

Engineers encounter a range of recurring communication challenges in both educational and workplace contexts. Addressing these challenges is essential in the design of educational material, since preparing future engineers requires not only familiarity with communicative tasks and genres but also the ability to anticipate and overcome the barriers that complicate them in practice.

Research has long highlighted the importance of competence in interpersonal, small-group, and formal communication, as well as skills such as clarity, negotiation, translation, and active listening (Darling & Dannels, 2003; Vest et al., 1995). These abilities are particularly critical for collaboration, networking, and cultural understanding in today's interdisciplinary and globalised workplaces (Lappalainen, 2009). Building on these insights, this chapter situates communication challenges within the lived practice of engineering work. The difficulties identified in the data are grouped into five broad categories: failures of clarity and alignment, interpersonal challenges, conflicting stakeholder priorities, language and cultural issues, and problems of information management.

### 7.1. Failure to Achieve Common Understanding

#### 7.1.1. Misalignment of Understanding of Project Goals, Structure, and Roles

Ensuring clarity around project goals, roles, and responsibilities emerges as a recurring challenge. When project structures are poorly defined, as illustrated in Austria, roles become confused and collaboration suffers: “There was a lack of knowledge about how such projects work. Yes, there was a problem with the project organisation.” Similar problems were reported in Finland, where unclear definitions of who is responsible for communication led to duplication of effort and coordination difficulties: “It's also important to decide who's in charge of communication... uncertainty about communication responsibilities also introduces difficulties in projects.”

Breakdowns also occur when goals and expectations are not shared or consistently maintained. In Austria, participants noted how differing assumptions about outcomes undermined cooperation: “if expectations aren't met, so what? That's just the way it is.” In Ireland, rapid staff turnover created further disruption, with shifting project managers impeding clarity and continuity: “the contractor had four different project managers...it wasn't a particularly smooth project.”

### 7.1.2. Communication Across Distributed Teams

Coordination across geographically dispersed teams is a recurring challenge, particularly in large or international consortia. Austrian participants noted that involving all relevant stakeholders in decision-making can be impractical, with scheduling difficulties leading to delays and the exclusion of key voices: “it's impossible to have everyone... in big consortia.”

Remote and hybrid work adds further complexity. Irish accounts describe how the loss of informal, real-time exchanges slows down decision-making: “with remote working [...] communications are happening at hours where you can't have verbal communication.” To manage geographical and temporal distance, participants pointed to reliance on digital platforms and tools. Romanian engineers stressed the need for proficiency with software and project management systems: “Engineers must be proficient in utilising communication software, project management systems, and collaborative platforms.” Finnish participants highlighted the need for additional written documentation to maintain alignment in distributed settings through meeting memos and other forms of written communication.

However, the Turkish report underscores the limits of digital communication, noting that virtual modes “often result in diminished connection among team members.”

### 7.1.3. Misalignment Across Hierarchies or Stakeholder Groups

Miscommunication across organisational layers and stakeholder groups emerges as a persistent barrier to shared understanding. A common issue is the distortion of information as it moves through hierarchical structures. Austrian participants noted that when technical content is filtered through intermediaries, essential details can be lost: “something is always lost...the sales rep is taught to say some overall things, not understanding the physics itself.” Irish accounts echo this, pointing out that access to higher levels of government is limited, making it harder to communicate nuance: “When you're dealing with the Minister...it's more difficult to talk them around because you have less access to them...with local politicians...you can engage constructively.”

Beyond hierarchy, projects involving multiple stakeholders face challenges of alignment and coherence. Portuguese participants observed that unless diverse actors are deliberately involved and expectations harmonised, “the project will not reach the main aims.” Turkish respondents similarly underscored the importance of adapting communication styles to different audiences, stressing the need to tailor messages across hierarchies and professional backgrounds, and emphasising adapting communication styles to suit diverse stakeholders.

#### **7.1.4. Assumptions About Shared Terminology**

Ambiguity caused by assumptions of shared terminology is a recurring challenge across contexts. A central issue is that the same terms can carry different meanings for different groups. Austrian data illustrates this with disputes over the word “product”: “the product manager was offended by the word 'product'...we as innovation make a finished product? No...” Romanian respondents highlighted a similar risk with company-specific jargon and abbreviations, noting that “employees involuntarily insert these words and abbreviations into their communication,” creating barriers to understanding.

Another recurring theme is the need to adapt language to specific audiences. Irish participants emphasised tailoring communication for different stakeholders, from site workers to politicians: “you may have to use different ways for a different person.” Portuguese and Finnish accounts likewise warned against relying on specialised language in wider contexts, stressing the need for clarity when speaking to journalists, clients, or non-specialists: “If I am a scientist and I’m speaking with a journalist...I cannot use the language that I use with my colleagues.” Turkish respondents further reinforced the need to actively check understanding, reporting that “feedback and confirmation are employed...particularly regarding terminology.”

#### **7.1.5. Vague, Ambiguous or Fragmented Messaging**

Unclear, vague, or fragmented messages pose a persistent barrier to effective communication. A recurring theme across contexts is the need for precision to prevent misunderstanding and errors. Austrian engineers emphasised that “technicians live from clear statements...it has to be communicated so no questions remain unanswered.” Romanian participants expressed the same concern, stressing that “effective communication involves conveying information clearly and accurately, leaving no room for ambiguity.” Finnish accounts also highlighted risks in written exchanges, noting that “emails are at big risk of being misunderstood. The sender must define clearly what they want the receiver to do.”

A further issue concerns the consequences of vagueness or incomplete information. Portuguese respondents described how “lack of clarity, miscommunication, and misunderstandings lead to a communication breakdown...hesitation to communicate clearly...generates doubts,” which in turn stalls projects and erodes trust among stakeholders.

Finally, fragmentation and overload emerged as additional obstacles. Turkish participants reported frustration that pertinent information becomes scattered and difficult to consolidate, underlining how dispersed communication across multiple channels makes it harder to maintain coherence and continuity.

### **7.1.6. Overly Technical Language for Non-Experts**

Excessively technical communication can alienate stakeholders who lack specialist expertise, creating barriers to engagement and shared understanding. One recurring theme is that overly detailed explanations can overwhelm non-technical audiences. Austrian participants noted that “when technicians talk... the client sitting opposite is overwhelmed by overly detailed content.” Irish engineers described a similar issue in written communication, where factual but highly technical reports fail to persuade: “these reports... have to be persuasive in terms of, you know, convincing a planning authority... or convincing a funding authority.”

Others emphasised the need to simplify and adapt language. Portuguese participants highlighted the importance of adjusting technical content to ensure accessibility: “We have to adapt our speech to ensure everyone understands.” Finnish engineers also drew attention to this, explaining that “communication style is different...neutral and informative style versus more uncontrolled team communication,” depending on audience familiarity and context.

Finally, several accounts point to audience-specific adaptation as essential in multidisciplinary settings. Romanian participants stressed that “effective communication involves adapting the message to the specific audience,” particularly when engineers must work across disciplinary boundaries.

## **7.2. Interpersonal Communication Challenges**

### **7.2.1. Fear of "Losing Face"**

Concerns about reputation and hierarchy consistently emerge as barriers to open communication. In Austria, participants described the fear of reputational damage or “loss of face” as one of the biggest obstacles, with team members reluctant to admit errors or misunderstandings. Another Austrian account highlighted the difficulty of sharing uncomfortable truths, stressing that engineers need to communicate not only positive results but also risks and costs, even when such information is unwelcome. Turkish participants similarly emphasised how hierarchical settings can inhibit open dialogue, noting that ego concerns and status differences often obstruct candid exchange and discourage individuals from challenging authority or acknowledging uncertainty.

### **7.2.2. Receiving Feedback and Criticism**

Open communication channels that encourage feedback and iterative refinement were seen as crucial for improving project outcomes and team dynamics. Portuguese participants described every meeting as “an opportunity to clarify doubts,” emphasising the importance of safe spaces where questions can be asked openly and technical details explained in accessible

terms. This openness allows misunderstandings to be corrected early, reducing the risk of misinformation influencing project decisions or deliverables. Romanian accounts added that constructive criticism is essential, noting that “effective communication requires a willingness to give and receive feedback.” Creating such feedback loops—whether through formal reviews, informal check-ins, or open-forum discussions—supports continuous adaptation and strengthens quality, safety, and efficiency in project work.

### **7.2.3. Willingness and Reluctance to Communicate**

Reluctance to share information openly was highlighted as a recurring obstacle to collaboration and trust. Austrian participants described how protective attitudes and lack of trust hinder transparency: “There are people not very happy to share their knowledge... if you don't have the trust, you cannot work together.” In Ireland, fear of legal repercussions and accountability led to defensive practices, with communication reduced to creating a “paper trail”: “everyone is constantly trying to cover themselves.” Portuguese accounts pointed to the risks of either withholding or hastily sharing information, both of which generate confusion and weaken trust: “I prefer to ensure that we are communicating correctly.” Finnish participants also described the difficulty of deciding what to disclose about incomplete tasks, noting that hesitation to share partial information can undermine stakeholder confidence and overall project clarity.

### **7.2.4. Real-Time Interaction Anxiety**

Anxiety around spontaneous or real-time communication was noted as a barrier, particularly for less experienced team members. Austrian respondents observed that while some individuals engage comfortably in impromptu exchanges, others struggle: “I'm a social person... but this is my personality.” In Ireland, graduate engineers were described as avoiding unscripted interactions, with one participant noting that “graduate engineers were anxious about making phone calls,” which limited their ability to resolve issues quickly. Finnish participants echoed these concerns, pointing to uncertainty among younger engineers: “new engineers don't necessarily know how to act in different situations.” Turkish accounts suggested a stronger reliance on written channels, reflecting a preference for clarity and precision in multilingual environments: “preference for written communication aligns with the group's need for clarity and precision.”

### **7.2.5. Lack of Trust and Relationship Building**

Building trust and maintaining strong interpersonal relationships were described as both essential and difficult. Austrian participants stressed that “you cannot work together if you don't have the trust,” underscoring its role as the basis of effective teamwork. Irish accounts likewise pointed to trust and established relationships as central to collaboration, noting that “you get to know them... you would have their back.” In Finland, participants reported that

poor listening, open conflict, or lack of rapport undermines trust and complicates cooperation: “if the chemistry between participants is missing... It's always a difficult situation.” Romanian participants confirmed the importance of interpersonal connection, emphasising empathy and active involvement: “actively engaging in conversations... fosters stronger relationships.”

#### **7.2.6. Lack of Empathy or Perspective-Taking**

Empathy and emotional intelligence were repeatedly identified as factors shaping the effectiveness of interpersonal communication. stressed the value of empathy in managing tone and recognising the emotional state of others: “We need to be empathetic... maybe it was a bad day.” Irish respondents similarly identify limited empathy—“They can't put themselves in the place of everyone else”—as exacerbating conflicts and reducing collaboration, emphasising emotional intelligence as a crucial communication skill. Finnish experiences reflect that limited empathy or poor listening intensifies conflicts, whereas emotionally intelligent interactions foster trust: “personal communication builds trust.” Romanian data reinforces the importance of active listening and empathy in fostering collaboration: “Active listening involves attentively hearing... demonstrating empathy.”

#### **7.2.7. Habitual Communication Styles and Ingrained Mindsets**

Persistent communication habits were identified as barriers to effective interaction and problem-solving. Irish participants highlighted an ingrained reliance on email, even when more direct methods could resolve issues more efficiently: “people just won't pick up the phone... You could probably save 10 emails.” Polish respondents similarly pointed to “habits” as obstructive, noting that many engineers fail to recognise how improving their communication practices could enhance professional effectiveness. Portuguese accounts emphasised the risks of ingrained patterns such as responding hastily, stressing instead the need to “take my time... to ensure we are communicating correctly.”

#### **7.2.8. Conflicting Stakeholder Priorities**

Differing stakeholder priorities significantly influence communication dynamics, requiring careful negotiation and transparent engagement across multiple contexts. Austrian reports highlight how varying stakeholder interests—such as design preferences, functionality, and cost—create friction that demands careful management: “Of course, there are points of friction that arise.” Additionally, tensions between business teams focused on profitability and engineers emphasising technical feasibility complicate communication unless mutual appreciation of perspectives is fostered: “In a team, you have very different sets of values... it can create tension otherwise.”

Irish participants similarly highlighted the challenge of competing objectives in political contexts, where representatives must balance local community opposition with the need for project approval: "politicians are vulnerable to electorates...they may have a local community that's entirely opposed." In Poland, competing priorities—such as cost minimisation versus the pursuit of high-quality outcomes—were reported to complicate cooperative communication.

Portuguese accounts described how clashes between local community interests and project goals can generate mistrust, with "inconsistent and hesitant communication" dividing opinions. Romanian participants also pointed to tensions between economic constraints and sustainable solutions, describing the difficulty of "encouraging clients to think and choose green solutions because of cost."

## **7.3. Language, Culture and Contextual Barriers**

### **7.3.1. Language Barriers Obstructing Understanding**

As engineering teams become increasingly international, adapting communication to differing language proficiencies is a recurring challenge. Polish participants observed that "language proficiency plays a key role in international teams," particularly where English functions as the lingua franca. Austrian, Portuguese, and Finnish accounts all described how multinational teams often rely on translation or localised adaptations to avoid misunderstandings. Portuguese respondents noted that "translation is a challenge," especially in projects spanning multiple nationalities or regions, while Finnish engineers stressed that "language skills have also become more and more important," sometimes even requiring English terms to be translated into Finnish to ensure clarity.

Romanian participants emphasised that engineers in multinational companies must manage not only linguistic differences but also varying expectations and communication styles. Turkish accounts added that, in some international settings, participants prefer "written communication over verbal interaction" as a safeguard for precision across language barriers.

### **7.3.2. Cultural Differences in Communication Styles**

Cultural variations strongly shape communication in international teams, with differing norms of politeness, hierarchy, and directness influencing how messages are exchanged and interpreted. Irish data highlighted contrasts in directness, where participants from other language cultures described themselves as "very blunt" or "very abrasive," noting the absence of phrases like "please" or "thank you." Adjusting to Irish colleagues' preference for more formal politeness—"When you come to Ireland, you have to be... 'I trust you are well...'"—

required deliberate adaptation. As one participant put it, “it’s also a matter of learning who you’re speaking to... some people you need to be nice to.”

Austrian respondents also pointed to challenges arising from culturally specific conventions, such as indirectness or hierarchical mediation: “Swedes will never say no... they always say yes or a half yes... Japanese have this face-saving... In Argentina, you must always involve a superior before reaching the expert.” Portuguese participants reinforced this, observing that “approaches that worked in Angola didn’t work well [in Kenya],” underscoring the need for context-sensitive strategies. Finnish data similarly emphasised the importance of cultural awareness: “Understanding foreign cultures reduces misunderstandings.” Romanian respondents highlighted the particular difficulties faced by graduates entering multinational environments without intercultural training: “We need to hire engineers who know how to communicate effectively... with people from different nations and cultures.”

### **7.3.3. Generational Differences in Communication Preferences**

Generational differences also shape communication practices, with contrasting preferences for channels and styles affecting effectiveness. Horizon Europe (R&D) respondents, half-jokingly, pointed to the changing habits of younger engineers: “You should do a TikTok video... about splitting the water molecule.” Irish senior engineers similarly observed that younger colleagues rely more heavily on digital tools such as text or email, often avoiding traditional calls: “Nowadays people just ping off an e-mail because it’s off my desk and onto your desk, and it’s a very easy thing to do.” Turkish respondents confirmed this divide, noting the challenge of balancing communication with both younger and older stakeholders, each of whom prefers distinct modes and approaches: “different age groups among students often prefer distinct modes of communication.”

## **7.4. Information and Information Gaps**

### **7.4.1. Lack of Documentation or Meeting Minutes**

Inconsistent documentation and poor record-keeping undermine project clarity and continuity. Austrian respondents emphasised that without minutes or written records, agreements are forgotten and discussions repeated: “Without a written record...teams lose track...these things are forgotten.” Portuguese participants similarly noted that disorganised or inaccessible documentation hinders alignment on essential facts: “Information was available, but it was poorly organised and not very accessible.” Finnish data confirmed the importance of written records, stressing that clear action items and minutes sustain progress even when teams change: “written communication also keeps the issue moving forward, even if people change.” Turkish

respondents added that fragmented or scattered records across multiple platforms create further confusion: “Scattered information...highlighting the need for formal documentation.”

#### **7.4.2. Lack of Information from Others**

Delays, omissions, and a lack of responsiveness consistently hinder project efficiency. Austrian data illustrate how reluctance or inability to admit misunderstandings or provide feedback creates significant delays: “They were not too good at admitting when they didn’t understand something... causing delays and misunderstandings.” In Ireland, slow responses to emails prolong even simple queries: “if someone doesn’t look at their emails...the whole thing could go on for weeks.” Polish respondents likewise reported that a “lack of response/feedback” produces information gaps and disrupts workflow. Portuguese accounts highlight similar effects, with postponed clarifications causing confusion and missed deadlines: “When there is no clarity...this impacts the progress of the project.” Finnish participants also noted that “slowness or absence of communication introduces errors... leads to disputes.”

#### **7.4.3. Information Overload**

Excessive information volume creates significant challenges for clear communication and task management. Austrian respondents described juggling multiple concurrent issues, stressing the need for systematic documentation: “I’m juggling many topics...if it’s not written down, it’s gone.” Irish participants reported being overwhelmed by email traffic, where important details risk being lost: “the volume of e-mails is insane...people just ping off an e-mail.” Turkish accounts similarly noted how constant messaging across numerous platforms leads to “information pollution,” blurs boundaries, and obscures crucial content: “the relentless stream of communication...blurring boundaries...information pollution from multiple platforms.”

#### **7.4.4. Poor Use of Nonverbal and Paraverbal Cues**

Ineffective or absent nonverbal and paraverbal cues can significantly compromise communication clarity. Irish engineers noted that written communication often leads to misunderstandings because tone and nuance are lost, sometimes creating unintended conflict: “you just can’t get someone’s tone from an email...emails will be picked up wrong.” Romanian respondents emphasised that engineers frequently struggle to interpret nonverbal cues effectively, complicating in-person exchanges: “interpreting nonverbal body language can present unique challenges.” Turkish accounts similarly highlighted that the absence of facial expressions, tone, and body language in indirect communication hampers clear understanding and conflict resolution: “Non-verbal cues and body language play a significant role in enhancing communication.”

## Key Takeaways

This chapter examined the main challenges engineers and researchers encounter when communicating in the context of green transition projects. The findings highlight barriers to clarity, alignment, and trust, cutting across spoken, written, and digital communication. Key themes include:

- Unclear project goals, responsibilities, or vague messages create confusion, duplication of effort, and delays. Excessive or fragmented information further undermines coordination, while poor documentation weakens continuity.
- Collaboration across geographically distributed teams depends heavily on digital tools. While these facilitate coordination, they hinder informal exchanges and reduce personal connection, making alignment more effortful.
- Communication across different stakeholder groups, hierarchical layers and disciplines often distorts messages or creates misunderstandings. Differing priorities—such as cost vs. sustainability or political vs. technical considerations—require careful negotiation and audience-specific adaptation.
- Specialised jargon, assumptions of shared terminology, and varying language proficiencies complicate understanding in multinational and interdisciplinary contexts. Translation, simplification, and confirmation are essential to avoid miscommunication.
- Trust, empathy, and active listening are vital for collaboration, yet ego, hierarchy, fear of reputational damage, or weak interpersonal rapport often inhibit open dialogue. Generational differences further complicate communication preferences.
- Anxiety around real-time interaction, especially among less experienced engineers, leads to reliance on written channels that may slow resolution. Entrenched habits—such as defaulting to email—persist even when quicker alternatives exist.
- The lack of nonverbal and paraverbal cues such as tone, facial expression, or body language in written and virtual communication often leads to misinterpretation and conflict.

This report has so far outlined key technologies and engineering project types identified by our research participants as contributing to the green transition. It has provided contextual framing for potential language and communication activities within engineering curricula and examined how such activities are embedded in the development, deployment, and diffusion of green technologies, along with the communicative challenges these activities present. Building on the findings of these previous chapters, the following chapter identifies key communication skills likely to be required by engineers working in green transition fields.

Table 5: Summary of the Communication Challenges faced by Engineers Working in the Field of “Green Transition” Technologies

FAILURE TO ACHIEVE COMMON UNDERSTANDING	INTERPERSONAL COMMUNICATION CHALLENGES	LANGUAGE, CULTURE, AND CONTEXTUAL BARRIERS
<ul style="list-style-type: none"> <li>• Unclear Project Goals and Roles (uncertain responsibilities, staff turnover, poor coordination)</li> <li>• Distributed and Remote Teams (time-zone gaps, scheduling issues, reduced informal contact)</li> <li>• Cross-Hierarchy and Multi-Stakeholder Misalignment (distorted messages, limited access, misaligned expectations)</li> <li>• Assumed Shared Terminology (inconsistent terms, jargon, lack of confirmation)</li> <li>• Vague or Fragmented Messaging (unclear instructions, missing details, scattered communication)</li> <li>• Overly Technical Language (excessive jargon, inaccessible to non-experts)</li> </ul>	<ul style="list-style-type: none"> <li>• Fear of Losing Face (reluctance to admit mistakes or deliver bad news)</li> <li>• Feedback and Criticism (defensive attitudes, lack of open dialogue)</li> <li>• Reluctance or Over-Caution in Sharing (withholding or over-filtering information)</li> <li>• Real-Time Interaction Anxiety (discomfort with spontaneous or verbal exchanges)</li> <li>• Lack of Trust and Relationship Building (weak rapport, poor listening)</li> <li>• Low Empathy or Perspective-Taking (limited emotional awareness or understanding)</li> <li>• Ingrained Habits and Communication Mindsets (email dependence, resistance to change)</li> <li>• Conflicting Stakeholder Priorities (divergent goals, technical vs. commercial tensions)</li> </ul>	<ul style="list-style-type: none"> <li>• Language Barriers (mixed proficiency, translation issues, written preference)</li> <li>• Cultural Differences (contrasting norms of hierarchy, politeness, or directness)</li> <li>• Generational Differences (different channel preferences and communication styles)</li> </ul> <p><b>INFORMATION AND DOCUMENTATION GAPS</b></p> <ul style="list-style-type: none"> <li>• Lack of Records or Meeting Minutes (missing documentation, forgotten agreements)</li> <li>• Missing or Delayed Information (slow replies, unclear feedback)</li> <li>• Information Overload (too many channels, excess messaging)</li> <li>• Weak Nonverbal or Paraverbal Cues (lost tone, gesture, or expression online)</li> </ul>

## 8. Communication-Related Competencies

This chapter draws on the findings of previous chapters to explore communication-related competencies that engineers working in green technology are likely to require in order to perform effectively in this field. The analysis took a broader approach to identifying competencies beyond simply reporting focus groups' responses to this question. This takes into account the problems associated with the self-reporting of learning needs (see e.g., Carter & Dunning, 2008). Instead, the analysis below reanalyses the findings presented in previous chapters on communicative interactions, means, networks and challenges for inferences on the skills and competences associated with them—many of which recur across multiple contexts and from multiple perspectives.

It is important to note that no individual competency exists in isolation. The competencies below are described in the context of their application with regard to specific communication means, specific applied communication contexts and overall core communication skills. In each case, the specific competency is brought to the forefront but is described within the broader competency ecosystem—at least insofar as this could be ascertained from the research data.

