SOCIAL SITE CHARACTERISATION & STAKEHOLDER ENGAGEMENT

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Contrary to popular opinion, social acceptance is not *the acceptance of a project by the majority of citizens*. The level of social acceptance for a project is not based on the results of a survey performed in a given population, on the basis of a shared vision of what it means to be "for" or "against". It is, in fact, a flawed democratic notion because it neglects that the conditions of acceptance are associated with each stakeholder, even if they are in the minority. It has been repeatedly confirmed that a minority opposition can be enough to block an entire project.

As a matter of fact, **social acceptance is the result of a process in which project stakeholders together define the minimal conditions that are needed to harmoniously integrate a project into a unique natural and human environment at a given time** (Caron-Malenfant & Conraud, 2009).

The process must be carefully planned and deployed for a successful outcome. It includes a series of key steps intended to prepare the stakeholder engagement phase, during which the conditions of acceptance mentioned above are negotiated between the different actors. Among these initial steps, the identification of key project stakeholders and the acknowledgement of their main concerns are of the utmost importance.

This process starts with an assessment phase that consists in a detailed characterisation of the conditions in which the project is to be implemented. Called the Social Site Characterisation phase, it has the following objectives:

- Characterise and understand the context of the project.
- Identify the project stakeholders and their positioning vis-à-vis the project (stakeholder mapping).
- Analyse and rank the issues and concerns that project stakeholders have about the project and that are likely to influence their position with regard to the project (materiality analysis).

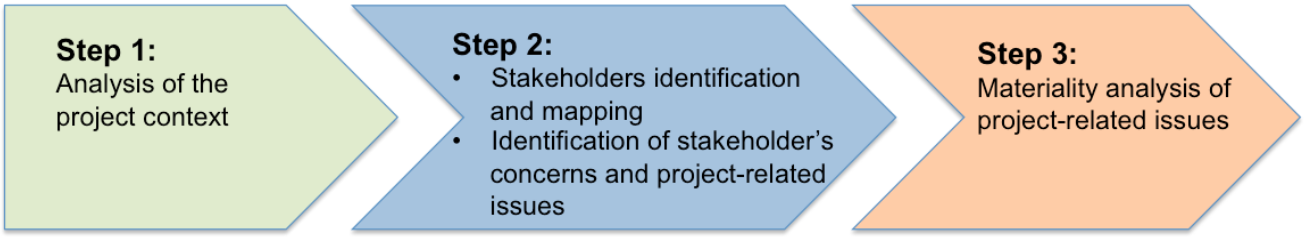
All this information is used to decide on a stakeholder engagement strategy that creates the best conditions for a fair and successful negotiation between parties and leads to an acceptable distribution of costs and benefits among project stakeholders. This negotiation process takes place during stakeholder meetings, where project conditions and possible options are discussed and evaluated using a set of commonly accepted criteria. The objective of these group meetings is to reach a consensus on the project design options and their implementation conditions

Report objective

The overall objective of this report is to propose a methodology targeted at creating the most favourable negotiating environment for all project stakeholders—including the project developer—to agree on project acceptability conditions. This process has been partially applied to a real CO_2 Capture and Storage project: the ULCOS project (see below).

This report provides four in-depth case studies detailing the critical early steps that a project most go through to first understand, then manage, the social environment in which a project is taking place. The case studies capture the context for each step in the process, as well as examples of the methodologies used, the results achieved and the lessons learned and recommendations for other projects. The case studies cover four stages in two phases, the first three explain the key stages in the social site characterisation phase, the fourth the enactment of a stakeholder engagement strategy.

Phase 1 - Social Site Characterisation



Phase 2 - Stakeholder Engagement

As the ULCOS project is currently on hold, the full stakeholder engagement phase was not rolled out. Instead, the engagement process was simulated with a small group of representatives from the project proponent, the Global CCS Institute (the Institute) and the contractors.