When transferring these competencies to instructional design, it allows for a more integrated or holistic approach. Instructional designers are encouraged to identify in each case the more specific “can do” statements and to elaborate their own tailored learning outcomes according to their instructional objectives. Each competency description here contains a detailed explanation and synthesis of relevant report content (with respective report sections provided for reference). A shorter, concise competency statement is then provided, which may be used as the basis for designing learning outcomes and instructional objectives.

The report content selected and provided in support of these competencies should be considered as illustrative rather than comprehensive—it may be that the competencies elaborated here relate to additional report sections beyond those that are explicitly referenced, and further cross-referencing may be required to achieve a greater level of saturation.

### 8.1. Communication Means

#### 8.1.1. Digital Collaboration

##### Video conferencing (e.g., Zoom, MS Teams, Google Meets)

This competency focuses on video conferencing as a digital channel, not on meetings in general (which are covered under *Meetings* in 8.1.3). Video conferencing enables engineers to hold real-time discussions when participants are geographically dispersed or working remotely. It

is used to run structured online sessions, maintain supervision and mentoring at a distance, and keep projects moving where in-person contact is limited (4.2.4; 5.1.1; 7.1.2). Video platforms are typically combined with documentation and task-tracking systems such as Confluence, SharePoint, or Jira so that decisions made on calls can be recorded and linked to follow-up actions (5.2.2).

Engineers may need to be able to set up and manage online meetings effectively: choosing appropriate tools, sharing screens and documents, and ensuring that remote participants can contribute on an equal footing (4.2.4). In international or multi-site projects, they use video conferencing to coordinate across time zones and organisations, supplementing calls with concise written records when informal exchanges are not possible (7.1.2). There may be dangers in reduced interpersonal connection in virtual formats (4.2.4; 5.1.1; 7.1.2), difficulties for trust-building and negotiation when meetings are conducted online rather than in person (5.1.1), and inefficiencies linked to “information pollution” when multiple platforms are used for the same task (5.2.2; see *Managing digital information overload*, below) and so they may need to recognise when video is sufficient and when face-to-face engagement would improve trust, negotiation, or relationship-building (4.2.4; 5.1.1).

*Uses video conferencing tools to run structured online discussions, supervise and mentor at a distance, and support collaboration across locations; integrates video calls with documentation and task-tracking systems, and judges when digital meetings are appropriate versus when in-person engagement is needed to build trust, negotiate, or resolve complex issues. (Related to report sections: 4.2.4; 5.1.1; 5.2.2; 7.1.2)*

## Asynchronous collaboration

Asynchronous collaboration supports engineering workflows by allowing engineers to exchange information, coordinate tasks, and maintain project momentum without requiring real-time interaction. It is a communication mode or practice in which engineers contribute without participating at the same time. It includes the use of structured discussion forums, message threads, shared documents, and written updates that accumulate over time (5.2.2), enabling teams to manage differing schedules, time zones, and workloads while preserving records of contributions for later reference.

Engineers may need to be able to use asynchronous communication to organise work logically, leave clear updates, and contribute to ongoing tasks in ways that keep colleagues informed. They also need to integrate asynchronous work with synchronous moments, knowing when a delayed exchange is appropriate and when a real-time call is needed for clarity (5.1.2; 5.2.2). Engineers must also guard against fragmentation when the same topic is spread across too many channels, consolidating key information when necessary (5.2.2). Asynchronous channels are positioned within a broader multi-channel approach. Alongside real-time

meetings and calls, engineers also need to use phone communication, messaging applications, and quick update channels for coordination in different contexts (5.1.2; 5.2.2). Indeed, asynchronous communication may not always be the most effective medium for all tasks—in certain contexts, verbal interaction may be preferred over digital messaging (5.2.2). Collaborating asynchronously can also lead to “information pollution” with communication on the same task being spread across multiple platforms, leading to inefficiency and fragmentation (5.2.2; see *Managing digital information overload*, below).

*Supports asynchronous collaboration by using structured asynchronous channels—such as discussion forums, shared documents, and written updates—to coordinate work and maintain continuity; integrates asynchronous contributions with real-time interaction when needed and manages risks of fragmented communication across platforms. (Related to report sections: 5.1.2; 5.2.2)*

## Digital project management tools

Digital project management tools provide the infrastructure that links communication, documentation, and workflow coordination in engineering projects. Platforms such as Confluence, SharePoint, Jira and others support structured reporting, issue tracking, documentation storage, and task assignment (4.2.3; 5.2.2). They enable distributed teams to maintain a shared reference point, ensure accountability, and keep decisions visible over time (4.1.12; 7.1.2).

Engineers may need to be able to use these systems to record meeting outcomes, document agreements, track progress, and ensure that information is stored coherently. This includes preparing written summaries, uploading minutes, confirming actions in writing, and linking communication to specific tasks or work packages (5.2.4). Engineers must also address limitations such as fragmented records or duplication when multiple platforms coexist, consolidating information where needed to maintain clarity (5.2.2).

*Uses digital project management platforms to organise documentation, link communication to tasks, and coordinate workflows across teams; ensures decisions are recorded, actions are trackable, and documentation remains centralised, consistent, and accessible across project stages. (Related to report sections: 4.1.12; 4.2.3; 5.2.2; 5.2.4; 7.1.2)*

## Managing digital information overload

Digital information overload is reported as a recurring challenge in engineering project work. Engineers communicate across multiple platforms, including email, messaging apps, documentation systems, and virtual meetings, often as part of multi-channel coordination (5.2.2). While this approach allows for flexibility, it also creates risks. Excessive platform use

for the same task can lead to “information pollution,” where messages become fragmented, duplicated, or lost across channels (5.2.2; 7.4.3). Engineers describe the “relentless stream of communication” as a factor that blurs boundaries, obscures content and undermines focus (7.4.3).

Engineers may need to be able to manage this volume of communication by organising and filtering information systematically. This includes prioritising high volumes of email traffic, where important messages can be overlooked if not tracked carefully (7.4.3). Documentation systems are used to retain essential information and avoid loss, especially when managing multiple concurrent issues (7.4.3). Engineers also need to align communication practices with project workflows. This involves deciding which messages require formal documentation and which should be addressed through real-time or informal exchanges. When tasks are discussed across multiple platforms without coordination, engineers must consolidate key content to prevent confusion and maintain consistency (5.2.2). Addressing these challenges requires both technical proficiency with digital tools and deliberate choices about how and where information is shared.

*Manages multiple communication channels strategically to maintain clarity and efficiency, filtering and prioritising high volumes of information while recognising the risks of overload, fragmentation, and reduced task focus when communication is spread across multiple platforms. (Related to report sections: 5.2.2; 7.4.3)*

### **8.1.2. Digital Dissemination**

#### Social Media

Social media is used in engineering communication to engage both professional and public audiences. Digital platforms such as LinkedIn, company websites, and other online channels support project visibility, professional networking, and audience interaction (5.2.3). Social media is also employed to promote innovations and project milestones through announcements, outreach initiatives, and public demonstrations, making technical advances visible beyond professional circles (4.3.3; 6.6.1).

Engineers may need to be able to use social media strategically by adapting language for non-specialists, selecting targeted messaging, and applying tools such as hashtags and audience segmentation to extend reach (4.3.3). Social media posts often complement traditional communication by directing audiences toward more detailed material and maintaining ongoing engagement alongside email, presentations, and formal publications (5.2.3; 6.6.1).

*Uses social media platforms to share concise, audience-appropriate updates, promote projects, and engage diverse publics; applies targeted strategies—such as hashtags, segmentation, and tailored messaging—to maximise visibility and complement broader communication efforts. (Related to report sections: 4.3.3; 5.2.3; 6.6.1)*

## Online Content

Online content includes structured information presented through company websites, dedicated project pages, and other controlled digital environments (4.3.3; 5.2.3; 5.3.8). It supports awareness-building, transparency, and stakeholder access to project updates, technical information, and organisational achievements (6.6.1). Unlike social media, online content is not primarily interactive; it provides sustained, curated information that audiences can consult at any time.

Engineers may need to be able to prepare and adapt online content so that technical information remains accurate while accessible to non-specialist readers (4.3.3). This includes distilling scientific details, preparing explanatory materials, and collaborating with colleagues who maintain websites or digital channels (5.3.8). Online content also serves marketing and outreach purposes by hosting promotional materials and supporting customer interaction (5.3.8).

*Creates and adapts structured online materials on company websites and other controlled platforms to communicate technical information, support stakeholder access, and enhance organisational visibility; tailors content for non-specialist audiences and collaborates with colleagues responsible for digital platforms. (Related to report sections: 4.3.3; 5.2.3; 5.3.8; 6.6.1)*

### **8.1.3. Verbal & In-Person**

#### Meetings

This competency focuses on meetings as a communicative event, regardless of whether they take place in person or via digital platforms (with the technical aspects of online tools covered under *Video conferencing* in 8.1.1, above). Meetings are used to align objectives, clarify responsibilities, and sustain cooperation among stakeholders. Engineers organise regular sessions such as *jour fixe* meetings to provide continuity and oversight, and arrange ad hoc meetings to address urgent issues, unblock decisions, or prevent delays (5.1.1; 4.1.10). Meetings also provide a setting for conflict resolution, where direct dialogue can clarify misunderstandings and manage competing priorities more effectively than written exchanges alone (4.1.11).

Engineers may need to be able to plan, structure, and facilitate meetings so that participants share a clear purpose, agenda, and expected outcomes. This includes engaging partners and funders at early stages, conducting kickoff meetings to establish shared goals, aligning technical solutions with client requirements, and coordinating work within consortia and project teams (4.1.2; 4.2.5; 6.1.5; 6.2.3; 6.3.1; 6.3.2; 7.1.2). In distributed settings, they must decide whether to convene online or in person, taking into account relationship-building, negotiation needs, and the complexity of issues under discussion (5.1.1; 6.2.3).

Meetings need to be tightly linked to written records. Engineers prepare minutes, summaries, and action lists—sometimes in real time—to confirm agreements and responsibilities (5.2.4). They ensure that documentation is systematic and accessible so that teams do not lose track of decisions, repeat discussions, or rely solely on memory (7.4.1). This requires balancing discussion time with the need to capture key points and integrating meeting outcomes into wider project documentation and task-tracking systems.

*Plans and facilitates effective meetings—whether in person or online—to align objectives, clarify responsibilities, and support collaborative problem-solving; chooses appropriate formats and participants, manages discussion to address conflicts and decisions, and links meetings consistently to written records and follow-up actions to maintain continuity and accountability. (Related to report sections: 4.1.2; 4.1.10; 4.1.11; 4.2.5; 5.1.1; 5.2.2; 5.2.4; 6.1.5; 6.2.3; 6.3.1; 6.3.2; 7.1.2; 7.4.1)*

## Presentations

Presentations are central to how engineers communicate technical and scientific work in real time across academic, industrial, and public settings. They support activities ranging from research dissemination to decision-making and stakeholder coordination. Engineers use presentations at conferences, working groups, workshops, and symposia to share results, interpret findings, and contribute to disciplinary knowledge (4.3.1; 4.3.2; 5.1.5; 5.1.6). In industrial and regulatory contexts, presentations help teams articulate feasibility, justify design choices, and secure approvals through oral hearings, demonstrations, and structured briefings (5.1.4; 5.3.5). They also play a role in early-stage discussions: interactive formats, pitch-style sessions, and technical walk-throughs help test ideas and align stakeholders before more formal documentation is produced (5.1.4).

Engineers must adapt their delivery depending on purpose (4.3.1; 5.1.4; 5.1.5; 5.1.6). This requires adjusting language and level of detail according to the audience, being able, where necessary, to simplify technical content, avoiding excessive use of scientific terminology, and maintaining audience interest by presenting information in accessible and engaging ways, whilst ensuring that presentations are still accurate for expert peers (6.6.1).

*Delivers structured, real-time presentations that communicate technical content across academic, industrial, and public settings; adapts purpose, depth, and delivery to diverse audiences and uses formats such as demonstrations, hearings, and pitch-style sessions to support understanding, persuasion, dissemination and decision-making. (Related to report sections: 4.3.1; 4.3.2; 5.1.4; 5.1.5; 5.1.6; 5.3.5; 6.6.1)*

## Telephone

Telephone communication is an important practice for efficiency, problem-solving, and relationship-building in engineering. Engineers are shown to rely on it to resolve issues quickly, reduce the inefficiencies of extended email correspondence, and clarify discrepancies before they escalate. Telephoning is also an important means of handling sensitive or contentious matters in advance of written documentation, maintaining constructive dialogue in situations where misunderstandings or divergent interests could otherwise disrupt progress (4.1.3; 4.1.8; 4.1.11; 4.1.13; 5.1.2).

Engineers may need to be able to use telephone communication to clarify technical details, coordinate perspectives from different stakeholders, and solve problems as they arise (4.1.8; 5.1.2). They may need to respond directly to discrepancies in design or on-site conditions, reducing delays and avoiding escalation (5.1.2; 7.2.7). Barriers are noted in the form of ingrained email habits and anxiety around unscripted interaction, particularly among younger engineers, highlighting the importance of engineers adapting their practice by overcoming reliance on written correspondence and developing confidence in spontaneous interaction (7.2.4; 7.2.7).

*Uses telephone communication to resolve issues, clarify details, and negotiate solutions before they escalate, both within and across disciplines; uses verbal telephone exchanges to complement written records and recognises when telephoning is more efficient than writing when streamlining collaboration and sustaining effective teamwork. (Related to report sections: 4.1.3; 4.1.8; 4.1.11; 4.1.13; 5.1.2; 7.2.4; 7.2.7)*

## Videos

Videos function as pre-recorded, reusable communication media that complement live interaction and support both organisational and educational knowledge transfer. Videos may be used within organisations as part of structured internal communication, positioned within or alongside other tools (PowerPoint, Intranet) to support clear, repeatable explanations when live meetings are impractical (5.1.4). They also play a role in external or educational communication, particularly for audiences—such as younger engineers and students—who prefer digital-first formats and respond more readily to video-based content (7.3.3).

Engineers may need to be able to produce video materials that present information coherently and professionally, ensuring that visual and audio elements reinforce clarity. Videos may complement live presentations by providing reusable demonstrations or supporting teaching and onboarding by offering explanatory content that learners can revisit independently. They also help maintain knowledge continuity across distributed teams and diverse communication preferences (5.1.4; 7.3.3).

*Creates clear, coherent, and audience-appropriate video materials that communicate technical content through structured, pre-recorded format; uses visual and audio media to support organisational knowledge transfer, educational activities, and public or stakeholder engagement in asynchronous contexts. (Related to report sections: 5.1.4; 7.3.3)*

## Informal Discussions

Informal discussions and spontaneous, unstructured conversations are an important part of professional practice in engineering, contributing to relationship-building, trust development, and early-stage idea-sharing. These exchanges take place in workplace settings, casual social spaces, and unplanned encounters, allowing engineers to communicate openly, resolve problems quickly, and strengthen professional ties (5.1.3; 4.2.1). Such informal discussions are essential for cultivating professional relationships, whether between colleagues, across project teams, or in broader stakeholder networks (4.1.3; 5.1.3), but they also provide opportunities for knowledge-sharing and cross-fertilisation of ideas, allowing engineers to contribute suggestions and shape preliminary directions in a low-pressure environment (4.2.1; 5.1.3, 5.1.4; 6.3.5).

However, it is also important to adapt the tone and content of informal conversations to context. While spontaneity and openness are valued, efficiency and focus remain important, especially when discussions occur outside formal work settings (5.1.3). Engineers, therefore, need to balance openness with concision, ensuring that informal exchanges remain productive. They also need to apply informal check-ins and feedback loops as part of iterative project work, using them to clarify misunderstandings and refine approaches (7.2.2).

*Engages in spontaneous, unstructured conversations, informal check-ins and casual exchanges to exchange information, identify emerging issues, and generate early ideas in collaborative settings; builds trust and strengthens professional relationships through direct, personal interaction with colleagues, stakeholders, and partners; adapts the tone and focus of informal discussions to suit workplace, social, or cross-organisational contexts while maintaining efficiency and clarity in exchanges. (Related to report sections: 5.1.4; 4.1.3; 4.2.1; 5.1.3; 6.3.5; 7.2.2)*

## Lectures and Classes

Lectures and classes are structured communication environments where engineers share specialised knowledge, provide instruction, and support academic and professional development. Unlike presentations (see above), which are event-based and goal-driven, lectures and classes unfold within educational programmes, research training environments, and professional development settings. They involve both one-way exposition and interactive modes—such as student reporting, discussion, laboratory walk-throughs, and participation in research activities (4.3.1; 6.5.2).

In this context, engineers must convert complex technical content into pedagogically coherent explanations that align with learning outcomes. This requires distinguishing between levels of prior knowledge: introductory audiences need simplified framing, stepwise explanation, and conceptual scaffolding, whereas advanced learners require depth, disciplinary nuance, and precision (5.1.6; 6.5.2). Lectures and classes, therefore, demand careful adaptation of examples, pacing, and terminology so that knowledge remains accessible across interdisciplinary and multi-level groups (4.3.1). Engineers also need to support learning processes, including questioning, mentoring, and providing structured opportunities for learners to articulate understanding.

*Communicates engineering knowledge in structured educational settings by designing lectures and teaching sessions that present complex material clearly, pedagogically, and at appropriate levels of depth; supports learning, mentoring, and interdisciplinary understanding through audience-adapted explanations and interactive instructional strategies. (Related to report sections: 4.3.1; 5.1.6; 6.5.2)*

## Non-Verbal Communication

Nonverbal and paraverbal cues are an important part of engineers' communication practices because their absence or misinterpretation can lead to misunderstanding and conflict.

Engineers may need to be able to apply nonverbal and paraverbal cues to clarify intentions in communication (7.4.4). This requires them to use tone, expression, and body language deliberately so that meaning remains clear when engaging with colleagues, clients, or other stakeholders. They may also need to be able to interpret nonverbal signals accurately to prevent misinterpretation during in-person exchanges (7.4.4). This involves recognising body language and other cues, even where interpretation is challenging, and adjusting responses to maintain clarity. Finally, they may need to respond to the limitations of written or indirect communication, where nonverbal cues are absent (7.4.4). They can address these risks by making their intended meaning more explicit, helping to avoid misunderstandings and unnecessary conflict.

*Applies nonverbal and paraverbal skills to clarify meaning, reduce the risk of misunderstanding or conflict, and support clear, respectful, and effective interaction; interprets body language and other nonverbal signals during in-person exchanges and recognise the limits of written or indirect communication where tone and expression are absent. (Related to report section: 7.4.4)*

## 8.1.4. Written Genres

### Email

Email is a core written communication tool in engineering, used to coordinate day-to-day professional interactions, document decisions, and maintain accountability through a permanent, traceable record (5.2.1; 4.1.12; 5.2.4). As a message-level tool, email supports a wide range of routine and project-specific exchanges—including procurement inquiries, stakeholder outreach, internal updates, and clarification of technical or managerial requirements. Effective emails clearly structure requests, deadlines, responsibilities, and consequences, reducing ambiguity and ensuring that necessary actions are understood (5.2.1).

Email also functions as a confirmation and verification mechanism, documenting the outcomes of meetings, calls, or negotiations to secure shared understanding and prevent future disputes (4.1.12; 5.2.4). In planning and procurement, it enables early engagement with suppliers and formalises written exchanges such as quotation requests and agreement documentation (4.1.2; 5.3.4). Across these contexts, email provides transparent, auditable written communication that can be referenced throughout the project lifecycle (4.1.2; 5.3.4).

Engineers need not only to compose emails rhetorically but also to use them strategically to manage workflows across distributed teams. This includes applying project-specific email addresses and distribution lists to maintain accessibility of information (4.1.1), and using cc fields deliberately to create visibility, escalation, or accountability structures involving management or key stakeholders (4.1.4; 4.1.12). Because email affords time for reflection, it is also an appropriate medium for sensitive or high-stakes exchanges where a controlled, written response may prevent escalation or discomfort (4.1.12; 5.2.4).

*Uses email as a structured written genre to coordinate tasks, document decisions, and ensure accountability; applies distribution lists and strategic copying practices to manage visibility; and employs email as a controlled medium for sensitive or high-stakes communication. (Related to report sections: 5.2.1; 4.1.12; 5.2.4; 4.1.2; 5.3.4; 4.1.1; 4.1.4)*

### Memos

Memos are used in engineering projects to document decisions, clarify mutual understanding, and maintain alignment among stakeholders. Brief written summaries—such as meeting memos, protocols, and short follow-ups—are employed to record agreements and track outcomes

across diverse settings. These documents support accountability, continuity, and coordination, particularly when verbal interaction is limited or delayed (4.1.12; 5.2.4; 7.1.2).

Engineers need to be able to write concise, structured memos that summarise key points from meetings or discussions. These records help confirm that all parties have a shared understanding of what was agreed and what actions are expected. In some contexts, short written summaries are used immediately after calls or meetings to verify alignment and avoid misunderstandings (4.1.12). These documents are also circulated to relevant stakeholders, including senior managers, to keep communication transparent and traceable. Engineers also use memos to support coordination across teams and over time. In both co-located and remote environments, memos help formalise outcomes and ensure that decisions are documented for future reference. This is particularly important in distributed teams, where informal or real-time communication may be limited due to scheduling or geographic constraints (7.1.2). Memos and similar records help preserve continuity and ensure that projects remain aligned as they progress.

When writing memos, engineers may need to adjust tone and formality to suit different institutional environments. In public institutions, memos may need to follow formal documentation practices, while in academic or collaborative research settings, a more informal tone may be appropriate (5.2.4; 4.1.12). In all cases, the core function of memos is to clarify, confirm, and maintain a shared understanding among participants.

*Uses memos and other brief written summaries to confirm mutual understanding, summarise decisions, and maintain alignment among stakeholders; produces records that support continuity, clarify outcomes, and serve as reference points in distributed or multi-party settings; adapts tone and formality to suit institutional contexts. (Related to report sections: 4.1.12; 5.2.4; 7.1.2)*

## Letters

Formal written correspondence is used in engineering settings as a structured tool to initiate, record, and formalise professional agreements. These documents support, for example, project planning, documenting commitments, aligning stakeholders, or establishing accountability, and can communicate expectations and obligations in an organised format. These documents are used alongside emails, quotations, and tenders to document exchanges and commitments that lead toward formal agreements, without carrying the legal status of contracts (5.3.2; 5.3.4).

Engineers may need to be able to draft formal letters that prepare and use formal letters that state commitments clearly and support early-stage coordination. Letters of intention are used to align stakeholders during early negotiations, particularly where formal contracts have not yet been signed (5.3.2). Collaboration letters or letters of agreement serve as official records of commitment in structured project documentation and may accompany planning proposals, as in the practice of contacting industry partners in advance and including signed letters to

strengthen applications for funding (4.1.2). These letters document the existence of preliminary partnerships and contribute to the viability of a proposal.

*Prepares and uses formal written correspondence to establish, confirm, and document professional agreements by drafting communications that clarify roles, support proposal submissions, and serve as preliminary records of stakeholder commitments; applies these letters to structure official communication, outline mutual intentions, and secure project partnerships prior to contractual finalisation. (Related to report sections: 4.1.2; 5.3.2; 5.3.4)*

## Reports

Formal reports document progress, record decisions, and support both internal coordination and external engagement. Effective reporting is essential for maintaining continuity, meeting compliance requirements, supporting decision-making, and communicating with a wide range of stakeholders. Reports function not only as technical records but also as persuasive tools, particularly when directed at regulatory or funding authorities (5.3.1; 6.4.1; 7.4.1).

Engineers need to be able to produce precise and structured reports that document actions, agreements, and project conditions. This includes preparing written records of meetings, site inspections, and progress updates that support coordination between design, production, and logistics teams (4.1.20; 4.2.3). These records ensure that milestones, decisions, and responsibilities are accessible and verifiable, particularly in settings involving multiple departments or changing personnel (7.4.1). They also use reports to communicate status, risks, and developments to both internal managers and external partners. Compliance reports and progress monitoring are used in parallel to meet formal documentation requirements and to track ongoing technical performance (5.3.1). Reporting structures also support internal accountability, with project teams required to inform senior management of developments affecting project timelines, budgets, or risks (6.3.4).

Preparing reports requires engineers to adapt reporting content and tone to suit different audiences. Reports must be structured to clarify objectives and align them with the interests or concerns of, for example, regulatory stakeholders, internal decision-makers, or financial controllers. Reports addressed to planning authorities or funding bodies must meet formal expectations while also presenting project information persuasively (6.4.1; 7.1.6).

*Produces thorough and precise reports to formally document decisions, agreements, and action items, while also clarifying objectives and tracking developments within teams; uses structured progress updates, compliance reports, and site inspection records to maintain continuity, coordinate work across departments, and communicate project status to both internal and external stakeholders; adapts report content to meet regulatory, managerial, and funding requirements,*

*ensuring clarity, accessibility, and persuasive impact when required. (Related to report sections: 4.1.20; 4.2.3; 5.3.1; 6.3.4; 6.4.1; 7.1.6; 7.4.1)*

## Legal and Regulatory Texts

Legal and regulatory texts provide the framework within which projects are planned, approved, and executed. The data shows that engineering activities must comply with legislation, certification requirements, permitting processes, and transparency obligations. This may include interacting with licensing authorities, environmental regulators, and government policymakers, as well as managing internal processes for interpreting and implementing legal requirements (4.1.14; 5.3.3; 6.4.1; 6.4.2; 6.4.3).

It is important that engineers can interpret and apply legislation that directly affects project design and execution. This may include analysing both finalised and draft legal texts to determine their specific impact on technical portfolios or organisational responsibilities (5.3.3). They may need to assess which teams and deliverables are affected by legislative changes and ensure that any regulatory adjustments are integrated into internal procedures (4.1.14). They also engage with permitting and certification processes as part of ensuring project compliance. This includes working with licensing authorities, certification bodies, and oversight agencies to meet standards related to safety, material efficiency, and sustainability (6.4.2). Required documentation may include environmental impact calculations, technical assessments, and formal applications for project approval (4.1.14).

As part of these processes, engineers may be required to maintain accurate and complete records that may be subject to legal scrutiny or public access. Freedom of Information (FOI) requests, for example, demand the production of all relevant documentation, including site photos and correspondence (5.3.3). Engineers may also need to work closely with EU affairs experts or lobbyists to monitor legal developments at the national or European level and to align project plans with policy directions and regulatory expectations (6.4.3).

*Interprets and applies legislation, permits, regulatory documentation, and reporting requirements to ensure legal compliance in engineering projects; reviews draft and enacted legal texts to assess project impact, meets certification and permitting obligations through communication with oversight bodies, and maintains documentation required for public disclosure and regulatory approval; aligns project activities with evolving regulatory frameworks through continuous monitoring and engagement with legal and administrative stakeholders. (Related to report sections: 4.1.14; 5.3.3; 6.4.1; 6.4.2; 6.4.3)*

## Contracts and Formal Agreements

Contracts and formal agreements serve as primary instruments for structuring relationships, defining responsibilities, and ensuring accountability in engineering projects. Written

agreements—including contracts, tenders, NDAs, and technology agreements—are used to regulate procurement, manage confidentiality, and document commitments between parties. These documents function as binding tools that formalise both technical and financial arrangements (5.3.4).

Engineers may need to contribute, in collaboration with legal experts, to the drafting and negotiating of contracts that define roles, deliverables, and legal obligations. This includes preparing formal documents such as tenders that specify customer requirements and responding to quotations in procurement processes that determine which party is commissioned (5.3.4). Technology agreements are used to govern collaborative engineering activities, while NDAs are selectively applied to manage confidentiality where appropriate (5.3.4). Engineers may also need to engage in financial negotiation to align project terms with budgetary constraints and payment structures. This involves clarifying investment needs, discussing pricing, and ensuring that contract terms are understood and accepted by all stakeholders (4.1.6). Engineers may also need to revise contract terms in response to legal or regulatory changes. When amendments to legislation occur, existing contracts may need to be updated to reflect new compliance conditions (4.1.14).

*Drafts and negotiates contracts and formal agreements such as non-disclosure agreements (NDAs), tender documents, and technology agreements to formalise business relationships and define project commitments, regulate procurement, clarify financial terms, and ensure legal accountability; revises contract terms in response to regulatory changes and engages in financial negotiation to align technical objectives with investment and cost expectations. (Related to report sections: 4.1.6; 4.1.14; 5.3.4)*

### Project Proposals

Project proposals are to secure funding, approvals, and partnerships and require coordination across technical and strategic dimensions. Proposals must communicate feasibility, align with stakeholder expectations, and meet both technical and strategic requirements. They function as formal submissions that justify project value, outline deliverables, and address compliance and financial considerations. Engineers need to be able to formulate proposals that include clearly defined objectives, structured milestones, and supporting data. This includes documenting timelines, budgets, and technical plans that demonstrate viability to external evaluators. Proposals must also be adapted to context—whether addressing planning authorities, public funders, or private investors—requiring a balance of factual reporting and persuasive framing (5.3.5; 7.1.6).

Proposal development often involves iterative coordination with industry partners, funding bodies, and regulatory authorities to ensure acceptance and support (4.1.2; 5.3.5; 6.1.5; 6.3.6). Engineers, when writing proposals, engage with industry partners and financial

stakeholders during proposal development. This includes securing letters of support, integrating feedback from potential sponsors, and conducting feasibility discussions before submission (4.1.2; 6.1.5). In many cases, proposals are presented both in writing and through meetings, with input from multiple stakeholders shaping the final version (5.3.5). In some cases, funding agencies may expect pre-established partnerships and evidence of originality or innovation before proposals can be approved (6.3.6).

*Formulates structured project proposals that demonstrate feasibility, align stakeholder objectives, and support funding acquisition through clear justifications, defined milestones, and detailed planning; develops persuasive submissions tailored to funding bodies, industry partners, and regulatory stakeholders, incorporating early-stage input, budgetary data, and technical assessments; coordinates with collaborators to validate project originality and secure pre-submission alignment where required. (Related to report sections: 4.1.2; 5.3.5; 6.1.5; 6.3.6; 7.1.6)*

## Declaration of Invention

A declaration of invention is a formal document used to initiate the intellectual property review process by identifying potentially patentable innovations. These declarations are required before patent applications can proceed and serve as internal mechanisms for evaluating novelty, assessing commercial viability, and determining the most appropriate channel for dissemination. They may also support structured decision-making on whether to pursue patent protection or share findings through other formats, such as scientific publications (5.3.7; 4.1.17).

Engineers and engineering researchers need to be able to prepare declarations that clearly describe the innovation, its distinction from existing solutions, and its potential impact. This includes articulating how the invention advances the current state of the art and compiling the necessary technical details to support novelty evaluation (4.1.17). The ability to document these elements clearly is a prerequisite for legal and commercial assessment and forms the basis of internal review.

In this context, engineers work in coordination with internal university offices, technology transfer units, and intellectual property professionals who evaluate whether the proposed innovation meets the criteria for patenting. These stakeholders manage the review process and may approve or decline further patent actions based on feasibility and strategic fit (6.5.3; 6.4.4). Collaboration across legal and technical domains is essential, as legal experts may not fully grasp the invention's significance, while technical staff may lack familiarity with patenting procedures (4.1.9). Development of these documents requires cross-disciplinary communication and systematic documentation of innovations. Declarations of invention formalise the transition from research outputs to intellectual property assets and function as the initial step in institutional and legal review processes for patent protection (5.3.7).

*Documents potentially patentable innovations to support the evaluation of novelty, commercial viability, and eligibility for intellectual property protection; prepares structured declarations that describe the state of the art and define the innovation's distinct contribution; coordinates with legal experts, internal university offices, and technology transfer units to ensure proper assessment and determine whether to proceed with patent applications. (Related to report sections: 4.1.9; 4.1.17; 5.3.7; 6.4.4; 6.5.3)*

### Marketing Materials

Marketing materials are used in engineering and commercial settings to promote products, communicate initiatives, and engage external audiences. These materials—ranging from advertisements and articles to digital content and targeted campaigns—play a role in external visibility, customer outreach, and product positioning. Marketing efforts are distinguished from scientific communication by their focus on persuasion, accessibility, and strategic alignment with commercial objectives (5.3.8; 6.2.2).

Engineers may need to be able to contribute to the creation and dissemination of marketing content that aligns with the technical and strategic goals of a project. This includes supporting the development of digital materials such as company website content, public-facing articles, and targeted promotional outputs designed to reach specific audiences (5.3.8). They collaborate with marketing, communications, and sales colleagues to support customer engagement and commercial alignment. This includes updating sales representatives on technical developments, preparing materials for product promotion, and coordinating with marketing teams during early-stage product launches or customer trials (6.2.2). Marketing personnel are also involved in direct communication with potential customers to assess needs and present solutions, positioning engineers as technical informants in the marketing process.

This requires effective coordination between technical and commercial functions and the ability to adapt language and format to non-specialist stakeholders. Engineers must exchange information with marketing experts who conduct market inquiries and assess feasibility, while also helping to translate technical content into promotional formats that support outreach, engagement, and public visibility (5.3.8; 6.2.2).

*Creates and supports persuasive promotional materials that present technical developments in commercially meaningful ways; collaborates with marketing and sales teams to align messaging with product goals, customer needs, and strategic commercial objectives; contributes technical insight to targeted campaigns, digital outreach, and product-focused communication. (Related to report sections: 5.3.8; 6.2.2)*

## Articles

Articles and scientific publications serve as key tools for communicating technical knowledge, sharing research outcomes, and contributing to professional development. Engineers, particularly those in R&D contexts, use written outputs—including peer-reviewed papers and academic articles—to engage with academic, industrial, and interdisciplinary audiences. These publications support structured knowledge exchange and often function as alternatives to patenting when innovations are not pursued for intellectual property protection (4.3.1; 5.3.6).

Articles may be used to support professional and academic visibility, contribute to the documentation of emerging technologies, and participate in broader technical discourse. They may also serve as a means of remaining current with developments in other domains, particularly where technology screening or cross-sector integration is involved (5.3.6). In either case, engineers need to be able to write with clarity and structure in ways that are appropriate for diverse readerships. This includes preparing publications that are both informative and pedagogic, with content tailored to audiences ranging from technical experts to multidisciplinary professionals, ensuring accessibility across disciplinary boundaries (4.3.1; 5.3.6).

*Writes and publishes well-structured articles and papers that are informative, pedagogic, and accessible to diverse audiences, including those beyond the engineer's immediate field, to support the dissemination of technical knowledge, cross-disciplinary engagement, and to promote professional and academic visibility. (Related to report sections: 4.3.1; 5.3.6; 5.3.8)*

## **8.2. Communication Contexts & Applications**

### **8.2.1. Business and Industry**

#### Customer engagement

Customer engagement is central to shaping project requirements, design decisions, and technical problem-solving. Customers appear across multiple phases of the engineering process—from early-stage idea generation and need identification to implementation and solution delivery. Communication with customers takes place through both formal and informal channels, requiring engineers to manage expectations, tailor information to audience expertise, and align solutions with functional and usability requirements. The data also describes challenges such as diverging stakeholder priorities and cost-related friction, requiring negotiation and adaptive strategies.

Engineers need to be able to engage with customers to clarify needs and expectations, particularly where client perspectives differ from technical or planning viewpoints (6.2.3). They can use presentations, pitches, and demonstrations to share technical information, including in

early-stage exploratory meetings and industry-hosted result-sharing sessions (5.1.4). This requires them to adapt the level of technical detail based on the client's expertise and context, avoiding content that may overwhelm less technically experienced audiences (5.1.4). They also need to be able to identify and respond to requirements embedded in formal documents, such as tenders, which communicate customer wishes and define deliverables (5.3.4).

They can conduct site visits and participate in face-to-face meetings to observe conditions, introduce products, or resolve problems in situ (6.2.3). They also coordinate with sales and marketing colleagues to present solutions and engage early with customers during product positioning (6.2.2). This requires them to translate technical content for use in promotional contexts, such as company websites or targeted campaigns (5.3.8). Where customer desires are not yet explicit, engineers can recognise market signals and frame technical solutions to respond to or influence future demand (4.1.5). In cases of conflicting expectations—such as cost constraints versus sustainability goals—they must negotiate priorities and maintain consistent communication to manage stakeholder friction (7.2.8).

*Engages directly with customers to diagnose technical challenges, clarify requirements, and co-develop responsive solutions; adapts communication methods to suit client expertise and expectations; interprets formal inputs such as tenders and customer specifications, responds through written and verbal exchanges, and coordinates with other colleagues to align technical outputs with usability and promotional needs; navigates conflicting priorities. (Related to report sections: 5.1.4; 5.3.4; 5.3.8; 6.2.2; 6.2.3; 4.1.5; 7.2.8)*

## Site visits

Site visits provide direct access to technical environments, clients, and on-site personnel. They are used to identify customer needs, resolve emerging problems, and manage the coordination of work during project implementation. While virtual meetings have become common, certain forms of communication—particularly those requiring trust, negotiation, or hands-on problem-solving—remain most effective through in-person engagement. Site visits enable engineers to respond to project demands in real time and ensure alignment between design intentions and execution.

Engineers need to be able to conduct site visits to communicate effectively with clients and contractors in context-specific settings (5.1.1). They can observe conditions firsthand to clarify customer expectations and usability requirements (6.2.3). During on-site interactions, they can identify and resolve issues immediately through direct dialogue with technical personnel, preventing delays and adapting solutions to real-time conditions (4.1.10). This requires them to coordinate across multiple teams—including contractors, subcontractors, and technicians—to ensure project goals and quality standards are met (6.1.3).

They can adapt their language and explanation style when speaking with diverse on-site stakeholders, addressing varying levels of technical knowledge and avoiding misunderstandings caused by assumptions of shared terminology (7.1.4). Engineers must also coordinate material and resource needs with subcontractors and suppliers, ensuring that communication remains timely and accurate throughout the construction or implementation phase (4.1.7). Across all interactions, they maintain professional and respectful communication, fostering cooperation and ensuring shared understanding during execution tasks (4.1.7; 6.1.3).

*Conducts site visits to identify client needs, resolve technical issues in real time, and coordinate with on-site personnel to align implementation with design specifications; engages in immediate, face-to-face exchanges with contractors, technicians, and clients, adapting language and communication methods to the audience; manages supply-related discussions and maintains collaborative, respectful dialogue to support project progress and quality outcomes. (Related to report sections: 5.1.1; 6.2.3; 4.1.10; 6.1.3; 7.1.4; 4.1.7)*

## Securing funding

Securing funding is a structured and multi-step communication task involving written proposals, stakeholder coordination, and persuasive engagement with funding bodies and planning authorities. Funding interactions are not limited to financial discussions but also encompass technical feasibility, innovation potential, and strategic alignment with policy or institutional goals. Effective communication is necessary both before and during proposal submission to ensure that project objectives meet funder expectations and that necessary support is obtained.

Engineers need to be able to present project proposals that clearly articulate feasibility, innovation, and technical value to funders and planning authorities (4.1.2; 5.3.5). They engage in both written and oral communication, submitting structured documents with justifications, data, and milestones to meet the requirements of contracting authorities, industry sponsors, and institutional funders (5.3.5; 6.3.6). These proposals often require early coordination with partners, including formal letters of support or pre-approval arrangements with companies and research bodies (4.1.2; 6.3.6).

They must adapt the style and content of communication to different audiences, simplifying technical language and emphasising persuasive reasoning when addressing non-specialist stakeholders such as policymakers, municipal authorities, or financiers (6.4.1; 7.1.6). This includes communicating budgetary needs and aligning with political or regulatory frameworks (4.1.2; 6.4.1). Engineers also coordinate with government affairs professionals or lobbyists when institutional advocacy is required, particularly for publicly funded or policy-sensitive projects (6.4.3). Across these contexts, securing funding involves strategic, audience-specific communication that combines technical expertise with targeted argumentation.

*Presents project proposals to funding bodies and planning authorities to demonstrate feasibility, technical merit, and innovation potential; engages with stakeholders through written submissions, meetings, and early consultations to align objectives and validate project viability; adapts language and content to meet proposal requirements, simplifying technical material and using persuasive argumentation; coordinates with industry partners, sponsors, and institutional actors to strengthen proposals and secure financial or regulatory support. (Related to report sections: 4.1.2; 5.3.5; 6.3.6; 6.4.1; 7.1.6; 5.3.1; 6.4.3)*

## Contractor Coordination

Clear, sustained communication with contractors helps in aligning construction and implementation activities with engineering requirements. Contractors appear as central actors in both supervised execution and lateral coordination with designers, architects, and clients. The data describes multiple communication formats—including structured meetings, site-based exchanges, and informal clarification opportunities—as part of this coordination. Engineers are expected to ensure alignment with specifications while also maintaining professional relationships and adapting to varied working styles and expectations.

Engineers need to be able to coordinate with contractors at all stages of project execution to ensure that work aligns with technical requirements and agreed deliverables (4.1.7; 6.1.3). This includes participating in structured meetings and site visits to address issues, clarify expectations, and reinforce understanding in context-specific settings (5.1.1; 4.1.7). They can adjust communication methods to suit the professional background and expertise of each contractor, ensuring that messages are appropriately tailored (4.1.9).

They can maintain open, respectful communication with contractors and subcontractors, building trust and sustaining cooperation across the duration of the project (4.1.7; 6.1.3). This requires managing both day-to-day exchanges with on-site personnel and broader coordination with supply-side partners such as subcontractors and suppliers (4.1.7). Engineers also support lateral collaboration with contractors during process implementation, acting as technical counterparts in shared supervisory and delivery roles (6.1.3). Across all contexts, communication practices are directed toward maintaining alignment between project goals, specifications, and practical execution.

*Maintains clear, ongoing communication with contractors to ensure that construction and implementation activities align with project specifications and engineering requirements; coordinates through structured meetings, site visits, and day-to-day exchanges to clarify expectations, address issues, and reinforce understanding; adapts communication methods to suit the expertise and role of each contractor while supporting respectful, cooperative relationships across the delivery process. (Related to report sections: 5.1.1; 4.1.9; 6.1.3; 4.1.7)*

## Design and Construction Issue Resolution

The resolution of design and construction issues is a collaborative, real-time activity requiring input from multiple perspectives. Engineers, architects, and other stakeholders engage in ongoing dialogue to adjust plans, address discrepancies, and ensure feasibility and compliance with technical standards. These interactions are described as time-sensitive and solution-oriented, often taking place through informal or verbal channels rather than extended written communication. Coordination across roles and disciplines is key to maintaining alignment as project conditions evolve.

Engineers need to be able to facilitate multi-perspective discussions that bring together technical, architectural, and environmental inputs to resolve design and construction issues (4.1.8). This includes checking design details with clients, designers, and team members to confirm that proposals remain compliant and practical under changing conditions (4.1.8). They can initiate targeted, real-time exchanges—such as phone calls or face-to-face meetings—to clarify problems before they escalate (4.1.8; 4.1.3). This requires prioritising immediacy and responsiveness in high-stakes or fast-moving project phases.

Engineers need to be able to adjust designs in dialogue with stakeholders to meet client needs without compromising regulatory or engineering requirements (4.1.8). In parallel, they maintain working relationships between design and site personnel, using short-form communication to reinforce shared understanding and execution readiness (4.1.3). These practices reflect a broader emphasis on coordinating across roles to keep projects moving forward under uncertain conditions.

*Facilitates real-time, multi-perspective discussions to resolve design and construction challenges; confirms technical feasibility and compliance through targeted exchanges with architects, contractors, and clients; prioritises informal, time-sensitive communication to adjust design plans in response to changing needs and conditions, address discrepancies before they escalate and sustain coordination between design and construction roles. (Related to report sections: 4.1.8; 4.1.3)*

## On-Site Problem Solving

The data presents on-site problem-solving as a real-time, communication-driven activity essential to maintaining progress during construction, installation, and implementation. Engineers engage directly with site personnel, technical staff, and project stakeholders to resolve emerging issues before they escalate. These exchanges are typically immediate, face-to-face, or verbal, with a focus on operational clarity, technical accuracy, and continuity of execution. The excerpts describe this communication as both hands-on and collaborative, requiring coordination across roles and rapid adaptation to project-specific challenges.

Engineers need to be able to identify and resolve technical issues through direct, on-site communication with contractors, technicians, and other project actors (4.1.10; 6.1.3). They can troubleshoot problems during implementation phases, using face-to-face dialogue or immediate verbal exchanges to clarify discrepancies and avoid delays (4.1.8; 4.1.10). This includes participation in both formal meetings and informal conversations to address setbacks before they affect delivery timelines (4.1.10).

They can coordinate with supervisors, department heads, and technical staff to solve operational challenges in dynamic, multi-team environments (4.1.10; 6.1.3). During final phases, they oversee installation and guide stakeholders through step-by-step procedures to ensure proper system function (4.1.15). These practices also involve lateral communication with designers and other professionals to maintain alignment during execution (6.1.3).

*Engages in direct, timely on-site communication to troubleshoot technical issues, prevent delays, and resolve design or construction problems efficiently; coordinates with contractors, technicians, and managers to address setbacks during implementation; provides real-time clarification through face-to-face dialogue, site inspections, or informal exchanges; oversees installation phases by guiding stakeholders through system setup and ensuring alignment with technical requirements. (Related to report sections: 4.1.8; 4.1.10; 6.1.3; 4.1.15)*

## Post-Implementation Troubleshooting

Post-implementation troubleshooting is an ongoing communicative task that supports system reliability, user satisfaction, and long-term performance. After installation or initial handover, engineers remain engaged through open channels of communication to address malfunctions and respond to changing project requirements. These interactions rely on prompt feedback, role clarity, and shared understanding—often involving coordination with external partners. Effective communication in this phase enables both immediate issue resolution and proactive maintenance.

Engineers need to be able to maintain communication beyond initial implementation to address operational problems and respond to evolving needs (4.1.16). They can engage in follow-up dialogue to clarify terminology and coordinate responsibility for maintenance and troubleshooting tasks (4.1.16). This includes gathering and responding to feedback from users or partners to resolve issues before they affect broader system performance (4.1.16; 4.1.10).

They can work collaboratively with technical staff, managers, or external stakeholders to resolve faults, implement fixes, and prevent downtime (4.1.16; 4.1.10). Communication may take place through formal or informal channels, depending on the urgency and context. These practices support immediate problem-solving and contribute to the continuous improvement of infrastructure or systems over time (4.1.16).