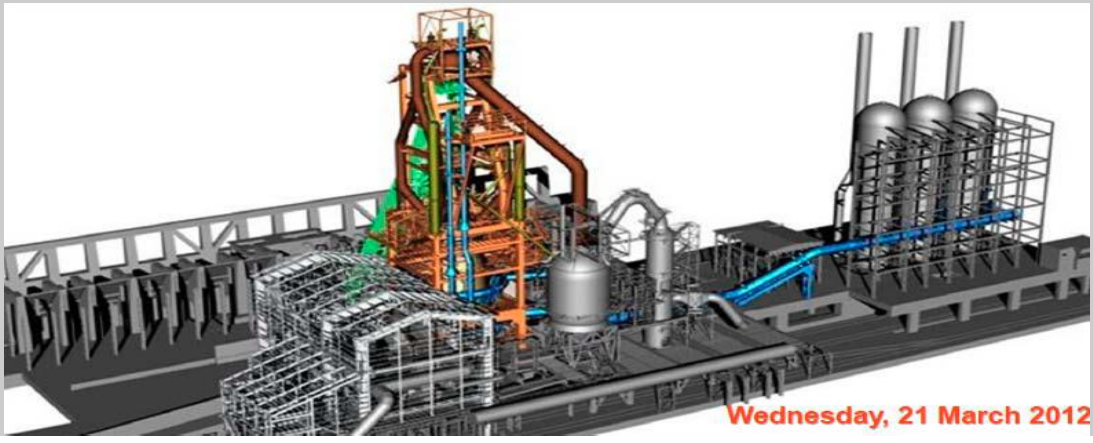
Analysis of the project context

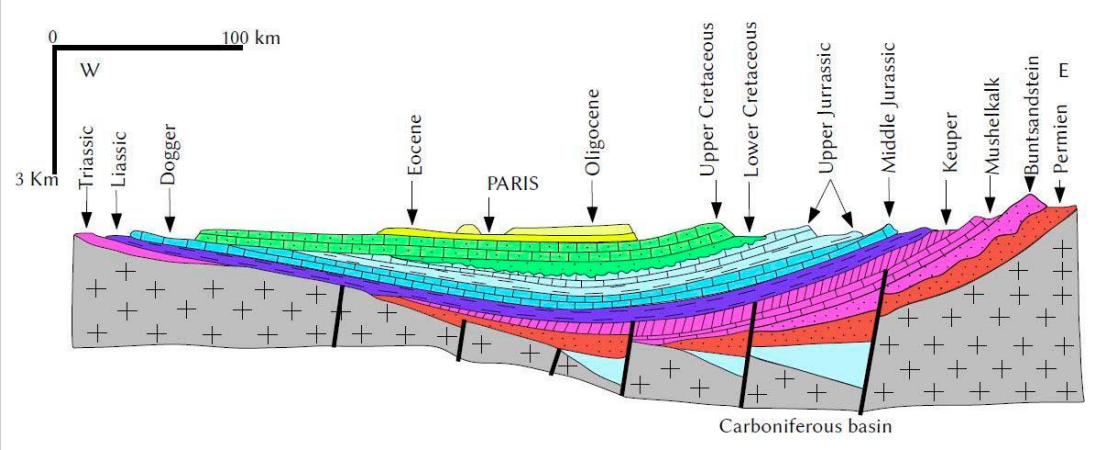
Preparing social acceptance through effective stakeholder engagement first requires a deep understanding of the project context: the local and regional socio-economic and environmental conditions, the concerns of communities with regard to the unique aspects of their environment and the local and regional political policies, among many other factors.

The ULCOS program as a case study

The ULCOS program is a series of coordinated projects launched in 2004. It is led by ArcelorMittal and supported by a consortium that includes most of the EU integrated steel producers (Tata Steel, ThyssenKrupp Steel, Saarstahl, Dillinger Hütte, Voestalpine, RIVA ILVA, SSAB and Ruukki), a minerals group LKAB, as well as a number of energy producers and technology suppliers, such as Air Liquide, EDF, Siemens, Statoil and the Biomass Technology Group (pulp/paper). The Project aims to deliver breakthrough process technology to produce steel from iron ore, with a CO_2 footprint at least 50% less than that of a benchmark high-tech steel mill. The program has examined about 80 different process routes and selected 4 families of ULCOS solutions based on fossil fuel (coal or natural gas) and CCS, and on the direct use of electricity. These have been fleshed out since 2006 and are now being scaled up at the demonstrator, pilot or large laboratory scales.