*Maintains open communication channels to identify malfunctions and respond to changing requirements after project implementation; coordinates with clients, managers, and maintenance personnel to clarify responsibilities and resolve technical issues; gathers and acts on feedback to support system reliability, minimise downtime, and ensure long-term functionality through ongoing dialogue. (Related to report sections: 4.1.16; 4.1.10)*

## **8.2.2. Crisis Communication & Rapid Problem Resolution**

### Swift, Transparent Communication

Managing time-sensitive or unexpected challenges and crisis situations in engineering projects requires swift, transparent communication. Whether addressing malfunctions, resolving financial uncertainties, or responding to public concern, engineers are expected to act quickly and communicate clearly to prevent escalation. Failure to do so—through delay, ambiguity, or omission—can result in mistrust, project setbacks, or misalignment between key stakeholders. In contrast, timely and open exchanges support immediate coordination, maintain credibility, and help contain risks.

Engineers are expected to act quickly by sharing accurate, unambiguous information with all relevant stakeholders to avoid delay, misunderstanding, or mistrust (4.1.6; 4.1.19). They can manage unexpected developments by offering concise explanations of failures or uncertainties (4.1.19), maintaining transparency to prevent reputational or operational damage (4.1.6). When appropriate, they use structured external communication—such as briefings or press statements—to ensure that stakeholders and affected groups have a reliable understanding of the situation (4.1.19).

*Communicates promptly and openly to maintain alignment, prevent escalation, and sustain trust during urgent or sensitive situations; ensures shared understanding through accurate, transparent updates across all affected parties. (Related to report sections: 4.1.6; 4.1.19)*

### Real-Time Updates

Providing real-time updates is necessary when managing rapidly changing conditions in engineering projects. Whether shared through digital platforms, phone calls, or in-person exchanges, timely updates help prevent delays, support quick decisions, and sustain coordination among distributed teams.

Engineers are able to select communication tools that fit the immediacy of the situation—messaging apps, calls, stand-up meetings, and ad-hoc conversations—and provide short, accurate updates that keep distributed teams aligned (5.2.2; 5.1.2; 5.2.3; 4.1.10). They replace slow or overly formal communication (such as long emails) with efficient, context-matched exchanges, supporting momentum in both structured and informal settings (4.2.1).

They also recognise when to avoid fragmented or excessive communication that may overwhelm stakeholders or obscure critical details (5.2.2; 4.1.18).

*Delivers concise, context-appropriate updates through suitable tools to support rapid decisions in dynamic environments; maintains team alignment while avoiding communication overload or fragmentation. (Related to 5.2.2; 5.2.3; 5.1.2; 4.1.10; 4.2.1; 4.1.18)*

### Stakeholder Trust Maintenance

Trust maintenance is an ongoing communication task that spans both routine project interactions and moments of potential conflict or uncertainty. Trust is supported by clear, consistent, and direct communication, while vague or delayed messaging can quickly undermine relationships with stakeholders. Engineers build trust through early relationship development, context-sensitive engagement, and efforts to clarify misunderstandings or conflicting interests. Maintaining trust is presented as essential to stakeholder cooperation, especially in large-scale or politically sensitive projects.

Engineers need to be able to foster trust through direct, consistent, and well-timed communication with stakeholders (4.1.3; 7.2.5). They can develop professional relationships early, using informal or verbal interaction to sustain open lines of communication throughout a project (4.1.3). They manage tension or misalignment by listening carefully, responding promptly, and avoiding ambiguity in both written and spoken forms (4.1.11; 7.1.5; 4.1.19).

They can negotiate across conflicting priorities by tailoring communication to stakeholder roles and using factual, well-structured messaging to build understanding (4.1.4; 7.2.8). In settings where mistrust has developed—such as in response to changes, delays, or unclear decisions—they can use proactive messaging and direct engagement to reduce opposition and restore transparency (4.1.18; 4.1.19).

*Manages public concerns and fosters stakeholder confidence through consistent, clear, and well-timed communication; uses direct interaction to build rapport, clarify project intentions, and reduce misunderstandings; responds constructively to mistrust or conflict, adjusting communication methods to meet evolving stakeholder needs. (Related to report sections: 4.1.3; 4.1.11; 7.1.5; 4.1.4; 7.2.8; 4.1.18; 7.2.5; 4.1.19)*

### Handling Emergencies

Handling emergencies requires engineers to coordinate communication during sudden technical failures or safety-critical events. Their primary task is to stabilise the situation by ensuring that all responsible parties receive clear, concise, and confirmed information under pressure. This involves establishing immediate communication channels, clarifying roles and terminology, and verifying instructions to prevent operational confusion (4.1.16; 4.1.19).

Engineers demonstrate the ability to maintain communication discipline in moments where misalignment can escalate risk. They issue targeted internal or public-facing updates only as needed, supporting rapid operational adjustment, containment of damage, and the preservation of system integrity over time (4.1.19).

*Establishes crisis communication channels, clarifies roles, and uses confirmation-based dialogue to coordinate rapid action during technical emergencies; provides essential updates that support system stabilisation and limit escalation. (Related to report sections: 4.1.16; 4.1.19)*

### 8.2.3. Interdisciplinary Teams

#### Facilitating cross-disciplinary discussions

Cross-disciplinary discussion is central to almost all engineering communication, linking distinct fields and professional practices to support research, development, and implementation. Engineers, scientists, technical specialists, and industry partners engage in shared problem-solving where communication connects laboratory knowledge with industrial and applied processes (6.1.5; 6.5.1). Interactions among disciplines require coordination of diverse perspectives and clear articulation of information (4.1.9; 6.5.1). Differences in data expectations and working methods often create communication challenges that must be negotiated through adaptive and transparent dialogue (4.1.9; 7.2.8).

Engineers need to be able to facilitate effective communication among professionals with varied disciplinary backgrounds to align objectives and ensure coherent project development (4.1.9). They need to interpret and convey specialised information in ways that accommodate collaborators' expertise, bridging disciplinary terminology and practice (4.1.9; 6.5.1). They also need to organise and participate in structured interaction formats such as conferences, workshops, and symposia, which provide formal opportunities for exchanging expertise between academic and industry professionals (5.1.5). Engineers are required to collaborate with non-technical specialists such as legal advisors, managers, and designers, ensuring that complex technical content is clearly communicated across domains (4.1.9; 6.1.6). When projects involve conflicting stakeholder priorities, they can negotiate these tensions and maintain open communication that enables alignment across professional and disciplinary boundaries (7.2.8).

*Facilitates communication among specialists from multiple disciplines, aligning objectives, translating technical information across fields, coordinating participation in formal knowledge-sharing contexts, and negotiating differing stakeholder perspectives to sustain effective interdisciplinary collaboration. (Related to report sections: 4.1.9; 5.1.5; 6.1.5; 6.1.6; 6.5.1; 7.2.8)*

### Coordinated knowledge exchange

Coordinated knowledge exchange enables collaboration among engineers, project partners, and industry stakeholders across local and international contexts. This becomes increasingly complex in geographically dispersed or hybrid work environments, where maintaining shared understanding requires deliberate structuring of information and decision-making processes (7.1.2). Communication in this context occurs through digital platforms, structured project meetings, and professional events, supporting the exchange of technical insights, progress updates, and strategic coordination (5.2.2; 6.3.2; 6.2.1). Engineers operate within multi-channel communication systems that combine formal documentation with real-time discussion, integrating emails, reports, messaging tools, and online meetings to maintain alignment within distributed teams (5.2.2; 7.1.2).

Engineers need to be able to coordinate structured knowledge exchange among diverse collaborators, including project managers, technical experts, and industry representatives (6.3.1; 6.3.2). They need to facilitate two-way information flow within consortia by linking partners' expertise to emerging project needs and ensuring that relevant knowledge reaches appropriate groups (6.3.2). They can employ digital communication tools to support collaboration across distances, combining synchronous meetings and asynchronous documentation to ensure that decisions and actions remain visible to all members (5.2.2; 7.1.2). They can also engage with industry professionals through conferences and seminars to present findings and refine project directions based on external feedback (6.2.1).

*Facilitates two-way knowledge exchange across teams, projects, and industries; integrates digital platforms and structured communication processes; connects consortium partners' expertise to shared objectives; and maintains alignment within distributed, international collaborations. (Related to report sections: 5.2.2; 6.2.1; 6.3.1; 6.3.2; 7.1.2)*

### **8.2.4. Internal Communication**

#### Framing technical information for internal stakeholders

Technical information must be framed not only for external audiences, but often also for stakeholders across different departments within the company—colleagues with whom engineers should share common organisational and strategic goals. Framing technical information for internal stakeholders requires engineers to adapt complex content for colleagues across different departments and organisational levels, ensuring that technical updates are understandable, relevant, and decision-ready. Large-scale projects involve multiple divisions such as design, production, and logistics, which depend on structured updates and internal reporting to coordinate progress and maintain shared understanding (4.2.3). Engineers routinely use digital communication systems, reports, and presentations to convey information clearly and efficiently across these units (5.1.4; 5.2.2).

Internal communication also supports alignment with management structures, where engineers report to executives, directors, and supervisors to maintain consistency between technical actions and organisational priorities (6.3.4). Because internal stakeholders often approach issues from different professional perspectives—technical, managerial, commercial, or administrative—engineers need to be able to frame technical information in ways that match the knowledge level, expectations, and decision-making responsibilities of internal stakeholders (6.3.4). Collaboration with subject-matter experts ensures accuracy while enabling engineers to reshape information for audiences such as sales, marketing, or administrative functions whose interpretations influence organisational strategy (6.2.2; 6.5.3).

*Translates complex technical information for internal audiences through structured reports, digital updates, and tailored presentations; collaborates across professional roles to maintain accuracy and relevance; and adapts content to support informed decision-making across departments and organisational levels. (Related to report sections: 4.1.3; 4.2.3; 5.1.4; 5.2.2; 6.2.2; 6.3.4; 6.5.3)*

## Organisational dialogue management

Organisational dialogue management focuses on the practical coordination of communication as it unfolds across teams. Engineers structure communication responsibilities, meeting routines, and interaction norms to support ongoing collaboration, shared situational awareness, and timely decision-making (4.1.1; 4.2.3; 4.2.5). This includes facilitating expectation checks, progress discussions, and kickoff sessions that keep project participants aligned.

A key element is balancing formal structures with informal, spontaneous exchanges—corridor conversations, coffee-machine discussions, or open-plan knowledge sharing—that support quick clarification, peer learning, and flexible problem-solving (4.2.1). Engineers must also maintain communication discipline by addressing slow responses, preventing misunderstandings, and mitigating overload caused by high message volume or fragmented channels (7.4.2; 7.4.3). In hybrid and distributed settings, engineers sustain interpersonal connection, supervision, and mentoring through digital platforms while recognising the challenges created by reduced visibility and accessibility (4.2.4; 6.3.5). Effective dialogue management ensures that communication processes remain coherent even as teams shift between modes, contexts, and levels of formality.

*Structures communication responsibilities and dialogue routines; coordinates formal meetings and informal exchanges; maintains clarity, responsiveness, and interaction quality; and mitigates overload or fragmentation to sustain collaborative alignment across teams. (Related to report sections: 4.1.1; 4.2.1; 4.2.2; 4.2.3; 4.2.4; 4.2.5; 6.3.5; 7.4.2; 7.4.3)*

## Knowledge Transfer and Mentoring

Knowledge transfer and mentoring focus on sustaining institutional expertise by ensuring that knowledge moves reliably from experienced engineers to newcomers or less experienced colleagues. Engineers support continuity by providing structured guidance, hands-on training, and deliberate mentorship that preserve technical and procedural understanding within teams (4.2.2).

They document essential know-how through reports, meeting notes, and shared resources to maintain continuity during staff transitions or project handovers (4.2.2). In hybrid and remote environments, engineers adapt supervision and mentoring practices to digital platforms, conducting regular check-ins and maintaining accessibility despite reduced face-to-face contact (4.2.4). This requires sensitivity to interpersonal dynamics, particularly for junior engineers who may hesitate to seek help without the informal proximity of an office environment.

*Transfers expertise through mentoring, documentation, and structured guidance; maintains continuity during personnel changes; and adapts supervisory communication to remote or hybrid contexts to support learning and integration. (Related to report sections: 4.2.2; 4.2.4)*

## Cross-Departmental Data Sharing

Cross-departmental data sharing concerns the movement of operational information—progress updates, resource data, design inputs, and assessments—across units such as design, production, and logistics. Engineers use structured reporting formats, shared documentation, and digital systems to ensure that all departments have consistent, timely access to the information required for coordinated work (4.2.3).

In geographically dispersed or hybrid contexts, engineers rely on digital platforms, meeting memos, project-management systems, and written documentation to maintain alignment when real-time communication is difficult (7.1.2). They integrate inputs from different units into consolidated records, prevent data silos, and ensure that distributed team members can track decisions and dependencies across organisational boundaries (4.2.3; 7.1.2).

*Coordinates accurate, timely data exchange across organisational units; maintains shared visibility through structured reports and digital platforms; and ensures transparent information flow to support unified project execution. (Related to report section: 4.2.3)*

## Remote Work Coordination

Remote work coordination focuses on managing collaboration when engineering teams are geographically dispersed, requiring deliberate use of digital communication tools and

structured virtual interaction. Engineers rely on platforms such as Teams, Zoom, and WhatsApp to maintain real-time contact, circulate updates, and document decisions across locations, ensuring continuity despite physical separation (4.2.4; 5.2.2). Scheduled online meetings—routine or ad hoc—act as key points of coordination, supporting progress tracking, clarification, and decision-making in digital environments (5.1.1).

Because remote work reduces spontaneous interaction and interpersonal visibility, engineers must actively maintain engagement, accessibility, and support, especially for junior colleagues who may hesitate to seek guidance without in-person proximity (4.2.4; 7.1.2). Effective coordination also involves recognising the limitations of exclusively virtual communication and creating a balance between efficient online workflows and moments of interpersonal reinforcement—either through enhanced digital interaction or periodic face-to-face meetings (5.1.1; 7.1.2).

*Coordinates collaboration across dispersed teams using structured virtual meetings and digital platforms; maintains connection, accessibility, and engagement; documents decisions and task progress across locations; and balances virtual efficiency with interpersonal presence to sustain alignment in remote or hybrid settings. (Related to report sections: 4.2.4; 5.1.1; 5.2.2; 7.1.2)*

## Team Goal Alignment

Team goal alignment focuses on creating and sustaining a shared understanding of project aims, ensuring that technical work, departmental activities, and organisational strategies move in the same direction. Engineers support this by coordinating structured communication between divisions such as design, logistics, and production, clarifying objectives and responsibilities to prevent divergence in priorities or workflow (4.2.3). Regular discussions, progress reviews, and expectation checks reinforce common goals throughout the project lifecycle and help teams recognise how their contributions fit into the broader project vision (4.2.5).

Because projects involve different stakeholder perspectives—balancing cost, quality, risk, and managerial expectations—engineers must facilitate open, integrative dialogue to negotiate these differences and maintain mutual understanding (7.2.8). They ensure that team-level objectives remain aligned with organisational priorities by communicating consistently with management and relaying decisions or strategic shifts transparently (6.3.4). Kickoff meetings and milestone reviews serve as key coordination points for confirming scope, timelines, and deliverables and for re-establishing alignment as conditions change (4.2.5).

*Facilitates alignment of technical, managerial, and organisational goals through regular structured discussions, expectation checks, and transparent communication with management; negotiates differing priorities; and ensures consistent understanding of shared objectives across teams and departments. (Related to report sections: 4.2.3; 4.2.5; 6.3.4; 7.2.8)*

## 8.2.5. Policy and Regulation

### Engaging with certification bodies

Engaging with certification bodies focuses on documenting and demonstrating compliance with legal, environmental, and technical requirements. Regulatory and certification authorities act as external stakeholders who verify conformity through permits, inspections, reports, and documented evaluations (5.3.3; 6.4.2). Communication with these bodies is procedural, evidence-driven, and centred on meeting predefined criteria.

Engineers maintain ongoing contact with certification organisations and oversight authorities by preparing formal reports and compliance documentation covering areas such as material efficiency, safety performance, sustainability indicators, and quality assurance (5.3.1; 5.3.3). This work requires familiarity with procedural documentation formats; accurate interpretation of legislative texts and regulatory criteria; and the ability to link technical information directly to the standards that govern it (5.3.3). Complex technical evidence must be presented in a form that fits regulatory expectations—clear, structured, traceable, and auditable—ensuring that project activities can be evaluated, approved, and continuously monitored within established legal and operational frameworks (5.3.3; 6.4.2).

*Prepares structured compliance documentation; interprets and applies regulatory requirements; communicates verified technical, environmental, and quality data to oversight authorities; and ensures project activities remain demonstrably compliant with established standards. (Related to 5.3.1; 5.3.3; 6.4.2)*

### Knowledge Brokering

Knowledge brokering concerns the translation of technical information into regulatory and policy-relevant terms to support accurate interpretation by government agencies, planning authorities, and regulatory staff. Engineers act as intermediaries who clarify technical concepts, contextualise operational data within legislative frameworks, and prevent misinterpretation by maintaining transparency and conceptual alignment (6.4.1; 7.2.8).

Knowledge brokering is not a question of advocacy or lobbying (for comparison, see *Influencing Regulatory Frameworks*, below) but of interpretive accuracy, compliance, and conceptual alignment. Engineers collaborate with planning authorities and government agencies, which involves clarifying technical content, contextualising data within legislative frameworks, and maintaining transparency to prevent misunderstanding or policy misinterpretation. They ensure that regulators understand the engineering reasoning behind project decisions, and that internal teams understand regulatory expectations (6.4.1; 7.2.8). Collaboration with government affairs experts and EU legislative specialists supports this

interpretive process by tracking changes in regulations and advising engineers on policy implications (6.4.3).

*Translates engineering expertise into policy-relevant formats, ensures mutual understanding between engineers and regulators, and collaborates with legal and governmental experts to interpret and apply evolving regulatory requirements. (Related to report sections: 6.4.1; 6.4.3; 7.2.8)*

## Influencing Regulatory Decision Making

Influencing regulatory frameworks is a strategic, future-oriented communication function in which engineers and associated professionals actively engage in policy development, advocacy, and regulatory shaping. Unlike compliance or interpretation, this competency involves persuasion, aiming to influence legislative outcomes, regulatory direction, and political support for engineering initiatives (6.4.3).

Engineers and government affairs professionals collaborate to monitor legislative developments to identify opportunities and to secure official support or funding for projects (6.4.3). Engineering organisations also have the opportunity to contribute to consultations or advisory processes to ensure that new frameworks reflect practical engineering considerations (6.4.3). Communication with policymaking bodies, planning authorities, ministries, and local governments involves positioning ideas, projects and results as viable, compliant, and socially beneficial, requiring sensitivity to political and community contexts (6.4.1; 7.2.8). This requires proactive engagement and strategic framing to align projects with broader policy priorities, such as sustainability or infrastructure development, while maintaining awareness of political sensitivities and competing interests (7.2.8).

*Engages in strategic dialogue with policymakers, advocates for supportive regulatory decision-making and frameworks, presents technical evidence to influence legislative outcomes, and aligns engineering initiatives with political and societal priorities. (Related to report sections: 6.4.1; 6.4.3; 7.2.8)*

## **8.2.6. Professional Networking**

### Building Stakeholder Relationships

Building stakeholder relationships involves the interpersonal and context-sensitive communication practices through which engineers establish trust and cooperation with project partners, communities, policymakers, and internal teams. These relationships often begin early—sometimes before any formal agreement—and rely on direct interaction such as phone calls, informal meetings, or on-site discussions to address concerns quickly and maintain rapport across organisations (4.1.3). Engineers also engage in structured communication to negotiate

objectives with users, community groups, senior management, and political actors, adapting messages to the needs and expectations of different audiences (4.1.4; 4.1.18).

Stakeholder priorities frequently diverge—cost, quality, political pressure, or technical feasibility—creating tensions that must be managed through transparent communication and careful negotiation (7.2.8). Trust forms the basis of sustained collaboration; active listening, empathy, and consistent interpersonal engagement help prevent misunderstandings and support cooperative problem-solving throughout the project lifecycle (7.2.5).

Engineers need to be able to build and maintain constructive stakeholder relationships through clear, context-sensitive communication. They can initiate early dialogue to develop rapport and shared understanding across organisations (4.1.3). They can adjust engagement strategies to different stakeholder roles and levels of influence, whether interacting with local communities, senior management, or political representatives (4.1.4). They can manage concerns by listening carefully, acknowledging competing priorities, and using targeted explanations to reduce resistance when project measures are contested (4.1.18; 7.2.8). They can also sustain long-term cooperation by maintaining consistent, trust-building communication through both formal and informal channels (7.2.5).

*Facilitates open, trust-based dialogue with diverse stakeholders; negotiates differing priorities through structured engagement; applies empathetic and context-sensitive communication to resolve concerns; and maintains long-term cooperation across technical, political, and community settings. (Related to report sections: 4.1.3; 4.1.4; 4.1.18; 7.2.5; 7.2.8)*

## Leveraging Networking Opportunities

Leveraging networking opportunities refers to the communication practices engineers use to establish, expand, and sustain professional connections across projects, industry, and research contexts. Meetings—formal, routine, small-group, or ad hoc—are viewed as key moments of interaction, with in-person exchanges often considered more effective for clarity, trust-building, and rapid problem-solving than digital formats alone (5.1.1; 4.1.3).

Networking also occurs in informal or semi-formal settings such as conferences, symposia, site visits, and spontaneous encounters, which allow engineers to exchange expertise, identify potential partners, and link technical capabilities across organisations. These environments support early-stage collaboration and help maintain professional ties within national and international consortia (5.1.5; 6.3.2). Digital platforms—particularly LinkedIn—extend these interactions by enabling ongoing visibility, contact maintenance, and wider professional outreach. Effective use of online tools requires adapting communication practices to platform norms and audience expectations (5.2.3). Interactions with external companies, distributors, carriers, and supply-chain partners also illustrate the networking dimension of everyday engineering communication (6.2.1).

Engineers need to be able to use both formal and informal networking opportunities to strengthen professional relationships and support collaboration. They can initiate and sustain rapport through in-person communication—meetings, site visits, or informal exchanges—that helps maintain goodwill and shared understanding across partners (4.1.3; 5.1.1). They can participate actively in conferences, workshops, and international events to connect with peers, researchers, and industry representatives and to exchange expertise (5.1.5; 6.3.2). They can also use digital platforms strategically to maintain visibility, follow developments, and cultivate long-term professional networks (5.2.3). By engaging with external businesses and supply-chain actors, they extend these relationships into the commercial and operational dimensions of engineering work (6.2.1).

*Builds and maintains professional networks through face-to-face meetings, conferences, and informal exchanges; engages strategically in formal and international networking events; and uses digital platforms to extend visibility and sustain cross-sector professional relationships. (Related to report sections: 4.1.3; 5.1.1; 5.1.5; 5.2.3; 6.2.1; 6.3.2)*

## **8.2.7. Public Engagement**

### Communicating Popular Science

Communicating popular science focuses on translating scientific and technical content into formats that are accessible to non-specialist audiences. Engineering teams use public demonstrations, outreach programmes, and events such as European Researchers' Night to raise awareness, explain innovations, and build acceptance for new technologies (4.3.3). These activities require engineers to simplify complex concepts, avoid specialist terminology, and select examples that connect with everyday experience, while still maintaining technical accuracy (4.3.3; 6.6.1). Presentations, pitches, and interactive demonstrations further support this process by making technologies tangible and creating opportunities for direct dialogue with public audiences (5.1.4).

Written and digital outputs also play a central role. Publications, reports, and online materials are designed to be informative or pedagogic, reaching across disciplinary boundaries to audiences such as students, professionals in adjacent fields, and interested laypersons (4.3.1). Science communicators, PR professionals, and journalists act as intermediaries, helping to shape messages for diverse audiences and ensuring that communication remains both precise and engaging (6.6.2).

Engineers need to be able to translate complex scientific and technical concepts into accessible and engaging formats to promote understanding and support informed public dialogue. They can adapt language and presentation style to suit lay audiences, avoiding jargon while maintaining factual accuracy (4.3.3; 6.6.1; 6.6.2). They can use public events, demonstrations, and visual or interactive tools to illustrate how engineering innovations relate to everyday life

(5.1.4). They can write or contribute to publications and outreach materials that communicate research outcomes across disciplines and to non-specialist readers (4.3.1). They can also collaborate with science communicators and journalists to refine key messages, ensuring that technical information is presented clearly and in ways that sustain public interest and trust (6.6.2).

*Translates complex technical content into accessible language; uses demonstrations, publications, and digital platforms to engage public audiences; and collaborates with communicators to ensure accuracy, clarity, and relevance in popular science outreach. (Related to report sections: 4.3.1; 4.3.3; 5.1.4; 6.6.2)*

## Addressing Public Concerns

Addressing public concerns centres on responding to early questions, uncertainties, and worries that arise when engineering projects affect local communities, landowners, or other publics. At this stage, stakeholders are seeking clarity rather than contesting the project. Engineers communicate project goals, anticipated impacts, and trade-offs through public meetings, outreach activities, and digital platforms, ensuring that affected groups understand what is planned and how it may influence them (4.3.3; 5.2.3; 6.6.3). Structured mechanisms—such as liaison officers, consultation rounds, and routine check-ins—provide reliable points of contact and help resolve uncertainties before they accumulate (6.6.3).

Clear, consistent communication is essential in this phase. Ambiguous, hesitant, or fragmented messages can allow minor concerns to solidify into mistrust or opposition (7.1.5; 4.1.19). Engineers must therefore give timely, precise updates, correct misunderstandings, and explain trade-offs where stakeholder priorities differ—for example, between local acceptance, environmental measures, and cost constraints (7.2.8). Addressing concerns also requires attentive listening and context-sensitive explanation that acknowledges anxieties without inflaming them (4.1.18). During sensitive moments or emerging crises, prompt and transparent communication through public statements, briefings, or online channels helps maintain trust and prevent escalation (4.1.19).

Engineers need to be able to manage and respond to early-stage public concerns through clear, consistent, and proactive dialogue. They can establish feedback mechanisms—community briefings, liaison roles, online Q&A channels—to ensure responsiveness (6.6.3; 5.2.3). They can correct misconceptions through timely updates and avoid vague or contradictory messaging (7.1.5; 4.1.19). They can explain project benefits, acknowledge trade-offs, and address differing priorities through targeted, empathetic communication (4.1.18; 7.2.8). They can also deliver swift, factual communication during sensitive phases to maintain public confidence and prevent concern from hardening into opposition (4.1.19).

*Manages early public concerns through clear, responsive, and context-sensitive communication; establishes feedback channels; corrects misunderstandings; and maintains trust through timely, consistent engagement across project stages. (Related to report sections: 4.1.18; 4.1.19; 4.3.3; 5.2.3; 6.6.3; 7.1.5; 7.2.8)*

### Media Interactions

Engineers may engage in structured interactions with communication professionals and public audiences through traditional and digital media channels. Engineering teams contribute to press releases, interviews, public announcements, and online content to share project developments, explain technical issues, and position initiatives in the public domain (4.3.3; 6.6.1). These activities require framing complex information in accessible language, selecting appropriate levels of detail, and adapting messages to the conventions of different media formats and platforms (4.3.3; 5.2.3).

Science communicators, PR experts, and journalists mediate these interactions, working with engineers to translate technical content into clear, accurate narratives that can be understood by non-specialist audiences while remaining faithful to the underlying evidence (6.6.2). Media work also has a strategic dimension: organisations use social and traditional media to increase visibility, shape public perception, and address tensions arising from differing stakeholder priorities or political sensitivities (7.2.8). In urgent or controversial situations, coordinated media briefings and timely updates are needed to prevent misinformation, reduce speculation, and maintain public trust (4.1.19).

Engineers need to be able to communicate effectively with media audiences through clear, consistent, and proactive messaging. They can prepare or contribute to press statements, interviews, and public presentations that explain project developments and technical issues in an understandable way (4.3.3; 6.6.1; 6.6.2). They can use media tools—including social media platforms, organisational websites, and online publications—to engage audiences and support institutional visibility (5.2.3; 4.3.3). They can collaborate with journalists and communication specialists to verify facts, refine key messages, and reduce ambiguity (6.6.2). They can also manage urgent or sensitive issues through structured media briefings and rapid public updates that help prevent escalation and sustain credibility (4.1.19; 7.2.8).

*Engages with media and public audiences through clear, proactive, and accessible communication; uses press briefings, social media, and public presentations to promote initiatives, manage concerns, and maintain trust. (Related to report sections: 4.1.19; 4.3.3; 5.2.3; 6.6.2; 7.2.8)*

## Citizen Engagement

Citizen engagement focuses on communication that enables meaningful public participation in projects with social, environmental, or local impact. Engineers and project teams use outreach programmes, public campaigns, and digital platforms to share accessible information about project goals, anticipated impacts, and progress, aiming to raise awareness and encourage involvement from affected communities (4.3.3; 6.6.1; 5.2.3). Strategic and targeted messaging—including marketing materials, campaign content, and tailored online communication—supports wider reach and helps position initiatives in ways that foster understanding and acceptance (5.3.8; 5.2.3).

Effective citizen engagement combines information provision with opportunities for input and dialogue. Engineers work with local authorities, regulators, and communication specialists to align outreach with policy frameworks while creating formal and informal channels—such as consultations, town-hall events, surveys, or interactive online tools—for citizens to express views and contribute to decision-making (6.4.1; 6.6.2; 6.6.3). This requires adapting language, tone, and format to diverse audiences, including those with limited technical background, and ensuring that communication remains inclusive, transparent, and responsive to community perspectives (4.3.1; 4.3.3; 6.6.1). Through these practices, citizen engagement becomes an ongoing, trust-based process rather than a one-off information exercise.

Engineers need to be able to design and manage communication strategies that promote meaningful citizen participation. They can use digital platforms, public campaigns, and social media tools to share accessible, accurate information and invite dialogue from different groups (4.3.3; 5.2.3; 5.3.8; 6.6.1). They can employ targeted messaging and participatory formats to build understanding, foster support, and encourage informed contributions from community members (4.1.4; 6.6.3). They can adapt their communication style to diverse audiences by translating technical content into inclusive and engaging formats and by coordinating with local authorities and regulators to ensure that outreach efforts are consistent with policy and regulatory frameworks (4.3.1; 6.4.1; 6.6.2).

*Uses digital platforms and targeted communication to encourage citizen participation; adapts messages for accessibility and inclusivity; builds trust through transparent dialogue; and collaborates with public institutions and communities to strengthen engagement. (Related to report sections: 4.1.4; 4.3.3; 5.2.3; 5.3.8; 6.4.1; 6.6.2; 6.6.3)*

### **8.2.8. Science and Academia**

#### Grant Proposals

Grant proposal writing is a strategic communication task that links technical feasibility with persuasive justification to secure financial or institutional support. Proposals serve as formal

documents that define objectives, milestones, and resource needs while demonstrating technical merit and wider societal or commercial relevance (4.1.2; 5.3.5; 6.3.6). They must satisfy the structural and thematic requirements of funding bodies and other decision-makers, using clear argumentation, supporting data, and verifiable plans (5.3.1; 5.3.5). Communication with funding institutions, planning authorities, and policy actors also involves positioning projects within regulatory and political frameworks, addressing compliance, environmental impact, and public interest (6.3.6; 6.4.1; 6.4.3).

Engineers need to be able to prepare grant proposals that are both technically sound and persuasive. They can translate specialised methods and data into accessible, outcome-oriented language for reviewers who may not share their technical background (4.1.2; 7.1.6). They can align project narratives with the criteria, policy priorities, and risk considerations of funding bodies and planning authorities (5.3.5; 6.4.1). They can coordinate with academic partners, industry stakeholders, financiers, and technology transfer offices to obtain evidence, support letters, and feasibility assessments that strengthen the submission (4.1.2; 5.3.1; 6.3.6). They can collaborate with government affairs experts and lobbyists to ensure that proposals reflect current legislative developments and funding agendas at national and European levels (6.4.3).

*Prepares structured and persuasive grant proposals; collaborates with academic, industry, and policy stakeholders; aligns project objectives with funding and regulatory priorities; and adapts technical content for clarity and impact across diverse audiences. (Related to report sections: 4.1.2; 5.3.1; 5.3.5; 6.3.6; 6.4.1; 6.4.3; 7.1.6)*

## Conferences

Conferences, workshops, and related events function as formal settings for presenting research, exchanging expertise, and building collaboration across academic, industrial, and professional communities. They provide structured formats—talks, posters, workshops, and special sessions—through which engineers report project outcomes and discuss technical or strategic issues (4.3.1; 5.1.5). These events also support ongoing relationship-building and early-stage collaboration, as informal discussions at conferences often lead to future partnerships and project ideas (4.1.3; 4.3.2).

Engineers need to be able to communicate research clearly and appropriately in conference settings. They can design and deliver presentations and posters that balance technical precision with accessibility for audiences from different disciplines and sectors (4.3.1; 4.3.2; 5.1.5). They can organise or contribute to workshops, symposia, and panel discussions that focus attention on specific topics and enable structured exchange of experience and results (5.1.5). They can use conferences to connect research outputs with industrial interests, policy debates, or educational initiatives, and to initiate or deepen professional networks (4.1.3; 4.3.2).

*Presents research findings in structured academic and professional forums, coordinating workshops, symposia, or poster sessions to promote exchange among engineers, researchers, and industry experts; adapts content and delivery to audience expertise and interests; engages in networking and collaboration-building during conference events to support the ongoing communication of research outcomes. (Related to report sections: 4.1.3; 4.3.1; 4.3.2; 5.1.5)*

## Research dissemination

Research dissemination is a structured process through which engineering results are communicated to academic, industrial, and other professional audiences. Presentations, scientific publications, and demonstrations are core channels for sharing findings, supporting decision-making, and connecting research with practical or commercial application (5.1.4; 5.1.5; 5.3.6). Demonstrations, test sites, and applied showcases make results tangible, while articles and reports provide permanent, citable records that can reach across disciplinary boundaries (5.1.4; 5.3.6). Dissemination also intersects with marketing and outreach, requiring coordination with communication and sales colleagues to distinguish between scientific reporting and promotional material (5.3.8).

Engineers need to be able to plan and carry out dissemination activities that match content, audience, and medium. They can prepare publications, technical reports, and presentations that convey complex results in a clear, structured form while maintaining scientific integrity (5.1.4; 5.3.6). They can adjust depth, terminology, and emphasis depending on whether they address specialist researchers, interdisciplinary peers, industry partners, or other professional stakeholders (5.1.4; 5.1.5). They can participate in conferences, workshops, and demonstration events to present findings, answer questions, and link research outputs to potential applications or further collaboration (5.1.5). They can also work with marketing and communication staff to frame research-based messages for targeted audiences without compromising accuracy (5.3.8).

*Prepares and communicates research findings through presentations, publications, and demonstrations adapted to diverse academic and industry audiences; designs accessible materials that convey technical insights clearly and accurately; coordinates dissemination through conferences and structured exchanges while distinguishing between scientific communication and promotional outreach. (Related to report sections: 5.1.4; 5.1.5; 5.3.6; 5.3.8)*

## Teaching

Teaching in engineering and research contexts is a structured communicative activity through which specialised knowledge, methods, and practices are transferred and further developed. Lectures and classes provide organised environments for presenting disciplinary content, linking current research to curricula, and preparing students for professional and academic work

(5.1.6). Teaching is tightly connected to research dissemination, with publications and project outputs used as pedagogic resources for diverse student groups (4.3.1; 6.5.2).

Students and early-career researchers appear both as recipients and contributors in these exchanges. Communication ranges from explanatory lectures and demonstrations to mentoring, supervision, and progress reporting, where students are expected to present their own work and reflect on results (5.1.6; 6.5.2). Effective teaching depends on adaptation to academic level and background, recognising that first-year students and doctoral candidates require different levels of conceptual depth and methodological detail (4.3.1; 5.1.6).

Engineers need to be able to design and deliver instruction that integrates research content with pedagogical aims. They can prepare lectures, exercises, and materials that present complex topics in a structured and comprehensible way for students from different disciplines and stages of study (4.3.1; 5.1.6). They can adjust examples, terminology, and expectations to match students' prior knowledge and future pathways, from introductory engineering education to advanced research training (4.3.1; 5.1.6; 6.5.2). They can use supervision meetings, laboratory sessions, and project-based work to guide students in applying research methods and to support their development as active participants in academic communication (6.5.2).

*Delivers structured instruction that integrates research communication with teaching practice; adapts language, content, and methods to different levels of student expertise, from introductory to advanced study; develops pedagogic materials that make research outputs accessible across disciplines; engages students as contributors through mentoring, dialogue, and progress reporting. (Related to report sections: 4.3.1; 5.1.6; 6.5.2)*

## Patent Applications

Patent applications concern the formal documentation and legal protection of technical innovations. The process requires engineers and researchers to translate complex mechanisms, experimental results, and functional principles into structured, legally precise descriptions that can be assessed by patent examiners and intellectual property professionals (5.3.7; 6.4.4). The declaration of invention plays a central role in this process, outlining novelty, state of the art, and the specific contribution of the proposed invention in clear, verifiable terms (5.3.7; 4.1.17). These documents form the basis for determining whether an invention qualifies for protection and whether it should proceed through the patenting pathway or be disseminated through other scientific channels. Effective patent communication, therefore, relies on accuracy, clarity, and cross-disciplinary coordination, linking scientific innovation with legal and institutional frameworks.

Engineers need to be able to prepare patent documentation that communicates technical content clearly to legal specialists, IP offices, and internal evaluators. They can structure

invention disclosures, describe mechanisms and distinguishing features with legal precision, and ensure that claims are substantiated by transparent technical evidence (4.1.9; 4.1.17; 5.3.7). They can collaborate with patent attorneys, technology transfer staff, and university offices to refine documentation, respond to evaluative feedback, and align submissions with institutional procedures and regulatory requirements (6.4.4; 6.5.3). These practices require the ability to frame scientific knowledge in a form that supports legal assessment, interdisciplinary understanding, and organisational decision-making.

*Prepares clear and accessible patent documentation; collaborates with legal, academic, and industry professionals to translate technical innovation into protected intellectual property; ensures clarity and interdisciplinarity in patent communication. (Related to report sections: 4.1.9; 4.1.17; 4.3.1; 5.3.7; 6.4.4; 6.5.3)*

### Technology Transfer

Technology transfer focuses on the structured communication processes through which research outputs are adapted, evaluated, and prepared for industrial or commercial application. Unlike patent communication, which centres on legal protection, technology transfer concerns the movement of innovations from research environments into practical use by collaborating with industry partners, marketing specialists, and applied stakeholders (4.1.17; 6.2.2). This involves documenting technical performance, clarifying novelty in relation to user needs, and coordinating feedback loops that allow prototypes and early-stage technologies to be tested and refined (4.1.17). Technology Transfer Offices and internal university structures support this work by assessing commercial potential, managing intellectual property pathways, and aligning research activities with external opportunities (5.3.7; 6.5.3). Communication across scientific, technical, commercial, and operational domains is therefore central to ensuring that research outcomes can progress toward market adoption.

Engineers need to be able to explain technical innovations in ways that support interdisciplinary evaluation and commercial decision-making. They can document inventions through structured reporting, outline performance requirements for industrial partners, and interpret user or market feedback to inform subsequent development (4.1.9; 4.1.17). They can collaborate with Technology Transfer Offices, marketing and sales colleagues, and external companies to assess feasibility, refine use cases, and coordinate early dissemination or demonstration activities (5.3.7; 5.3.8; 6.2.2; 6.5.3). They can also support the alignment of R&D results with manufacturing constraints, regulatory considerations, and customer expectations, ensuring that research outputs transition effectively into applied settings. These practices rely on the ability to connect technical reasoning with market-oriented communication and to manage exchanges across institutional and disciplinary boundaries.

*Facilitates the movement of research outputs toward industrial application; coordinates feedback and evaluation across research, legal, and commercial actors to refine technologies and align them with market needs; and adapts technical information to support feasibility assessment and early adoption. (Related to report sections: 4.1.9; 4.1.17; 4.3.1; 5.3.7; 5.3.8; 6.2.2; 6.4.4; 6.5.3)*

## 8.2.9. Strategic Communication and Advocacy

### Advocacy

Advocacy in engineering focuses on influencing policy, regulatory, and funding conditions so that projects and technologies can advance within supportive frameworks. Engineers and project teams communicate with planning authorities, regulators, and public administrations to position initiatives in terms of compliance, environmental impact, and societal relevance (6.4.1; 4.1.4). Exchanges with certification bodies secure recognition for sustainability and quality performance, providing evidence that projects meet formal standards (6.4.2). Alongside these direct interactions, organisations rely on government affairs experts and lobbyists who monitor legislative developments, coordinate with EU or national institutions, and argue for regulatory or financial support aligned with technical objectives (6.4.3). Advocacy, therefore, links technical reasoning with political and administrative realities, ensuring that engineering perspectives inform policy debate and resource allocation.

Engineers need to be able to articulate technical positions in ways that resonate with policymakers, regulators, and institutional decision-makers. They can prepare concise, evidence-based inputs—briefing notes, reports, or presentations—that address compliance, environmental performance, and social implications in terms relevant to public authorities (6.4.1; 6.4.2). They can adapt their arguments to different levels of governance, from local administrations to national ministries, remaining sensitive to electoral pressures, community expectations, and competing priorities (4.1.4; 7.2.8). They can collaborate with government affairs staff and lobbyists to supply robust technical evidence, clarify feasibility constraints, and align advocacy with evolving legislative agendas (6.4.3). Through these practices, engineers contribute substantively to policy discussions without losing sight of regulatory constraints and societal concerns.

*Engages with policymakers, regulators, and advocacy professionals to position engineering projects within supportive policy and funding frameworks; prepares evidence-based arguments that connect technical, environmental, and social considerations; and collaborates with government affairs experts to monitor legislation and align initiatives with regulatory priorities. (Related to report sections: 4.1.4; 6.4.1; 6.4.2; 6.4.3)*

## Targeted messaging

Targeted messaging refers to the deliberate alignment of content, terminology, and communication channels with the needs of specific stakeholder groups. Engineers address technical specialists, policymakers, managers, and the general public, each requiring different levels of detail and different forms of explanation (4.1.4; 6.1.6). Within expert communities, highly technical exchanges are sufficient and efficient, as participants “speak the same language” (6.1.6). In more heterogeneous contexts—such as energy transition projects or public engagement—engineers must adapt terminology and structure to avoid overload or misunderstanding (6.1.6; 6.6.1). Social media and online platforms, including LinkedIn, websites, and targeted posts, extend these practices by enabling fine-grained audience selection and real-time interaction, while also demanding platform-specific skills such as hashtag management and content optimisation (5.2.3). Targeted messaging thus underpins how information travels across technical, institutional, and public settings.

Engineers need to be able to design and implement communication strategies that adjust message complexity, tone, and medium to the audiences they address. They can use specialist terminology and detailed data when working with technical experts, while simplifying explanations and clarifying core concepts for mixed or non-technical groups (6.1.6; 6.6.1). They can select appropriate channels—formal correspondence, professional networks, or social media—and adapt content to the conventions and affordances of each platform, including the strategic use of tags, visuals, or concise formats to reach intended recipients (5.2.3). They can ground targeted messages in clear justification and factual support, particularly where stakeholder buy-in and accountability are at stake (4.1.4). By aligning content, form, and channel, they maintain precision while maximising relevance and engagement for each stakeholder segment.

*Applies audience-specific communication strategies across technical, institutional, and public contexts; selects and manages appropriate platforms to enhance visibility and interaction; and calibrates message complexity, tone, and evidential support to stakeholder needs. (Related to report sections: 4.1.4; 5.2.3; 6.1.6; 6.6.1)*

## Shaping public opinion

Shaping public opinion in engineering contexts centres on building informed, trust-based support for technologies, projects, and sustainability measures among non-specialist audiences. It may include outreach activities such as demonstrations and public events, where technical concepts are presented without dense scientific terminology to maintain accessibility and interest (4.3.3; 5.1.4; 6.6.1). Strategic communication is used to position organisations and projects in the public mind, particularly in the context of the green transition, where acceptance of new infrastructures and practices may involve visible change or higher short-term costs

(4.3.3; 6.4.1). Presentations, town-hall meetings, and media engagement help clarify benefits, trade-offs, and rationales for decisions (5.1.4; 6.4.1). Science communicators, journalists, and PR professionals act as intermediaries, reshaping technical material into narratives that are both accurate and understandable, while repeated emphasis is placed on the risks of inconsistent or opaque messaging for public trust (6.6.2; 6.6.3).

Engineers need to be able to link technical developments explicitly to societal values, environmental goals, and everyday concerns. They can explain complex systems and sustainability measures in plain language, using examples, visuals, and demonstrations that show why a solution is needed and how it works (4.3.3; 6.6.1; 5.1.4). They can work with communication specialists and journalists to refine key messages, avoiding jargon while preserving conceptual accuracy and quantitative evidence (6.6.2). They can design outreach that acknowledges potential objections—such as cost, disruption, or environmental risk—and addresses them directly with transparent reasoning and data (4.1.4; 6.4.1; 6.6.3). Through consistent, proactive communication across events, media, and digital channels, they help shape public understanding and support for engineering and sustainability initiatives.

*Connects technical and sustainability initiatives with public values through accessible explanation, demonstrations, and strategic outreach; collaborates with communication professionals to craft accurate, engaging narratives; and uses consistent, transparent messaging to build trust and encourage informed support. (Related to report sections: 4.1.4; 4.3.3; 5.1.4; 6.4.1; 6.6.1; 6.6.2; 6.6.3)*

## Securing approvals

Securing approvals focuses on the structured communication required to obtain formal authorisation and funding for specific projects. Proposals, reports, and compliance documents provide the written basis on which contracting authorities, funding institutions, and certification bodies assess feasibility, risk, and alignment with policy objectives (5.3.1; 5.3.5; 6.3.6). These texts combine technical data, milestones, and cost estimates with persuasive framing to convince planning and funding authorities that a project is both viable and desirable (5.3.5; 6.4.1). Interactions with financiers and funding agencies often begin before submission, as partners are consulted to test feasibility and ensure that planned activities meet eligibility and evaluation criteria (6.3.6). In parallel, communication with certification bodies confirms that proposals and project designs satisfy defined sustainability, material, and quality standards (6.4.2). Securing approvals, therefore, ties together technical documentation, regulatory compliance, and strategic argumentation within formal decision-making procedures.

Engineers need to be able to prepare proposals and reports that meet procedural requirements while communicating project value clearly and convincingly. They can assemble data-supported justifications, define measurable milestones, and describe risks and mitigation

strategies in structured formats expected by funding and regulatory bodies (5.3.1; 5.3.5; 6.3.6). They can shape narratives that connect technical solutions to policy goals, community needs, and environmental targets, recognising the political and social context in which decisions are made (6.4.1; 7.2.8). They can liaise with funding institutions, financiers, and project sponsors to clarify expectations, adjust proposals, and align project plans with available instruments and criteria (6.3.6). They can coordinate with certification organisations to demonstrate conformity with sustainability and performance benchmarks as part of the approval process (6.4.2). Through these activities, engineers translate project concepts into decision-ready documentation that enables formal endorsement.