The CCS chain includes capture on a Blast Furnace in Florange, transportation over about 80 km and storage in a deep saline aquifer in Lorraine. Below is a bird's-eye view of the planned ULCOS-BF demonstrator in Florange, with the geological section of the Paris sedimentary basin. The aquifer is located in the lower Triassic Buntsandstein sandstones: storage would take place somewhere below the Upper Jurassic Cuestas.





To catch all the key elements that shape the local context, a structured analysis that systematically investigates several key dimensions is recommended. For this report, a system known as PESTEL analysis (The Stationery Office, 2004) was used, which covers the following dimensions:

- Political factors: local and national political trends that influence an area's development.
- Economic factors: strengths, weaknesses and structure of the regional economy.
- Social factors: social, historical and cultural aspects of the area.
- Technological factors: current state of the technology and local technical expertise that could foster the development of local actors.
- Environmental factors: local fauna and flora conditions and sites of cultural/ historical significance to be accounted for during project implementation.
- Legal factors: regulations that apply to CCS development or industrial development in general.

This type of detailed context analysis allows the project developer to understand the characteristics of the area in which the project is to be implemented. The two main outputs of this analysis are:

- A deep understanding of the main regional challenges, in particular those that are likely to influence the stakeholders' perceptions of the project,
- A preliminary identification of project stakeholders, for instance people and organizations that may be impacted by project activities or local actors who have an interest in the project and may prove to be influential.

In addition, this context analysis helps the project proponent gain insight and show concern about the area in which it plans to operate, and to better account for local specificities when deciding on project options (at the design stage or during the operation phase). This type of open attitude will greatly contribute to developing a relationship of trust with project stakeholders, which is key for effective dialogue during the stakeholder engagement phase.

The ULCOS project context highlights

The PESTEL analysis makes it possible to identify relevant facts that may influence ULCOS project development from a social acceptance standpoint.

Even though the Lorraine Region has valuable economic assets and is leading French exports to Germany, its *départements* have suffered from the worldwide economic crisis and the deindustrialization plague, which has recently impacted France. Moselle (*Capture area*) is the *département* that has suffered the most in terms of exposure to economic decline, whereas Meurthe-et-Moselle (*Transportation area*) has a broader economic diversification and Meuse (*Storage area*) is more dedicated to agricultural activities.

The lack of industrial prospects has affected the entire region. Average economic performances have resulted in residents' concerns about employment conditions. Among the three *départements*, Meuse lags far behind its neighbours in terms of economic vitality, project development, innovation potential and the ability to attract new residents.

The region's strong industrial background still remains a competitive advantage that local authorities intend to promote. A territorial development strategy has been implemented, aiming at strengthening economic vitality by developing interactions and synergies between existing territorial assets, and by developing a culture of innovation in specific domains (thanks to the implementation of competitive clusters and financial subsidies from local and national sources). The main objective of such an ambitious strategy is to protect and foster employment prospects. The ULCOS project fits into this landscape and is therefore welcomed by most of the local politicians.

However, Lorraine regional representatives and communities have also expressed concerns about the ULCOS project's possible impacts on the environment. Biodiversity, groundwater resources and landscapes are important local assets that are also part of Lorraine's identity. They largely contribute to the quality of life of the residents and some of the natural areas are protected by law (e.g. Habitat Directive).

Finally, the tangible impacts of CCS projects can be complex to determine and can therefore be extremely confusing for non-experts. In accordance with European directives, specific regulatory frameworks have been implemented for Environmental Impact Assessments and public consultation. Projects such as ULCOS have to comply with these new regulations.

Identification and mapping of project stakeholders

The second step covers the identification of project stakeholders (stakeholder identification) and characterizing the positioning of the various stakeholders with respect to the project (stakeholder mapping). This step involves first agreeing on a definition of the somewhat confusing notion of a stakeholder. For the purposes of this project, a stakeholder was defined as: "a person or organization that:

- is actively involved in the project,
- has interests that may be positively or negatively affected by the performance or completion of the project,
- may exert influence over the project, its deliverables or its team members."

This important step is usually achieved through iterations in the analysis, progressively refining both the stakeholder list and the characterisation of their positioning.

Stakeholder identification

The identification of project stakeholders requires first specifying:

- The project timeline and spatial scope: different people / organisations may be affected depending on the project phase.
- The potential project issues (including both tangible and intangible impacts) that also provide information on people or organisations potentially affected by the project implementation.