*Develops structured, evidence-based proposals and reports that satisfy procedural requirements and persuade funding and regulatory bodies; aligns technical content with policy, sustainability, and stakeholder priorities; and coordinates with funders, financiers, and certification authorities to secure project authorisation and support. (Related to report sections: 5.3.1; 5.3.5; 6.3.6; 6.4.1; 6.4.2; 6.4.3; 7.2.8)*

## Overcoming Resistance

Overcoming resistance concerns communication with stakeholders who already oppose or challenge project measures. In these situations, issues such as cost, sustainability commitments, technical feasibility, and political accountability may collide, creating friction between project teams, clients, and communities (7.2.8; 4.1.4). In infrastructural and land-use projects, resistance may stem from compulsory purchase, environmental impacts, or perceived inequities—conditions that require careful, sustained engagement to rebuild confidence (4.1.18; 6.6.3). Engineers and project managers rely on early listening, dialogue, and context-specific explanation to acknowledge objections, clarify constraints, and negotiate adjustments that stakeholders may accept (4.1.18; 6.6.3). As the material shows, unclear or inconsistent communication exacerbates opposition and undermines cooperation (7.2.8; 6.6.3).

Engineers need to be able to address active opposition through communication strategies that recognise concerns while clarifying technical and practical limits. They can listen carefully to the underlying sources of resistance—economic, environmental, social, or political—and reflect these back in proposals or explanations (4.1.18; 6.6.3). They can negotiate adaptations to contested measures, making trade-offs explicit and framing options in ways that align technical requirements with local priorities (4.1.4; 7.2.8). They can provide clear, consistent, and well-timed updates that reduce uncertainty, correct misinformation, and prevent gaps from being filled by rumour (4.1.18; 6.6.3). By maintaining an ongoing, two-way dialogue rather than relying on one-directional announcements, engineers increase the likelihood that contested measures are understood, workable, or at least constructively debated.

*Uses empathetic, dialogic communication to address active opposition; negotiates trade-offs in ways that respect stakeholder priorities; and provides clear, timely information to rebuild trust and support cooperation around contested measures. (Related to report sections: 4.1.4; 4.1.18; 6.6.3; 7.2.8)*

## 8.3. Underlying Language and Communication Competencies

### 8.3.1. Cognitive & Functional Skills

#### Evaluating

Evaluation (as a cognitive–discursive process) enables engineers to connect technical judgment with formal decision-making in patenting, regulation, feasibility, and compliance. This involves determining whether innovations are sufficiently novel to warrant protection, using structured records such as declarations of invention (5.3.7). Regulatory texts must be examined in detail to identify obligations, assess their impact on specific technical areas, and determine whether project plans require adjustment (5.3.3). Evaluation also includes verifying whether products and processes satisfy legal, industry, and certification requirements through compliance reporting and progress documentation (5.3.1). Financial considerations and contractual expectations form an additional dimension, particularly in negotiations where investment needs and cost structures must be reviewed and agreed (4.1.6; 6.2.2). Across these contexts, evaluation combines analytical precision with clear, defensible documentation.

Engineers need to be able to assess technical, regulatory, and commercial information and justify decisions through structured reasoning. They can analyse legislative or regulatory texts to interpret requirements and determine their relevance for ongoing work (5.3.3). They can review the originality and value of new developments using tools such as declarations of invention and feasibility assessments (5.3.7; 5.3.1). They can evaluate cost, investment, and contractual parameters in financial negotiations to ensure alignment between technical needs and business expectations (4.1.6; 6.2.2). These evaluations must be clearly argued, recorded, and communicated in ways that support internal decisions, demonstrate compliance, or advance patenting procedures.

*Evaluates evidence, procedures, and outcomes to determine accuracy, relevance, and adequacy; interprets information to form justified judgments and communicates conclusions clearly and transparently, ensuring that decisions are based on verifiable reasoning. (Related to report sections: 5.3.7; 5.3.3; 5.3.1)*

## Explaining

Explanation (as a cognitive–discursive process) ensures that processes, requirements, and technical decisions are understood across teams and stakeholder groups. During installation and start-up, engineers guide technicians through step-by-step procedures, clarifying system behaviour and responding to questions in real time to minimise errors (4.1.15). Communication with suppliers requires clear descriptions of how equipment, software, or components apply to project needs and how they must be integrated to meet technical specifications (6.1.2). In collaborative meetings, explanation supports feedback, correction of misunderstandings, and alignment before decisions are finalised (7.2.2). Excessively detailed technical language can create barriers for non-specialists, making audience adaptation essential (7.1.6). Academic and mentoring contexts further require tailoring explanations to different levels of expertise and experience (6.5.2). Effective explanation brings clarity, reduces risk, and enables accurate implementation.

Engineers need to be able to explain concepts, procedures, and technical reasoning in ways that ensure shared understanding. They can give structured, step-by-step instructions during installation or commissioning activities to support accurate system operation (4.1.15). They can clarify product applications and technical requirements for suppliers and technical partners, ensuring correct integration (6.1.2). They can adapt explanations to avoid overwhelming non-specialist stakeholders, using accessible language and verifying understanding through discussion and feedback loops (7.1.6; 7.2.2). In academic or supervisory settings, they can adjust explanations to the learner’s level, supporting knowledge transfer and professional development (6.5.2).

*Explains technical concepts and procedures clearly and logically; adapts detail and structure to audience needs; and uses dialogue and feedback to confirm understanding and support accurate implementation. (Related to report sections: 4.1.15; 7.1.6; 7.2.2; 6.1.2)*

## Reporting

Reporting (as a cognitive–discursive process) transforms complex technical or organisational activity into structured, interpretable accounts. It involves selecting, organising, and verbalising relevant information—such as progress, conditions, risks, or compliance status—in forms that allow others to evaluate developments, follow reasoning, and make informed decisions. Engineers draw on this skill when preparing progress reports, inspection records, internal updates, or regulatory documentation that must be coherent, accurate, and usable across audiences and decision contexts (4.2.3; 5.3.1; 4.1.20; 6.3.4).

Reporting also requires discursive adaptation: balancing technical detail with clarity (7.1.6), shaping information according to stakeholder needs—including financiers, authorities, and

managers—and presenting evidence in a way that supports evaluation rather than merely recording facts (4.1.6; 6.4.1).

Engineers need to be able to interpret ongoing work and convert it into structured discourse. They can extract salient developments, articulate reasoning, and produce reports that make processes, conditions, or outcomes intelligible to others (4.2.3; 4.1.20). They can adapt structure and style to match different audiences and communicative purposes—tracking, verifying, persuading, or coordinating (5.3.1; 7.1.6; 6.5.2).

*Transforms complex activity into structured, evaluable discourse; selects and organises information to support interpretation, coordination, and decision-making. (Related to report sections: 4.2.3; 5.2.4; 4.1.20; 5.3.1; 6.3.4; 7.1.6)*

### Summarising

Summarising (as a cognitive–discursive process) condenses interactional content—dialogues, meetings, calls, negotiations—into concise, verifiable representations. It distils key points, agreements, responsibilities, and next steps into a minimal written form that stabilises shared understanding after communicative events (4.1.12; 5.2.4).

Where reporting selects and structures extended project activity, summarising captures the interactional moment: interpreting what was said, resolving ambiguities, and formalising the mutually understood version of the exchange. Summaries function as reference points that reduce future misunderstanding, ensure alignment, and maintain discourse continuity across teams and time (4.1.12).

Engineers need to be able to abstract the core meaning of an interaction and express it succinctly, distinguishing agreed facts from opinion, decision from discussion, and responsibility from context (4.1.12; 5.2.4). They can phrase summaries neutrally and precisely, supporting clarity and reducing the cognitive load needed to recall or reconstruct prior dialogue.

*Condenses interactional content into concise, shared representations; stabilises understanding and preserves coherence by capturing essential points from communicative events. (Related to: 4.1.12; 5.2.4)*

### Leveraging plurilingual skills

Plurilingual work in engineering involves drawing on more than one language—and more than one mode—to keep communication clear when teams span countries and linguistic backgrounds. In multinational settings, engineers move between national languages and English, and between spoken and written channels, to accommodate different levels of confidence and fluency (7.2.4; 7.3.1). Some colleagues are comfortable with impromptu calls

or corridor conversations, while others—especially graduates or less experienced staff—avoid real-time interaction and feel anxious about phone calls or unscripted exchanges (7.2.4). In these cases, written messages in a shared language can provide the clarity and processing time people need. Teams also use translation and localisation: English terms may be converted into local-language equivalents, and project materials reformulated so that all participants understand key concepts despite differing language proficiencies (7.3.1). Plurilingual practice, therefore, goes beyond literal translation; it is an ongoing adjustment of language, medium, and pace so that everyone can follow and contribute.

Engineers need to be able to combine languages and communication modes flexibly to maintain clarity and inclusion in multilingual environments. They can shift between English and national languages, or between spoken and written channels, when they notice anxiety or uncertainty about spontaneous interaction (7.2.4). They can translate or reformulate key terminology, adapting English terms into local equivalents where necessary to prevent misunderstandings (7.3.1). They can simplify sentence structures, repeat or paraphrase important points, and use follow-up emails or messages to stabilise meaning after meetings, particularly when participants have differing linguistic backgrounds and expectations (7.2.4; 7.3.1). In doing so, they treat plurilingual resources not as a problem to be managed, but as a toolkit for keeping communication precise and collaborative.

*Combines and adapts multiple languages and communication modes to maintain clarity and inclusion in multilingual contexts; translates, reformulates, and aligns terminology to bridge linguistic gaps and support accurate, collaborative interaction. (Related to report sections: 7.2.4; 7.3.1)*

### Using English as a lingua franca

Using English as a lingua franca enables engineers from different linguistic backgrounds to share a common working language in international projects. In many teams, English functions as the default medium for meetings, emails, and documentation, but participants' proficiency levels vary considerably (7.3.1). Language skills “play a key role”, and engineers must manage not only vocabulary and grammar, but also divergent communication styles and expectations (7.3.1). Translation may be a challenge, sometimes requiring English technical terms to be rephrased or translated into local languages to ensure clarity, and there may be a preference for written English over spoken interaction as a safeguard for precision in multilingual settings (7.3.1). English in these contexts is therefore negotiated rather than “native-like”: it is adjusted, paraphrased, and supported by translation and written confirmation so that it works as a practical tool for all members of the team.

Engineers need to be able to use English flexibly and inclusively as a shared professional language. They can adapt vocabulary and phrasing to colleagues' proficiency levels, avoiding

culture-specific idioms, overly complex structures, or dense jargon that may cause confusion (7.3.1). They can check understanding by paraphrasing key points, inviting questions, and following up spoken exchanges with short written summaries when needed. They can work with translators or bilingual colleagues to localise essential terminology into national languages where this improves comprehension, while still maintaining a coherent English-based working frame for international coordination (7.3.1). Through these practices, they treat English as a collaborative resource—something to be adjusted and negotiated—rather than as a test of correctness.

*Uses English flexibly and inclusively as a shared working language in international collaboration; adapts vocabulary, phrasing, and delivery to accommodate different proficiency levels, supports understanding through paraphrase and written confirmation, and works with translation or localisation where needed to maintain accuracy. (Related to report sections: 7.2.4; 7.3.1)*

## Intercultural sensitivity

Intercultural sensitivity involves recognising how cultural norms shape communication—directness, politeness, hierarchy, formality—and adjusting interaction styles accordingly. International engineering work often brings together colleagues with distinct expectations about tone, decision-making, and interpersonal conduct (7.3.2). Differences in directness may be interpreted as rudeness or evasiveness, and varying hierarchical norms determine who should be addressed and how openly disagreements may be expressed (7.3.2). Engineers described modifying their style—adopting more polite openings, acknowledging hierarchy, or softening requests—to align with local expectations (7.3.2). Others highlighted that approaches successful in one cultural context may fail elsewhere, requiring adaptable and context-aware strategies (7.3.2). New graduates entering multinational environments may struggle without explicit preparation, underscoring the need for deliberate, reflective intercultural competence (7.3.2).

Engineers need to be able to interpret cultural cues and adjust their tone, formality, and level of directness to maintain respectful and effective communication across diverse settings (7.3.2). They can adapt phrasing, acknowledge hierarchy where appropriate, and select culturally aligned ways of framing requests or feedback. They can recognise when local communication norms require indirectness, mediation, or relational politeness, and adjust their approach to avoid unintended offence or misunderstanding. This sensitivity enables collaboration that is both inclusive and professionally aligned with local expectations.

*Adjusts tone, hierarchy, and directness to align with cultural expectations; recognises and interprets social and contextual cues and applies culturally appropriate forms of politeness and interaction to maintain respect and avoid misunderstanding. (Related to report section: 7.3.2)*

### 8.3.2. Emotional and Social Intelligence

#### Active listening

Active listening supports respectful, focused dialogue in both internal teamwork and stakeholder engagement. Attentive communication helps prevent escalation where misunderstandings or unclear messages might otherwise lead to conflict (4.1.11). In negotiations with landowners, communities, or other hesitant stakeholders, careful listening to concerns creates the conditions for fair proposals and reduces resistance to difficult measures (4.1.18; 6.6.3). Trust within teams similarly depends on partners feeling heard; when listening is weak, “chemistry” erodes and cooperation becomes fragile (7.2.5). Accounts in this research also highlight the value of direct interaction—phone calls, meetings, site visits—when tone, nuance, and nonverbal cues are important for resolving tension (4.1.11; 6.6.3). Emotional awareness underpins these practices: noticing when others are frustrated, anxious, or sceptical helps engineers respond constructively rather than defensively (7.2.6). Across settings, active listening involves sustained attention, clarification, and responsive follow-up that keeps communication open and solution-oriented (4.1.11; 4.1.18; 7.2.5; 6.6.3; 7.2.6).

Engineers need to be able to listen attentively and without distraction, focusing on what their counterparts say before responding. They can use clarification questions, paraphrasing, and short summaries to check understanding and prevent misinterpretation in complex or sensitive exchanges (4.1.11; 4.1.18). They can choose communication channels that support nuance—such as calls or face-to-face meetings—when written messages risk sounding confrontational or incomplete (4.1.11; 6.6.3). They can notice emotional cues and adapt their response accordingly, acknowledging concerns and frustrations rather than dismissing them (7.2.5; 7.2.6). In this way, they use active listening to maintain trust, keep dialogue constructive, and create space for joint problem-solving.

*Listens attentively and empathetically to understand perspectives, clarify meaning, and maintain constructive communication; uses understanding rather than confrontation to prevent escalation and support collaborative work. (Related to report sections: 4.1.11; 4.1.18; 7.2.5; 6.6.3; 7.2.6)*

#### Empathy

Empathy enables engineers to recognise how others feel and to adjust communication accordingly. In negotiations with landowners or communities affected by infrastructure projects, acknowledging worries and priorities before presenting proposals builds trust and increases the likelihood of acceptance (4.1.18). Within teams, cooperation depends on the sense that colleagues understand each other’s pressures and constraints; where empathy is lacking, small frustrations escalate, and collaboration suffers (7.2.5). Emotional intelligence supports this work by helping engineers interpret tone, context, and nonverbal cues, and by moderating reactions when interactions become tense (7.2.6). Examples highlight that limited empathy—being

unable “to put themselves in the place of everyone else”—intensifies conflict, while empathetic engagement stabilises relationships and facilitates joint decision-making (7.2.5; 7.2.6). Empathy, therefore, functions as a lens through which engineers perceive others’ experiences and as a guide for how they respond in communication.

Engineers need to be able to notice and interpret emotional signals—frustration, anxiety, scepticism, enthusiasm—and factor them into how they speak and act (7.2.6). They can respond to stakeholders and colleagues by acknowledging their situation, showing patience when tensions are high, and adjusting tone to reduce defensiveness (4.1.18; 7.2.5). They can use empathetic understanding to shape the timing and framing of proposals, explanations, or requests so that they are more likely to be received constructively (4.1.18). In everyday collaboration, they can recognise when someone needs support, space, or clearer guidance, and adapt their communication accordingly (7.2.5; 7.2.6). Through these practices, empathy turns awareness of others’ emotions into concrete choices that protect trust and enable joint problem-solving.

*Recognises and responds to others’ emotional states to maintain trust and cooperation; adjusts communication tone and approach to de-escalate tension, foster understanding, and sustain respectful, solution-oriented interaction. (Related to report sections: 4.1.18; 7.2.5; 7.2.6)*

## Conflict management

Conflict management addresses situations where misunderstandings, competing priorities, or strained relationships threaten project progress. Breakdowns in dialogue, unclear messages, and delayed responses can turn minor issues into serious disputes (4.1.11; 4.1.19). Tensions arise around trade-offs—such as cost versus quality, or political pressure versus technical feasibility—requiring transparent discussion and negotiation (7.2.8). Early, open engagement helps avoid escalation: clarifying facts, correcting misinterpretations, and explaining changes promptly reduces mistrust, particularly in high-stakes projects such as dam construction or major infrastructure (4.1.11; 4.1.19). Conflict management is applied as a structured communication practice that stabilises collaboration under pressure, repairing interaction once disagreement has already taken hold (4.1.11; 4.1.18; 4.1.19; 7.2.8; 7.4.4).

Choice of medium matters: calls or face-to-face meetings allow tone, body language, and immediate clarification where emails are easily misread (4.1.11; 7.4.4). When resistance comes from external stakeholders, engineers need to understand concerns before proposing solutions, combining empathy and factual justification to rebuild cooperation (4.1.18).

Engineers must listen actively to uncover the underlying interests that fuel tension—whether technical, commercial, political, or emotional (4.1.11; 7.2.8). They can acknowledge frustration, clarify misunderstandings, and explain constraints transparently to reduce suspicion or defensiveness. They can choose communication channels that de-escalate: phone or face-to-

face meetings where tone, nonverbal cues, and immediate clarification help prevent further misunderstanding (4.1.11; 7.4.4). They can adapt their style when interacting with anxious, oppositional, or culturally diverse stakeholders—for example, listening first to landowners before proposing difficult measures (4.1.18).

They can also mediate tensions arising from conflicting priorities (profitability vs feasibility, community concerns vs project goals, quality vs cost), guiding stakeholders toward shared understanding rather than competition (7.2.8). Pre-existing relationships and ongoing trust-building play an essential role in reducing hostility and keeping discussions constructive (4.1.11).

*Addresses disagreement and tension through open, empathetic communication; listens actively, clarifies misunderstandings, and uses appropriate tone and medium to de-escalate conflict and restore working relationships. (Related to report sections: 4.1.11; 4.1.18; 4.1.19; 7.2.8; 7.4.4)*

### Interpersonal rapport

Engineers need to be able to cultivate and maintain trust-based relationships with colleagues, partners, and stakeholders over time. They can show consistent interest in others' perspectives, follow up on previous conversations, and remain approachable for questions and feedback (5.1.1; 5.1.3). They can use both formal and informal interactions—structured meetings, mentoring sessions, hallway conversations—to create spaces where concerns and ideas can be raised early and without embarrassment (4.2.4; 5.1.1; 5.1.3). They can combine empathy and attentive listening to signal reliability and respect, recognising that these micro-interactions accumulate into a climate of trust (7.2.5; 7.2.6). When working with communities or external partners, they can maintain rapport by being present, responsive, and consistent in tone and information (6.6.3). Through these practices, interpersonal rapport becomes a deliberate part of engineering communication rather than a by-product of chance encounters.

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*Builds and maintains trust-based relationships through empathy, attentive listening, and open communication; fosters collaboration and mutual understanding by creating supportive spaces for dialogue, feedback, and connection in both formal and informal contexts. (Related to report sections: 4.2.4; 5.1.1; 5.1.3; 6.6.3; 7.2.5; 7.2.6)*

## Generational communication adaptation

Generational communication adaptation addresses differences in channel preference, style, and expectations between age groups and career stages. Senior professionals often value direct conversation, calls, and face-to-face contact, while younger engineers rely more on digital tools—email, messaging, social media—as their default mode of interaction (7.3.3). This shift affects perceptions of responsiveness, formality, and effort; quick emails may feel efficient to some and evasive or impersonal to others. Turkish accounts highlight the challenge of balancing these expectations in mixed groups, where students and older stakeholders prefer different modes and speeds of communication (7.3.3). In academic and research contexts, communication also varies with experience level: first-year students, master’s students, PhD candidates, and postdocs require different levels of guidance, scaffolding, and autonomy (6.5.2). Teaching, mentoring, and supervision, therefore, involve adjusting tone, detail, and feedback style to match learners’ knowledge and professional maturity (6.5.2). Generational adaptation is not about stereotyping age groups but about recognising patterned differences and responding in ways that keep communication clear and inclusive (6.5.2; 7.3.3).

Engineers need to be able to adjust communication channels and styles to bridge generational preferences in both workplace and academic settings. They can combine traditional and digital tools—meetings, calls, emails, messaging—so that important information reaches people in ways they can act on (7.3.3). They can be explicit about expectations for response times, level of formality, and preferred channels to avoid confusion. In teaching and supervision, they can adapt explanations, feedback, and independence to the learner’s stage, moving from more directive guidance with less experienced students to more collaborative dialogue with advanced researchers (6.5.2). When working across age groups, they can be aware of how tone and medium may be interpreted differently and adjust their approach to keep communication accessible, respectful, and effective (6.5.2; 7.3.3).

*Adapts communication style, detail and medium to bridge generational preferences and expectations; balances traditional and digital approaches to ensure clarity, inclusion, and effective exchange across age groups. (Related to report sections: 6.5.2; 7.3.3)*

### 8.3.3. Message Formulation

#### Adapting language for diverse audiences

Adapting language for diverse audiences enables engineers to communicate effectively across technical, managerial, public, and intercultural settings. Presentations, demonstrations, hearings, and town-hall formats require shifts between specialist terminology and accessible explanation (5.1.4). When engaging clients, authorities, or non-experts, engineers simplify or reframe technical content to avoid overwhelming listeners and to maintain accuracy (7.1.6). Communication planning supports this process by defining target audiences, information goals, and appropriate channels (4.1.1).

Within professional groups, shared shorthand supports efficient exchange (6.3.5), but cross-disciplinary work requires clarification of terms and reformulation to match different knowledge bases (4.1.9; 6.5.1; 5.3.6). Teaching and academic settings likewise demand adjustments: first-year students, master's students, and PhD researchers each require different levels of detail and abstraction (5.1.6; 6.5.2). In multilingual or international teams, adaptation may involve translation, localisation, or strategic use of English as a lingua franca (7.3.1).

Cultural and organisational diversity also influences tone, politeness, hierarchy, and framing (7.3.2; 7.1.3). Effective communication, therefore, depends on situational judgement: knowing when to provide detail, when to simplify, and how to adjust form, structure, and terminology so that information remains precise, accessible, and contextually appropriate.

Engineers need to be able to adjust register, terminology, tone, and structure to suit different levels of expertise, cultural norms, and organisational expectations. They can simplify complex information without compromising accuracy when speaking to clients, authorities, students, or the public (5.1.4; 7.1.6). They can clarify or reformulate discipline-specific terms when collaborating across fields or institutions (4.1.9; 6.5.1; 5.3.6). They can adapt explanatory communication from introductory to advanced levels (5.1.6; 6.5.2). In multilingual or international contexts, they can use translation, localisation, or clear ELF practices to maintain shared understanding (7.3.1).