It is useful to classify the identified stakeholders, assigning them to broad categories such as: public actors, economic actors, institutes and academia, civil society organisations, Environmental NGOs, local communities and internal company stakeholders. A first set of criteria can also be applied to filter out some of the stakeholders who may prove to be peripherally positioned with respect to the project.

Stakeholder mapping

- *Stakeholder scouting*: After identification, investigations should continue, essentially through stakeholder interviews, with the objectives of (1) fully characterising the interviewees, gathering information on other stakeholders and identifying new ones; (2) recording

stakeholders' perceptions of project issues and capturing low signals (very specific concerns that may be hidden during group discussions) and (3) introducing key stakeholders to the project.[1]

An additional objective is to deepen the understanding of the project context.

Lines of discussion: key questions	Purpose
What is the stakeholder's raison d'être?	▪ Gather information on stakeholder identity ▪ Identify their activities in the area ▪ Identify their core motivations in day-to-day activities ▪ Identify the values they are defending ▪ **Evaluate their interests and concerns**
With which actors is the stakeholder interacting?	▪ Gather information on other actors and the social dynamics of the area (e.g. networks, fields of responsibility) ▪ **Evaluate their sphere of influence** (power)
How does the stakeholder think they would be affected by the project?	▪ Capture part of their perceptions of the project and of the project developer ▪ **Capture low signals: potential non-identified societal issues** ▪ **Evaluate their attitude toward the project**

Proceeding with caution is recommended for the interviews: start with easy-to-reach stakeholders, who are close to the project and in favour of it. Encourage those stakeholder's to suggest and put you in contact with other potentially interested people.

- Stakeholder mapping: Once stakeholders are identified and broadly classified, their positioning with respect to the project is evaluated according to a few key dimensions, which will make it possible to infer their behavioural intentions. A 3-Dimensional mapping technique is proposed, considering these key dimensions:
  - *Power:* combination of the ability to directly impact the project (direct force) and the ability to influence key decisions, for instance through other stakeholders. Power is evaluated as high or low.
  - *Attitude:* essentially the stakeholder's expressed opinion toward the project, formed from its observations, experience and knowledge. Four types of attitudes are considered, ranging from positive to negative: (1) collaborative, (2) opportunistic, (3) challenging and (4) hostile.
  - *Interest:* the state of curiosity towards the technology or the project. Interest is evaluated as high or low.
- Profiling stakeholders: the mapping of a stakeholder according to these three dimensions enables the evaluation of the strength of their relationship with the project, as well as their profile. 16 profiles have been defined: Sponsor, Punisher, Opponent, Watchdog, Ambusher, Cynic, Time bomb, Mercenary, Cheerleader, Crossed finger, Sleeping giant, Independent

[1] Tools have already been developed to record this kind of data, for instance: http://www.globalccsinstitute.com/publications/communication-and-engagement-toolkit-ccs-projects/online/32156 or http://www.globalccsinstitute.com/publications/social-site-characterisation-concept-application/online/35371

thinker, Silent doubter, Whisperer, Second cousin and Silent gambler. All of these categories are indicators of the different behavioural intentions of the various stakeholders.

Materiality analysis of project issues

This third phase of the Social Site Characterization workflow consists of identifying the most significant concerns and/or expectations expressed by the most important project stakeholders.

Materiality analyses originate from accounting practices and aims to determine what information or figures should be accounted for in a specific context. For the development of a large industrial project, a materiality analysis consists of a comparison between the external stakeholders' and the project developer's concerns or expectations about the project. It basically compares "what is relevant to the stakeholders" with "what is relevant to the company".