*Adapts tone, terminology, and structure to suit diverse audiences; balances precision with accessibility; clarifies and reformulates technical language for non-specialists; adjusts presentation style, channel, and tone across disciplinary, organisational, and cultural boundaries. (Related to report sections: 6.6.1; 5.1.4; 7.1.6; 4.1.1; 6.3.5; 5.1.6; 6.5.2; 4.1.9; 6.5.1; 5.3.6; 7.3.1; 7.3.2; 7.1.3)*

#### Ensuring clarity and concision

Ensuring clarity and concision centres on precision, structure, and deliberate choice of communication channel. Engineers define terms explicitly, avoid jargon, and confirm

understanding, especially in multilingual or cross-functional teams where terminology may be interpreted differently (7.1.4; 7.3.1). Written records—emails, memos, meeting notes—provide accountability, traceability, and stability across project stages (5.2.4). Verbal discussion complements documentation in complex or sensitive contexts where ambiguity must be resolved immediately (7.4.2). Concision reinforces this clarity by focusing attention on essential information. Engineers structure messages with headings, summaries, and clear actions to avoid overload and fragmentation (5.2.1; 7.4.1). They document decisions and outcomes rather than full discussions and ensure that information is neither scattered across channels nor diluted with unnecessary detail (5.2.4). These practices require the communicator to prevent vagueness, avoid assumptions of shared terminology, and provide only what is necessary for accurate interpretation and action (7.1.4).

Engineers need to be able to produce communication that is precise, explicit, and economical. They can define key terms, refine messages, and check understanding to prevent ambiguity in technical, managerial, and multilingual environments (7.1.4; 7.3.1). They can decide when to document information formally and when to seek clarification through live discussion (5.2.4; 7.4.2). They can structure written communication with clear summaries and action points, ensuring that essential information is readily identifiable and not obscured by excess detail (5.2.1; 7.4.1). They can maintain accuracy while avoiding needless complexity, allowing teams and stakeholders to act confidently on the information provided.

*Produces precise, unambiguous communication; structures information clearly; confirms understanding; and delivers essential content with disciplined, economical use of language across diverse stakeholder groups. (Related to report sections: 7.1.4; 7.3.1; 5.2.4; 7.4.2; 5.2.1; 7.4.1; 7.2.4)*

## Effective storytelling

Effective storytelling connects technical information with purpose, impact, and audience engagement. In public communication, engineers use narrative structure, accessible language, and concrete examples to explain innovations and build trust (4.3.3). Demonstrations, outreach events, and public celebrations frame developments as coherent stories of progress, showing how technologies contribute to societal goals. Strategic messaging positions projects within broader policy or sustainability contexts, strengthening public acceptance and interest (4.3.3).

In professional and regulatory settings, storytelling underpins structured reporting. Reports not only document results but also organise them into backgrounds, methods, findings, and implications to show logic, progress, and significance (5.3.1). Well-framed narratives help regulators, funders, and partners understand how technical performance supports compliance, feasibility, or investment decisions.

Engineers need to be able to frame technical information within coherent narratives that explain context, process, significance, and impact. They can adapt storytelling style for public audiences by avoiding excessive technical detail, using relatable examples, and highlighting relevance (4.3.3). They can structure professional and regulatory reports so that readers can follow the sequence of reasoning and see how evidence supports recommendations or decisions (5.3.1). They can align narrative framing with stakeholder needs—such as compliance, funding, policy alignment, or community engagement—while maintaining accuracy and integrity.

*Uses narrative structure to present context, process, and results coherently; links technical outcomes to stakeholder needs and public understanding; and frames achievements and lessons learned to inform, persuade, and motivate. (Related to report sections: 4.3.3; 5.3.1)*

### 8.3.4. Managing Difficult Communications

#### Giving and receiving feedback

Giving and receiving feedback is central to collaborative engineering work, ensuring that technical issues are clarified early, project continuity is maintained, and misunderstandings do not escalate. Engineers use both formal and informal mechanisms to sustain constructive dialogue: structured reviews, technical meetings, and site inspections help refine decisions (5.1.3; 4.1.10), while spontaneous exchanges—whether on site or in workplace corridors—enable immediate resolution of uncertainties and support everyday problem-solving (5.1.3; 4.1.10).

Open communication loops help prevent delays and information gaps. When team members hesitate to raise concerns or admit uncertainty, progress slows and coordination weakens (7.4.2). Similarly, reluctance to share knowledge or overreliance on written records for self-protection can limit transparency and trust (7.2.3). Effective feedback practices, therefore, depend not only on technical clarity but also on interpersonal conditions that allow engineers to question, correct, and refine work without fear of reprisal (7.2.2; 4.1.16).

Engineers need to be able to establish and sustain feedback loops that support continuous improvement, timely clarification, and shared understanding. They can offer feedback clearly and constructively, address issues early, and respond promptly to others' questions or concerns (7.2.2; 4.1.16). They can encourage colleagues to express uncertainty openly—whether during formal reviews or informal discussions—and treat critique as part of collaborative problem-solving rather than conflict (4.1.11; 7.2.3). They can recognise cultural or organisational barriers that inhibit honest exchange and create conditions in which dialogue remains respectful, practical, and directed toward resolving problems efficiently (7.2.3; 7.4.2).

*Facilitates open and constructive feedback through formal reviews and informal dialogue; encourages timely exchange, clarifies misunderstandings, and promotes mutual learning while addressing barriers to transparency and defensiveness. (Related to report sections: 4.1.10; 4.1.11; 5.1.3; 4.1.16; 7.2.2; 7.2.3; 7.4.2)*

## Preserving face in sensitive discussions

Preserving dignity in sensitive discussions is essential in engineering contexts where disagreement, uncertainty, and hierarchical dynamics intersect. Concerns about reputation or status can cause individuals to withhold questions, avoid admitting mistakes, or refrain from challenging decisions, limiting the openness required for effective collaboration (7.2.1). Cultural norms surrounding politeness, deference, and directness influence how engineers express critique or raise concerns, requiring careful adaptation to maintain respect and avoid embarrassment (7.3.2).

Breakdowns in dialogue—whether through avoidance, escalation, or overly blunt communication—can delay problem resolution and strain working relationships (7.4.2; 4.1.11). Creating communicative settings that protect participants' dignity helps ensure that difficult issues can be addressed constructively rather than suppressed or allowed to worsen (4.1.10; 7.2.2).

Engineers need to be able to manage sensitive discussions in ways that maintain dignity and openness across hierarchical and intercultural settings. They can choose communication modes that minimise defensiveness—such as face-to-face dialogue instead of confrontational emails—and maintain a constructive tone even when addressing conflict, error, or disagreement (4.1.11; 7.2.2). They can balance directness with tact, adapting their phrasing and level of explicitness to cultural expectations while ensuring that essential information is communicated clearly (7.3.2; 7.2.1). They can foster environments where concerns can be raised without reputational risk, enabling trust, cooperation, and shared problem-solving to develop over time (7.2.2; 7.4.2).

*Manages sensitive discussions with tact and cultural awareness; maintains dignity and openness across hierarchical and intercultural contexts; applies respectful communication strategies to prevent loss of face and sustain collaboration. (Related to report sections: 4.1.10; 4.1.11; 7.2.1; 7.2.2; 7.3.2; 7.4.2)*

## Handling negative messages

Engineers may need to communicate information that is unwelcome, uncomfortable, or potentially reputation-threatening—such as risks, delays, costs, design limitations, operational failures, or community opposition—in ways that are clear, timely, and respectful. This involves

preventing escalation by ensuring that all affected parties receive accurate information before misunderstandings take root (4.1.19). In hierarchical or politically sensitive contexts, engineers must communicate uncomfortable truths even when doing so is socially or professionally difficult (7.2.1). On-site interaction often requires immediate, direct dialogue—through inspections, briefings, or urgent consultations—to resolve issues quickly and avoid compounding problems (4.1.10). When stakeholders hold conflicting priorities, the communicator must acknowledge their concerns, explain constraints honestly, and frame negative information in a way that preserves trust while enabling informed decision-making (7.2.8; 4.1.18). Across these contexts, the emphasis is not on resolving interpersonal conflict *per se* but on transparent delivery of difficult information before it becomes a conflict.

Engineers must deliver difficult messages openly and with professional tact. They can communicate risks, failures, or constraints promptly, using clear explanations rather than evasive or overly softened phrasing that might obscure the seriousness of the issue (4.1.19; 4.1.10). They can contextualise negative information by explaining trade-offs and conflicting values—such as cost versus sustainability or feasibility versus community preferences—without blaming or provoking defensiveness (7.2.8; 4.1.18). They can choose communication channels that minimise misinterpretation, opting for direct dialogue rather than emails when tone or nuance matters (4.1.11; 7.4.4). They can also recognise when reputation, status, or hierarchy might make colleagues reluctant to admit problems, and foster an atmosphere in which transparency is safe (7.2.1).

*Communicates risks, constraints, and unwelcome information openly and accurately; balances honesty with tact; and uses clear, timely dialogue to prevent escalation, preserve trust, and support informed decisions in contexts of conflicting priorities. (Related to report sections: 4.1.10; 4.1.11; 4.1.18; 4.1.19; 7.2.1; 7.2.8)*

### 8.3.5. Negotiation & Persuasion Skills

#### Negotiating contracts

Negotiating contracts is important because it enables engineers and stakeholders to establish clear, transparent, and accountable agreements governing project work. Formal letters, letters of intention, tenders, quotations, nondisclosure agreements (NDAs), and contracts structure communication between parties, define responsibilities, and record commitments (5.3.2; 5.3.4). Procurement and competitive bidding depend on written exchanges that specify customer requirements, performance expectations, and price–performance criteria before a supplier is commissioned (5.3.4). Financial negotiations with clients, financiers, and partners clarify budgets, payment terms, and cost-sharing arrangements, reducing the risk of delay or misunderstanding in large projects (4.1.6). As legal and environmental regulations change,

contractual terms are revised in coordination with regulatory bodies so that project activities remain compliant with new legislation, permits, and oversight requirements (4.1.14).

Engineers negotiate and formalise financial and contractual arrangements that support project delivery. They discuss prices, budgets, and payment conditions with clients, financiers, and partners to establish a shared understanding of costs, schedules, and commercial constraints (4.1.6). They prepare and exchange formal letters, letters of intention, tenders, quotations, NDAs, and contracts that document both preliminary and final agreements, including responsibilities, deliverables, and confidentiality provisions (5.3.2; 5.3.4). They assess competing offers in terms of performance, value, and risk, and ensure that contractual language reflects what has been agreed (5.3.4). When legislation, standards, or licensing conditions change, they coordinate contractual adjustments with legal or regulatory counterparts to maintain compliance while protecting existing collaborations (4.1.14).

*Negotiates, documents, and revises financial and contractual agreements with stakeholders, using formal letters, tenders, and contracts to align prices, responsibilities, and legal obligations in a clear and compliant way. (Related to report sections: 4.1.6; 5.3.2; 5.3.4; 4.1.14)*

## Aligning stakeholder interests

Aligning stakeholder interests is essential in engineering projects where funders, managers, technical experts, politicians, and affected communities bring different priorities and constraints. Funding institutions assess feasibility and originality and expect projects to match defined criteria and broader research or commercial objectives (6.3.6). Internal management—CTO, CEO, executives, supervisors, and compliance teams—monitor risks, schedules, and strategic fit, and require communication that supports oversight and organisational coherence (6.3.4). Government affairs experts and lobbyists focus on legislative alignment and policy support, positioning projects within national and European frameworks (6.4.3). Stakeholder engagement activities coordinate these perspectives using targeted messaging, consultation, and justification through facts and figures (4.1.4). At the same time, tensions arise around cost versus quality, profitability versus technical feasibility, and economic constraints versus sustainable solutions (7.2.8). Local communities and landowners must also be included in negotiations about land use, public concerns, and social and environmental impacts (4.1.18; 6.6.3).

Engineers manage conflicting stakeholder interests and seek workable compromises. They coordinate dialogue between project teams, funding bodies, and management to clarify objectives and resolve tensions between commercial and technical goals (6.3.6; 6.3.4). They work with politicians, regulators, and government affairs professionals to align project communication with policy frameworks and political realities, including community sensitivities (4.1.4; 6.4.3). They engage with local communities and landowners by listening to concerns,

explaining project measures at appropriate times, and adapting communication to local conditions to avoid mistrust and opposition (4.1.18; 6.6.3). Where cost, quality, sustainability, and profitability compete, they address trade-offs explicitly and develop solutions that multiple parties can accept, rather than optimising solely for one interest group (7.2.8).

*Facilitates transparent negotiation among and across diverse stakeholder groups (including funders, managers, authorities, and affected communities) to balance cost, quality, feasibility, and social impact, aligning diverse stakeholder interests around workable project objectives. (Related to report sections: 4.1.4; 4.1.11; 4.1.18; 6.3.4; 6.3.6; 6.6.3; 7.2.8)*

## Crafting persuasive proposals

Crafting persuasive proposals is important because proposals serve as key communication tools for securing funding, partnerships, and regulatory approval in engineering projects. Planning proposals combine technical description, budget justification, and strategic framing to convince funding agencies, planning authorities, and partners of a project's viability (4.1.2). Early collaboration with industry and other sponsors, supported by letters of agreement and preliminary discussions, strengthens submissions and demonstrates credible backing (4.1.2; 5.3.5). Project proposals set out objectives, methods, milestones, and expected outcomes, together with numerical justifications and supporting data (5.3.5). These documents must show not only technical feasibility but also added value, originality, and alignment with policy, environmental, and societal expectations (5.3.5; 6.4.1). Reports used in funding and planning processes follow similar logic, moving beyond descriptive accounts to structured, persuasive communication (5.3.1).

Engineers prepare proposals that integrate technical content with argumentation tailored to decision-makers. They structure planning proposals so that aims, methods, resources, and timelines are explicit and supported by data and milestones (4.1.2; 5.3.5). They involve sponsors, industry partners, and funding bodies at an early stage, incorporate feedback into drafts, and adjust proposals to address feasibility and originality concerns (4.1.2; 5.3.5). They align proposal framing with the language and criteria used by planning and regulatory authorities, showing how projects meet compliance requirements and address environmental and community impacts (6.4.1). They draw on reporting practices—highlighting achievements, lessons learned, and projected benefits—to demonstrate why a proposal merits approval and support (5.3.1).

*Prepares structured, evidence-based proposals that integrate technical detail with persuasive argumentation, aligning objectives and justifications with the expectations of funding bodies, regulators, and project sponsors. (Related to report sections: 4.1.2; 5.3.1; 5.3.5; 6.4.1)*

### Influencing decision-making

Influencing decision-making involves using written and strategic communication to shape how planning, funding, and regulatory authorities evaluate projects. Reports—project reports, compliance reports, progress updates, and site inspection records—document performance, verify adherence to standards, and provide a basis for funding and regulatory decisions (5.3.1). Well-prepared reports highlight achievements and lessons learned, and can encourage others to adopt similar approaches or support further work (5.3.1). Compliance reports confirm that products and projects meet regulatory requirements and are submitted to certification bodies as part of formal approval processes (5.3.1). Government affairs experts and lobbyists extend this work by monitoring legislation, interpreting policy changes, and advocating for projects within national and European institutions (6.4.3). Their activities complement technical reporting by ensuring that projects remain visible and aligned with evolving legal and political frameworks.

Engineers contribute to decision-making by producing documentation that informs and persuades, and by collaborating with policy-facing specialists. They write project and compliance reports that accurately record progress, demonstrate adherence to standards, and present results in ways that underline feasibility, risk management, and impact (5.3.1). They structure these documents so that key findings and implications are easy to identify, using clear argumentation rather than purely descriptive reporting when addressing planning and funding bodies (5.3.1). They work with government affairs and EU Affairs experts to ensure that reports and related materials respond to current legislative requirements and policy agendas (6.4.3). They provide the technical input needed for advocacy, enabling government affairs staff and lobbyists to represent project interests credibly in political and regulatory processes (6.4.3).

*Influences planning, funding, and regulatory decisions by combining accurate reporting with strategic framing and collaboration with government affairs specialists, demonstrating compliance, impact, and policy relevance in a persuasive way. (Related to report sections: 5.3.1; 6.4.3)*

### **8.3.6. Terminology and Contextual Literacy**

#### Familiarity with emerging technical trends

Communication around sustainability, innovation, and the green transition relies on accurate and up-to-date technical vocabulary. Engineers work with industry experts, researchers, and interdisciplinary partners, requiring a shared understanding of emerging concepts, methods, and environmental terminology. Professional dialogue across these groups helps them connect research insights to practical applications and follow how terminology evolves within and across disciplines and in collaboration with industry experts (4.3.2; 4.1.17; 6.1.1; 6.5.1).

Engineers need to maintain an active understanding of new sustainability and technology terms, using them appropriately when explaining developments to colleagues, industry partners, and interdisciplinary teams. They can interpret research language, apply emerging concepts in practical discussions, and clarify how new ideas relate to familiar processes or constraints (4.1.17; 6.5.1). They can engage in continuous learning by participating in professional exchanges—such as conferences, cross-disciplinary meetings, and collaborative reviews—that expose them to updated terminology and trends (4.3.2).

*Develops and maintains vocabulary and conceptual understanding of disciplinary and cross-disciplinary topics; exchanges, interprets and applies emerging terminology ideas on sustainability and technological trends through professional interactions across disciplinary and industry contexts. (Related to report sections: 4.3.2; 4.1.17; 6.1.1; 6.5.1)*

### Familiarity with business and policy environments

Engineering communication often extends beyond technical detail into business, financial, and regulatory domains. Proposals, negotiations, and regulatory exchanges require engineers to understand the terminology and contextual frameworks used by policymakers, financiers, and organisational leaders. Effective communication depends on aligning technical information with administrative expectations, policy requirements, and broader institutional priorities (4.1.2; 4.1.6; 6.4.1).

Engineers need to interpret and apply policy and business terminology when working with government bodies and decision-makers. They can frame technical decisions in terms that reflect financial reasoning, budgeting requirements, and policy considerations (4.1.2; 4.1.6). They can interpret regulatory language and respond appropriately to approval processes, compliance obligations, and political or community sensitivities (6.4.1). They can also act as intermediaries within multidisciplinary teams, translating between technical viewpoints and business or policy priorities to support coherent decision-making (7.2.8).

*Communicates effectively with policymakers, financiers, and industry partners by using accurate business and policy terminology and aligning technical information with organisational, financial, and regulatory contexts. (Related to report sections: 4.1.2; 4.1.6; 6.4.1; 7.2.8)*

### **8.3.7. Communication Mindsets**

#### Engagement mindset

Engineering work depends on an active, outward-looking stance toward the wider professional ecosystem. Engagement here is less a discrete skill and more a willingness to step into shared spaces: to show up at meetings, conferences, site visits, and informal exchanges ready to contribute, listen, and learn. This mindset treats contact with industry, academia, and practice

as a routine part of engineering work rather than an occasional extra (6.1.5; 4.3.2). It assumes that design, implementation, and research are interconnected and that engineers should stay in touch with architects, site personnel, technical experts, and production teams as ideas move toward real-world application (6.1.1; 6.1.3; 6.1.4; 6.1.6).

Engineers with an engagement mindset seek out opportunities to exchange knowledge, not just respond when asked. They initiate and maintain contact with industry partners (6.1.5), respond constructively in interdisciplinary settings (4.1.9), and remain available to designers, suppliers, and production staff so that technical decisions stay aligned with practical constraints (6.1.2; 6.1.3; 6.1.4; 6.1.1). They approach professional networks and events as spaces for mutual learning rather than one-way dissemination (4.3.2). This mindset underpins more applied skills—such as presenting, reporting, or negotiating—by shaping whether engineers actually enter those arenas, stay informed, and remain receptive to external input.

*Recognises the value of active engagement with professional, academic, and industrial communities and maintains an open, outward-looking stance that supports knowledge exchange and ongoing learning. (Related to report sections: 4.3.2; 4.1.9; 6.1.1; 6.1.2; 6.1.3; 6.1.4; 6.1.5; 6.1.6)*

## Collaborative mindset

A collaborative mindset is about how engineers position themselves in relation to others once they are in shared work: not just “working together”, but treating goals, decisions, and information as genuinely shared. Collaboration here is understood as an attitude of co-ownership, transparency, and mutual support across teams, institutions, and cultures. It assumes that projects depend on aligned goals (4.2.5; 6.3.2), effective use of collaborative tools where needed (5.2.2; 7.1.2), and a readiness to bridge disciplinary and cultural differences rather than retreat into silos (4.1.9; 6.1.5). Trust, empathy, and reliability are not side benefits; they are treated as core conditions for joint work (7.2.5; 7.2.6).

Engineers with a collaborative mindset organise their communication to make teamwork easier. They help create and maintain shared structures—meetings, documents, platforms—that keep everyone aligned (4.2.5; 6.3.2; 5.2.2; 7.1.2). They adjust how they speak and write so that colleagues from other disciplines or cultures can follow and contribute (4.1.9). They also invest in relationships: listening actively, honouring commitments, and responding in ways that build confidence and mutual respect (7.2.5; 7.2.6). Where applied skills describe what is done (e.g. chairing a meeting, drafting a memo), this mindset describes how and why it is done—whether communication structures are inclusive, whether others are invited in, and whether cooperation is sustained over time.

*Recognises the value of collaboration and adopts a cooperative, trust-building approach that supports shared goals, transparent coordination, and inclusive communication across disciplines and institutions. (Related to report sections: 4.1.9; 4.2.5; 5.2.2; 6.1.5; 6.3.2; 7.1.2; 7.2.5; 7.2.6)*

## Continuous improvement orientation

Continuous improvement orientation is important because communication practices in engineering are shaped by habits that can either support or undermine collaborative work. Some preferred modes—such as relying on long email threads, rushing responses, or avoiding direct dialogue—can produce avoidable delays or misunderstandings. Recognising and adjusting these patterns allows engineers to improve clarity, strengthen teamwork, and respond more effectively to project needs (7.2.7).

Engineers need to evaluate whether their communication habits contribute to or hinder progress and adjust those habits accordingly (7.2.7). This includes choosing more appropriate channels, slowing down when precision matters, seeking feedback, and integrating more effective approaches into routine workflows. A mindset of continual refinement strengthens both individual practice and team coordination.

*Recognises the impact of personal communication habits on clarity, responsiveness, and teamwork, and maintains a reflective orientation toward improving these practices. (Related to report section: 7.2.7)*

### **8.3.8. Meta Communication**

#### Developing communication plans

Developing communication plans is important because complex engineering projects involve many actors, overlapping activities, and differing organisational cultures. Formal planning provides a shared structure that clarifies responsibilities, channels, and expectations, helping teams avoid unnecessary confusion and maintain alignment throughout the project (4.1.1). Clear plans also ensure that communication activities are coordinated through project managers who link technical, financial, and strategic partners, enabling purposeful meetings, efficient information flow, and coherent decision-making (6.3.1).

Engineers need to be able to design and implement formal communication plans that define goals, audiences, roles, and channels (4.1.1). They can establish mechanisms—such as distribution lists, project-specific email addresses, or centralised systems—that keep participants informed and ensure consistent access to project information. This includes integrating organisational tools such as ERP systems into communication planning so that workflows and documents remain coherent and transparent (4.1.1). Engineers also coordinate

through project managers, who organise meetings, align workflows, and act as communication interfaces between technical and strategic actors (6.3.1).