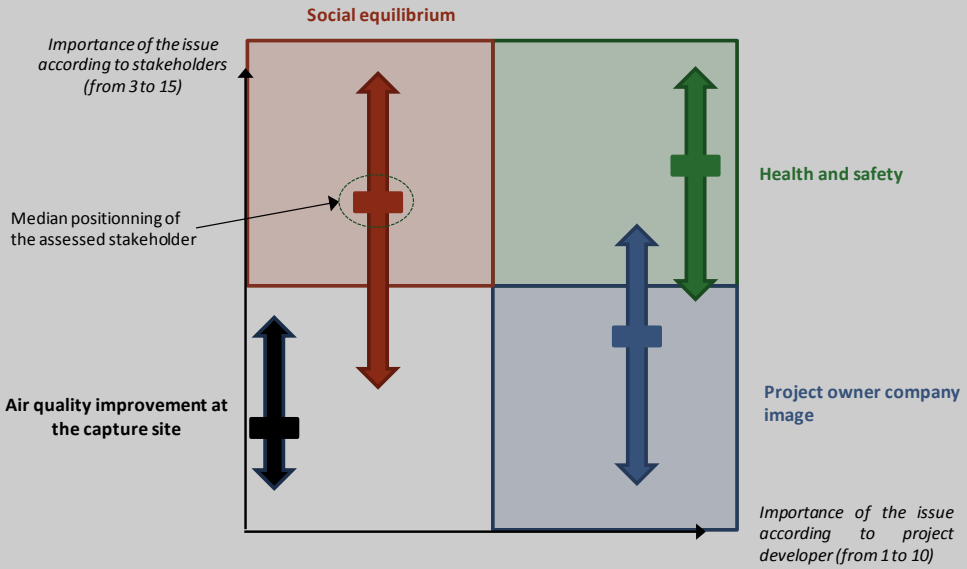
This analysis starts with a detailed listing of stakeholders' concerns about the project, which mainly stem from the material collected during stakeholders' interviews. For large industrial projects, these issues or concerns can be classified into three broad categories: (1) Environment, (2) Society and communities, and (3) Industrial sector, company and project related.

- "What is relevant to the company": the project developer is asked to rank each issue from the company's perspective on a scale from 1 to 10 (1 being a non-relevant issue because its existence is hypothetical or because its link to the project is weak; 10 being a strong issue directly related to the success or failure of the project).
- "What is relevant to the stakeholder": each external stakeholder is also asked to evaluate the importance of the various issues or concerns. Three levels are proposed*: (1) Strong*: when the issue strongly affects a stakeholder activity, raison d'être, values or interests; *(2) Average* if the issue is not of major importance but may impact its day-to-day life or activities; (3) *Weak*, if the issue is acknowledged but of little importance to the stakeholder.

Stakeholder and project developer views on project issues are compared using a "materiality analysis" cross-plot. The X-axis (company axis) shows the importance of a specific issue for the project developer, while the Y-axis (stakeholder axis) shows the level of concern that a stakeholder has about a specific issue, weighted by the importance of this stakeholder to the project, as derived from the stakeholder mapping.

Materiality analysis of a few issues / concerns related to the ULCOS project

Based on the assessment of a sample of stakeholders' preoccupations, a few recommendations could be delivered in terms of communication and "consensus building":



Social equilibrium (fair distribution of costs and benefits): this issue is usually not the project developer's main preoccupation (3/10), although key project stakeholders consider this concern of high importance. Not considering this issue could generate opposition from stakeholders who are negatively impacted by the project implementation and who do not benefit from positive fallouts.

Community safety at the storage site: both the stakeholders and the project developer are very concerned about this issue. Since it is recognized as a priority for both parties, this topic will certainly be addressed. The problem will be finding a way of dealing with the issue that satisfies all parties. These commonly shared issues should be the first to be discussed among stakeholders. By reaching a consensus on these points, the project developer will start building up trust, thus facilitating future "negotiations" on more controversial issues.

Project owner company image: this issue has low importance for stakeholders whereas it matters to the project developer. External stakeholders are usually not sensitive to the project branding and/or have mixed opinions about the company. The project developer should make sure that decisions taken in relation to the project (design options, willingness to communicate) do not affect the Company image.

Air quality improvement at the capture site: the issue has low significance for both the stakeholders and the project developer. Although this point was mentioned, it appears that CO_2 capture will not modify the quality of the air at the capture site. This can be classified as a "non-issue". The project developer should thus exclude this element from any communication messages.

Once these three steps have been completed, the project developer has a comprehensive understanding of (1) the project stakeholder base and (2) the most important project issues and concerns, for each of the stakeholders. This information can then be used to define the stakeholder engagement strategy that will eventually lead to a "consensus" on the conditions that would make the project acceptable (one of the key success factors identified for a successful engagement strategy (GCCSI, 2012)). The variety of stakeholders is accounted for in the materiality cross-plots, not only considering an "average" stakeholder positioning but also each individual stakeholder positioning (hence the range represented by the double arrow along the stakeholder dimension).

Integrating the project into its environment will necessarily require some level of negotiation between the project developer and the actors composing the project ecosystem. This process will consist in a gradual mutual adjustment of both sides' expectations, so that the conditions for social acceptance are finally obtained.

Stakeholder engagement

The last phase examined through this study consists of defining and implementing a stakeholder engagement strategy aimed at agreeing on a set of conditions for an acceptable project implementation with the project stakeholder community. The stakeholder engagement process was simulated for the ULCOS project conditions to demonstrate its feasibility and effectiveness. However, the actual engagement phase could not be run because the project was put on hold.

The stakeholder engagement phase is intended to help the project developer facilitate project implementation (Miller M.A., Vaughan E., 2012), (Desbarat J. & al., 2010), (Prangnell M., 2013), and it should:

- **Demonstrate** that the project has tangible **benefits** for individuals and/or local groups at the local and regional or national level.
- **Ensure** that stakeholders concerns are heard and dealt with seriously.
- Confirm that the project developer intends to create a relationship based on **truthfulness** and **confidence**.

The proposed engagement strategy is defined based on the results of analyses performed during the previous steps: (1) project context analysis, (2) stakeholder identification and mapping, and (3) materiality analysis. Lessons learned from stakeholder engagement activities in other CO_2 storage projects are also key inputs to avoid repeating mistakes.

For this study, the methodology used promotes stakeholder engagement through group discussions with the ultimate ambition of giving stakeholders the opportunity to co-construct some areas of a project with the developer. During the group discussions (called focus groups), stakeholders are invited to co-define possible project design (and implementation) options, and evaluate them using a multi-criteria assessment technique. These options and their evaluations are then discussed in their technical, economic, environmental and social dimensions.

The project is not considered as a whole by stakeholders. For better focus and more relevant debates, different groups of stakeholders address the various activities (or compartments) of the project: capture, transport and storage. To that end, the different geographical areas corresponding to the footprint of each of these activities is first specified. The first two (capture and transport) are clearly localized, so the associated area is easy to define. It is more complex for storage operations, mainly because of the huge difference between the extension of the CO_2 plume and the extension of pressure effects. Indeed, two areas are defined: the first one is congruent with the storage complex; the second one includes a much larger part of the saline aquifer used for storage.

Four "techno-geographical" entities are thus considered, and a specific engagement strategy is designed and implemented for each. In the context of this report, the methodology is demonstrated for the storage activity only.

Definition of focus groups

Stakeholders are usually grouped according to their interests or concerns vis-à-vis the proposed CO_2 storage project. Stakeholders are also sub-divided by "competencies" (see below).

A peaceful environment must be created, to establish the best conditions for a constructive dialogue.

Co-construction of project options (or scenarios)

The first step is to agree on a common evaluation framework that will satisfy all stakeholders; this is a necessary condition for an objective evaluation of stakeholders' ideas or preferences. This evaluation framework is used to build and compare different project options. It comprises two key elements:

- The project options to be evaluated: a list of possible options given by the project developer augmented by alternatives proposed by stakeholders. All options are evaluated, whatever they are.
- A set of strategic issues and associated evaluation criteria: the evaluation is performed by measuring the performance of the various options according to the different criteria. In our case, the criteria are divided into three categories of strategic issues: 1) techno-economic, 2) environmental and 3) socio-economic.

Evaluation

Each criterion is scored from 0 to 10 depending on whether the option has a positive (10) or negative (0) performance. Stakeholders evaluate strategic issues according to their "competencies", namely:

- Techno-economic issues are evaluated by the project leader.
- Environmental issues are evaluated by independent experts.
- Socio-economic issues are evaluated by external stakeholders.

Analysis

The assessed options are then compared using two main performance indicators:

- The overall performance, which indicates the ability of an option to meet all criteria.
- The performance equilibrium, which indicates the ability of an option to adequately balance the different categories of strategic issues.

The combination of these two indicators—performance and equilibrium—allows a global evaluation of the acceptability of the option.