*Develops structured communication plans that define goals, audiences, roles, and channels; integrates organisational systems to maintain transparency; and coordinates communication through project managers to ensure coherent information flow and consistent stakeholder engagement. (Related to report sections: 4.1.1; 6.3.1)*

## Establishing protocols and guidelines

Establishing protocols and guidelines is important because reliable communication depends on shared rules that define how information should be produced, stored, and exchanged. Protocols reduce ambiguity during execution by standardising documentation practices, clarifying responsibilities, and ensuring that all participants follow the same procedures for managing project information (4.1.1). These predefined rules also help project managers coordinate workflows and maintain coherence across technical, financial, and administrative activities (6.3.1).

Engineers need to be able to design and apply communication procedures that specify how messages, reports, and documentation must be created, formatted, verified, and circulated (4.1.1). They can use organisational guidelines—embedded in ERP systems or other shared platforms—to ensure consistency, compliance, and information traceability across distributed teams. Protocols also support orderly execution of meetings, reporting cycles, and handovers by ensuring that participants work with the same expectations and follow agreed steps (6.3.1). By maintaining predictable information pathways, engineers help prevent fragmented practices that undermine coordination.

*Designs and applies communication protocols that define responsibilities and information pathways; ensures procedural consistency through guidelines and systems integration; and collaborates with project managers to align communication activities with established organisational rules. (Related to report sections: 4.1.1; 6.3.1)*

## Documenting activities

Documenting activities concerns the creation and maintenance of the project's formal record: the written artefacts that capture agreements, commitments, and institutional knowledge over time. This includes jointly written protocols, letters of intention, collaboration letters, tenders, contracts, and NDAs that give structure and legal or quasi-legal weight to professional relationships (4.1.12; 5.3.2; 5.3.4). Documentation also underpins continuity when staff change roles or leave projects, ensuring that decisions, designs, and rationales remain accessible beyond individual memory (4.2.2). Well-organised records prevent information from

becoming scattered across platforms and help teams avoid repeated discussions, loss of context, and disputes over what was decided (7.4.1). Where documentation is inconsistent or fragmented, clarity and coordination suffer, underscoring the need for deliberate, systematic record-keeping (7.4.1).

Engineers need to be able to produce and maintain documentation that is structured, traceable, and usable across the project lifecycle. They can formalise commitments and expectations in letters, tenders, contracts, and related documents that clearly state responsibilities, conditions, and scope (5.3.2; 5.3.4). They can record activities, decisions, and milestones in ways that support handover, onboarding, and long-term knowledge preservation, rather than relying on informal channels alone (4.1.12; 4.2.2). They can organise documentation so that it is stored coherently, remains accessible to relevant stakeholders, and avoids fragmentation across multiple systems, thereby sustaining project clarity and reducing the risk of confusion or conflict (7.4.1).

*Produces and maintains structured written records—including protocols, letters, tenders, contracts, and handover materials—that document activities, agreements, and technical details; organises documentation to preserve institutional knowledge, ensure accountability, and prevent loss of clarity over time. (Related to report sections: 4.1.12; 4.2.2; 5.3.2; 5.3.4; 7.4.1)*

## Key Takeaways

This chapter set out to identify the communication-related competencies required for engineers working in the field of green transition technologies. Building on findings from previous chapters, it reinterpreted communicative activities, means, and challenges to derive a structured competency framework. The analysis emphasised that communication competence in engineering is multidimensional and context-dependent rather than a collection of discrete skills. The analysis demonstrates that:

- Competencies operate across three interconnected levels: (1) communication means, encompassing the use of digital, verbal, and written modes; (2) communication contexts and applications, describing how these means are adapted to specific professional domains; and (3) underlying language and communication competencies and mindsets, which provide the cognitive, linguistic, and social foundation for effective performance.
- These levels are best understood as complementary lenses rather than discrete tiers: many competencies necessarily cut across them. Competence in engineering communication is inherently integrative and situated: engineers typically evaluate, explain, report, negotiate, and build rapport simultaneously within a single interaction. Analytical, social, linguistic, strategic, and meta-communication abilities therefore operate interdependently, and overlap between competencies is both inevitable and desirable. The framework intentionally preserves this overlap to reflect real communicative situations rather than artificial, abstracted skill boundaries.
- The three-level structure is intended as an applied design tool, not a rigid taxonomy. By viewing communicative activity through the lenses of means, context, and underlying competencies, the chapter provides a flexible framework for developing learning outcomes and instructional strategies that reflect the realities of professional engineering communication. Educators and trainers can select and combine competencies in ways that match their own curricular aims, sectors, and learner profiles.

Together, these findings position communication competence as a core professional capacity underpinning both the technical and social dimensions of green transition engineering. The following chapter brings these insights together, outlining the overall conclusions of the report and discussing their implications for future research, curriculum design, and the evolving communicative landscape of engineering practice.

Table 6: Summary of Communicatio-Related Competencies (Potentially) Required by Engineers Working in the Field of “Green Transition” Technologies

<p><b>COMMUNICATION MEANS</b></p> <p><b>Digital Communication Competency</b></p> <ul style="list-style-type: none"> <li>• Video conferencing (e.g., Zoom, MS Teams, Google Meets) (coordinate dispersed teams; pair meetings with docs/task tools; know when in-person is better)</li> <li>• Asynchronous collaboration (time-shifted updates via forums/email/docs; complements real-time channels)</li> <li>• Digital project management tools (record decisions; align workflows; integrate docs, messaging, meetings)</li> <li>• Managing digital information overload (prioritise/filter/consolidate; avoid fragmentation across channels)</li> </ul> <p><b>Digital Dissemination</b></p> <ul style="list-style-type: none"> <li>• Social Media (promote projects; target audiences; use accessible language; integrate with wider comms)</li> <li>• Online Content (web/digital materials for awareness/marketing; tailored for non-specialists; enable engagement)</li> </ul> <p><b>Verbal &amp; In-Person</b></p> <ul style="list-style-type: none"> <li>• Meetings (plan/align/decide; document outcomes; choose online vs in-person for trust/negotiation)</li> <li>• Presentations (structured talks/demos; adapt depth/tone; inform/persuade varied audiences)</li> </ul>	<ul style="list-style-type: none"> <li>• Telephone (resolve issues quickly; handle sensitive topics; complement written records)</li> <li>• Videos (structured knowledge sharing; align with internal standards; adapt to generational preferences)</li> <li>• Informal Discussions (build trust; surface issues early; quick problem-solving and idea sharing)</li> <li>• Lectures and Classes (pedagogic delivery; level-appropriate explanations; transfer research to learners)</li> <li>• Non-Verbal Communication (use/interpret tone &amp; body language; make intent explicit when cues are absent)</li> </ul> <p><b>Written Genres</b></p> <ul style="list-style-type: none"> <li>• Email (coordinate/confirm; create traceability; structure asks and deadlines)</li> <li>• Memos (concise decision summaries; confirm alignment; maintain continuity)</li> <li>• Letters (formalise early commitments; structure pre-contract alignment)</li> <li>• Reports (document progress/compliance; coordinate teams; inform/persuade regulators &amp; funders)</li> <li>• Legal and Regulatory Texts (interpret/apply laws; manage permits/certification; keep FOI-ready records).</li> </ul>	<ul style="list-style-type: none"> <li>• Contracts and Formal Agreements (define roles/deliverables; negotiate terms; revise for legal changes)</li> <li>• Project Proposals (justify feasibility; align stakeholders; secure funding/approvals)</li> <li>• Declaration of Invention (capture novelty; trigger IP review; coordinate with TTO/IP experts)</li> <li>• Marketing Materials (translate tech for customers; align with sales/marketing; support outreach)</li> <li>• Articles (publish research; disseminate across disciplines; alternative to patenting when apt)</li> </ul> <p><b>COMMUNICATION CONTEXTS &amp; APPLICATIONS</b></p> <p><b>Business and Industry</b></p> <ul style="list-style-type: none"> <li>• Customer engagement (clarify needs; tailor detail; align solutions with usability/cost)</li> <li>• Site visits (observe context; solve issues in real time; coordinate onsite stakeholders)</li> <li>• Securing funding (craft persuasive proposals; align to policy; coordinate endorsements)</li> <li>• Contractor Coordination (set expectations; sustain cooperation; tailor methods to roles)</li> <li>• Design and Construction Issue Resolution (multi-party real-time fixes; keep feasibility/compliance)</li> </ul>	<ul style="list-style-type: none"> <li>• On-Site Problem Solving (troubleshoot fast; prevent delays; guide installs step-by-step)</li> <li>• Post-Implementation Troubleshooting (keep channels open; resolve faults; minimise downtime)</li> </ul> <p><b>Crisis Communication &amp; Rapid Problem Resolution</b></p> <ul style="list-style-type: none"> <li>• Swift, Transparent Communication (act fast; share clear facts; prevent escalation)</li> <li>• Real-Time Updates (choose the right tool; enable quick decisions; avoid overload)</li> <li>• Stakeholder Trust Maintenance (be consistent/timely; tailor to roles; address tension early)</li> <li>• Handling Emergencies (establish channels; confirm roles/terms; issue timely public updates)</li> </ul> <p><b>Interdisciplinary Teams</b></p> <ul style="list-style-type: none"> <li>• Facilitating cross-discipline discussions (translate terms; align objectives; include non-technical roles)</li> <li>• Coordinated knowledge exchange (structure two-way flow; integrate sync/async tools; avoid overload)</li> </ul> <p><b>Internal Communication</b></p> <ul style="list-style-type: none"> <li>• Framing technical information for internal stakeholders (adapt depth/tone; support decisions)</li> <li>• Organisational dialogue management (set responsibilities; structure meetings/docs; sustain feedback)</li> </ul>
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- Knowledge Transfer and Mentoring (mentor systematically; document tacit know-how; support remote)
- Cross-Departmental Data Sharing (standardise updates; ensure accessibility; prevent silos)
- Remote Work Coordination (schedule structured online touchpoints; track tasks; preserve connection)
- Team Goal Alignment (run expectation checks; surface misalignments; keep project/org fit)

## Policy and Regulation

- Engaging with certification bodies (prepare compliance docs; verify metrics; meet standards)
- Knowledge Brokering (translate tech to policy; collaborate with legal/policy experts; ensure clarity)
- Influencing Regulatory Decision-Making (advocate with evidence; align with priorities; monitor legislation)

## Professional Networking

- Building Stakeholder Relationships (start early; listen with empathy; sustain informal contact)
- Leveraging Networking Opportunities (use events/meetups & LinkedIn; balance face-to-face/digital)

## Public Engagement

- Communicating Popular Science (simplify without loss; use demos/events/media)

- Addressing Public Concerns (set feedback loops; issue precise updates; reduce opposition)
- Media Interactions (prepare clear statements; collaborate with PR/journalists; be timely)
- Citizen Engagement (design inclusive outreach; target messages; coordinate with authorities)
- Aligning stakeholder interests (reconcile priorities; foster transparency; sustain cooperation)

## Science and Academia

- Patent Applications (draft accessible claims; liaise with IP/legal; protect novelty)
- Grant Proposals (structure/persuade; align with calls/policy; coordinate partners)
- Teaching (design pedagogic sessions; adjust for level; mentor actively)
- Conferences (present clearly; tailor formats; network for collaboration)
- Research dissemination (choose channels; balance precision/clarity; distinguish promo vs. scholarly)
- Technology Transfer (document inventions; bridge R&D-legal-market; run feedback loops)

## Strategic Communication and Advocacy

- Advocacy (engage policymakers; evidence-based persuasion; secure approvals/funding)

- Targeted messaging (segment audiences; pick channels; match tone/complexity)
- Shaping public opinion (transparent narratives; align with values; sustain visibility)
- Securing approvals (data-backed cases; show feasibility/compliance/benefit; coordinate actors)
- Overcoming Resistance (listen empathetically; time messages; negotiate trade-offs)

## UNDERLYING LANGUAGE AND COMMUNICATION COMPETENCIES

### Cognitive & Functional Skills

- Evaluating (assess novelty/compliance/impact; justify judgments; document evidence)
- Explaining (step-by-step clarity; tailor depth; verify understanding)
- Reporting (structured, accurate records; enable decisions/compliance; audience-aware tone)
- Summarising (concise confirmations; clarify decisions/actions)

### Emotional and Social Intelligence

- Active listening (attend/clarify; defuse conflict; build trust)
- Empathy (read emotions; modulate tone; sustain cooperation)
- Conflict management (address issues early; choose medium; restore trust)

## Diversity & Inclusion

- Leveraging plurilingual skills (switch/translate/reformulate; align terminology; include all speakers)
- Using English as a lingua franca (simplify/rephrase; check comprehension; balance accuracy & approachability)
- Intercultural sensitivity (adapt directness/politeness/hierarchy; read context; prevent misreads)
- Interpersonal rapport (create safe dialogue; nurture openness; support teamwork)
- Generational communication adaptation (bridge channel/tone preferences; digital & traditional)

## Message Formulation

- Adapting language for diverse audiences (balance precision/accessibility; clarify terms; match channel/tone)
- Ensuring clarity and concision (define terms; focus essentials; confirm mutual understanding)
- Effective storytelling (context-process-results; show impact)

## Managing Difficult Communications

- Giving and receiving feedback (enable open loops; be timely/specific; reduce defensiveness)
- Preserving face in sensitive discussions (use tact; protect dignity; adapt directness to culture/hierarchy)

- Handling negative messages (state risks/costs clearly; keep tone respectful; act early to resolve)

### **Negotiation & Persuasion Skills**

- Negotiating contracts (align prices/terms/deliverables; formalise with letters/tenders; revise for legal changes)
- Crafting persuasive proposals (evidence-based arguments; clear milestones; aligned to funder/regulator needs)

- Influencing decision-making (combine facts with framing; show feasibility/compliance; align with policy)

### **Terminology and Contextual Literacy**

- Familiarity with emerging technical trends (stay current on concepts; use accurate sustainability/tech terms)
- Familiarity with business and policy environments (use precise financial/policy language; align with frameworks)

### **Communication Mindsets**

- Engagement mindset (participate actively; share/absorb knowledge; connect research and practice)
- Collaborative mindset (coordinate across teams; adapt styles; build trust for joint work)
- Continuous improvement orientation (reflect on habits; replace inefficient modes; refine clarity & tone)

### **Meta Communication**

- Developing communication plans (define goals/audiences/channels; assign roles; integrate systems)
- Establishing protocols and guidelines (standardise procedures; clarify responsibilities; ensure compliance)
- Documenting activities (record decisions/agreements; organise archives; preserve continuity)

## 9. Conclusion

### 9.1. Summary of Report Findings

The insights from the analysis have allowed us to identify and map a range of communication skills and competencies needed by engineers working in the green transition—and potentially also in other areas.

Our findings indicate that green-tech engineers must be proficient across digital, written, and face-to-face communication modes. This includes managing real-time coordination through video conferencing, asynchronous collaboration via shared platforms, and handling digital overload across multiple channels. Strong in-person communication remains essential, while non-verbal awareness supports respectful and clear interaction. Engineers must also produce a wide array of written genres, from short emails and internal memos to complex reports, proposals, legal texts, and marketing materials, each requiring a tailored tone and audience orientation.

Communication takes place across diverse professional settings. Engineers must work closely with clients, contractors, and funders to align expectations and coordinate tasks. In emergencies, timely and transparent messaging is essential to resolve issues and maintain trust. Cross-disciplinary and internal collaboration depends on structured knowledge exchange, consistent documentation, and coordinated digital practices—especially in remote or hybrid teams. Communicating with policymakers, regulators, and public audiences requires the ability to frame technical content in accessible terms, advocate for sustainable solutions, and address stakeholder concerns constructively. In academic and innovation contexts, engineers must also present research findings, secure grants, and support technology transfer through clear, structured communication.

To support this applied communication, engineers need to demonstrate clarity, flexibility, and strategic intent in how they frame and deliver information. This includes the ability to explain technical content clearly, summarise key points, and document innovations accurately. Emotional and social intelligence—particularly active listening, empathy, and conflict management—supports trust-building and effective team dynamics. Engineers must adapt communication styles for different cultural, generational, and institutional contexts, ensuring accessibility without compromising technical accuracy. Negotiation, persuasion, and feedback skills are also vital for aligning interests, refining ideas, and supporting continuous improvement.

At the base level, however, effective communication is supported by broader awareness of the business, policy, and sustainability environments in which engineering projects unfold. Engineers benefit from a mindset oriented toward engagement, collaboration, and reflective learning, along with a recognition of how their communication practices influence project

outcomes. A commitment to continuous improvement—particularly in communication strategy and delivery—helps ensure engineers can meet the demands of their work.

The insights provide the foundation for a wide-ranging framework of competencies that engineers—depending on their specific professional context—may be required to demonstrate in the course of their work. The competencies identified are deliberately broad and, in many cases, overlapping. This reflects the complex, interdependent nature of communication in engineering practice, where skills and behaviours often operate simultaneously across multiple modes and contexts. Rather than presenting discrete or isolated categories, the framework situates competencies within complementary perspectives that highlight their practical interconnections.

Competencies have been framed through three principal lenses: the *means of communication* (such as written, spoken, and digital forms); the *communication contexts and applications* in which communicative activity is situated within engineering projects; and the *underlying communication competencies* that enable effective interaction across technical, social, linguistic, cultural and institutional boundaries. This multi-perspectival organisation is intended to help educators and instructional designers in diverse settings select the frame—or combination of frames—that best aligns with their teaching objectives and professional contexts.

When applied to instructional design, the framework supports a holistic and integrative approach to communication teaching. Designers are encouraged to identify, within each competency, specific “can do” statements that describe observable performance relevant to their teaching content, and to translate these into tailored learning outcomes suited to their local curricular context. Each competency entry includes both an extended synthesis of relevant report data and a concise statement that encapsulates its practical application, allowing for flexible adaptation to different educational purposes. The overall goal has been to consolidate the extensive evidence gathered in this study into a structured, usable format that supports the design of communication instruction in engineering education for as wide and diverse a range of users as possible.

## 9.2. Limitations and Further Research

This report has provided a broad breakdown of communicative interactions, communication means and communication partners that (green transition) engineers are likely to engage with in the course of their work, together with some of the challenges they face. The data has emerged from primary qualitative insights, although for the purpose of this report, it has been interpreted through secondary qualitative analysis.

The reliability of the results may have been affected by inconsistencies in how participants or facilitators understood and applied the focus group tasks—for instance, in Poland, participants debated whether to focus on glass or plastic production. Such differences reflect how local

contexts shaped interpretations of sustainability-related processes. The validity of the findings may also be influenced by varying understandings of what constitutes “green transition” engineering. It cannot be excluded that some participants described processes or challenges based on experiences that do not align with a widely shared definition of green transition. Furthermore, since each partner conducted and interpreted focus groups independently—often in local languages and with limited opportunity to share raw data—some variability in interpretation and emphasis was inevitable. The validation phase, equally, was open to problems of groupthink and “the desire to achieve consensus and uniformity” with other report writers may potentially impact the reliability of the final results (Resnik & Smith, 2020, p. 99).

In addition, the project was shaped by a practitioner-driven orientation, prioritising immediate pedagogical relevance and contextual responsiveness over robust theoretical elaboration. While this ensured that the research remained grounded in authentic professional practices, it also meant that potentially important analytical constructs were not explicitly defined or consistently applied across sites. This reflects a common challenge in applied educational research, where time-limited, goal-oriented projects rely heavily on practitioner intuition and experience (Hamann & Kosmützky, 2021). Such approaches can result in under-theorised findings that may be less transferable or potentially perceived as less valuable by teachers and learners (For a discussion on this in the context of English for Specific Purposes (ESP), see Arnó-Macià et al., 2020). The identification of competencies needed, having been inferred through a reanalysis of findings on communicative interactions, means, networks and challenges, avoided inductively drawing on participants’ self-perceptions of needs (see e.g., Carter & Dunning, 2008), but these would certainly benefit from deductive validation with a larger pool of engineering professionals to determine the extent to which these competency descriptors truly reflect the realities of engineering practice.

That said, the application of life cycle analysis as a means of stimulating the identification of communication-related activities within the scope of a particular field of engineering proved to be a very useful and lively way of inductively generating data. While it may not have been possible in this case to present the results in the form of a lifecycle analysis, it may be interesting for future research to explore more deductively how these communication tasks fit into specific individual project- or product lifecycles. Research could benefit from more quantitative approaches to mapping statistically the extent to which engineers engage in each of these communicative practices or how the different communication partners are networked with one another. This could be useful through the lenses of different engineering disciplines and projects and may lead to an even more targeted approach to the design of technical and engineering communication within a project (cf. Andrews & Tham, 2021) or to the development of project-specific communication training.

Identification of any statistically particularly prevalent practices or network relationships might also lend itself to greater in-depth ethnographic research. Studies using linguistic methodologies, for example, critical genre analysis (CGA), may help shed light on the

relationship between communication and professional practices in engineering projects by examining how certain genres are constructed, interpreted, and used in professional contexts to achieve specific communicative purposes, and how these communication practices themselves are shaped by professional practices (Bhatia, 2016). Applications of Activity Theory (Engeström, 2014) could also provide a useful framework for analysing communication as part of wider systems of professional activity, rather than as isolated exchanges. It would allow communicative practices observed in ECO-GT to be understood in relation to mediating tools (e.g., templates, digital platforms), organisational rules (e.g., quality standards, reporting obligations), role divisions (e.g., project lead, technical expert), and shared outcomes (e.g., project deliverables).

It is also worth noting that the project's data collection phase concluded in early 2024, capturing a snapshot of communicative practices that, while rich and varied, did not yet reflect the influence of newly emerging AI technologies. In the time since, generative AI tools have begun to reshape how engineers and other professionals engage with routine professional tasks to enhance workplace productivity (See Al Naqbi et al., 2024 for a detailed literature review). Not only do these tools influence traditional communication processes (See, for example, Karinshak et al. (2023), for a discussion on the use of generative AI in formulating public messages) but also introduce new forms of linguistic mediation, requiring engineers not only to produce and interpret language, but also to prompt, evaluate, adapt, and collaborate with algorithmically generated output. On this basis, Berdanier and Alley (2023), for instance, call for an overhaul in how writing is taught in engineering. The absence of discussion of generative AI tools in the ECO-GT focus group data may be due either to the genuinely limited adoption of such tools at the time of data collection or participants' reluctance to disclose generative AI use amid unclear organisational norms—recent studies suggest such use is often tied to legitimacy concerns and reputational risks, with self–other biases reinforcing fears of judgment (Celiktutan et al., 2024; Watermeyer et al., 2024). Nonetheless, this gap highlights a significant blind spot and underscores the need for extended analysis that anticipates shifts in communication practices beyond those captured in the project's original scope. If engineering graduates already struggle to transfer communication skills into traditional workplace settings (Ford et al., 2021; Petrovic & Pale, 2021), the emergence of AI-mediated tasks introduces an added layer of complexity. This debate signals the need for communication frameworks to remain responsive to evolving professional practices.

Despite some of the methodological weaknesses described in this report, the authors are confident that the individual competencies are adequately indicative of the incidents of situated communication revealed in the original focus groups (each one is cross referenced to the section of analysis that informs it) and serve as a useful and practicable resource for developing or integrating communication related content into higher education engineering curricula. However, it is important again to reiterate that this list cannot be considered comprehensive, but as a basis for further research and refinement.

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