Test of the stakeholder engagement methodology for the ULCOS project

This methodology was tested in the context of the ULCOS project, during a simulation exercise performed with a group of five persons, each playing the role of a key project stakeholder. Storage was the only compartment considered. Project options were discussed, evaluated and compared:

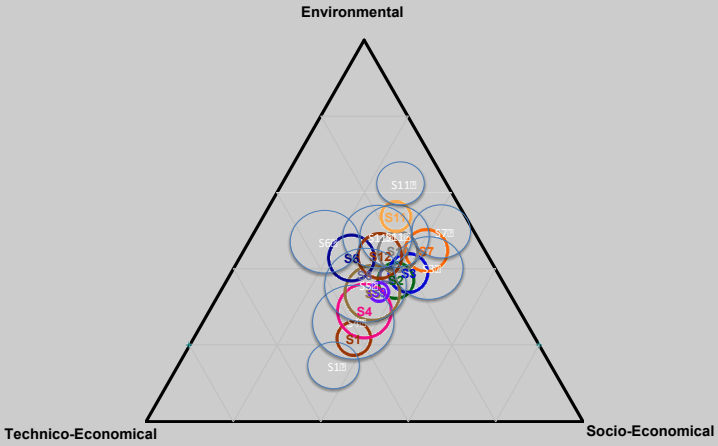
- **Step 1: Definition of the focus groups**
- **Step 2: Co-construction**

The evaluation framework consisted of 12 storage options, identified by stakeholders, and 3 evaluation criteria were selected for each issue (techno-economic, environmental and socio-economic), with a total of 9 indicators.

- **Step 3: Evaluation**

The 12 options were evaluated for each of the 9 criteria.

- **Step 4: Analysis and interpretation**



The results of the evaluation process provide strategic information to the project developer, by identifying the most acceptable options (during this simulation, the S5 option showed the highest and most-balanced performance) with the highest probability of meeting stakeholder acceptance. As a corollary, the project manager can identify dissatisfied actors very early on, along with their potential reasons for blocking the project.

Conclusion

The proposed stakeholder engagement strategy makes it possible to build a consensus through:

- The involvement of all stakeholders in a project co-construction process that reveals and asserts their expectations, and takes into account their positions and demands.
- The evaluation of project options according to a set of criteria that is validated by all stakeholders, in their diversity and with their specificities.
- An objective comparison of the different design options for a project.

This work has also left a few research questions unanswered, mainly about the definition of an optimum strategy for stakeholder engagement: What are the best ways to organize focus groups, to convey information about the project (message sources and vehicles), to prepare for efficient and open debates? How to deal with hostile stakeholders? How to address stakeholders not willing to be engaged? Best practices already exist in other domains that can serve as starting references. Beyond expertise in communication, it seems that two fields of research can be called upon to contribute: the theory of engagement and the theory of commitment.

Introduction

Contrary to popular opinion, social acceptance is not *the acceptance of a project by the majority of citizens*. The level of social acceptance for a project is not based on the result of a survey performed in a given population, on the basis of a shared vision of what it means to be "for" or "against". It is, in fact, a flawed democratic notion because it neglects that the conditions of acceptance are associated with each project stakeholder, even if they are in the minority. It has been repeatedly confirmed that a minority opposition can be enough to block a whole project.

Two definitions of social acceptance are given below; the first one takes a socio-ecological perspective:

"Social acceptance is the result of a **process** in which the stakeholders together define the **minimal conditions** that are needed to enable a project to be **harmoniously integrated into a unique natural and human environment** at a given time**"** (Caron-Malenfant & Conraud, 2009).

The second one comes from the field of social psychology:

Social acceptance is derived through a **judgmental process** by which individuals impacted by or able to impact a project:

(1) **Compare** the perceived conditions in which a project is to be implemented with the current situation and alternatives.

(2) **Decide** whether these conditions are acceptable or not. If the existing conditions are judged to be insufficient, an individual **will initiate a behaviour** (often, but not always, within a constituency group) that is believed likely to **shift conditions** toward a more favourable alternative (adapted from Brunson (Brunson, Mark W., 1992)).

"Social acceptability" is then defined as the conditions that lead to "social acceptance" (the result).

These two definitions are by no means contradictory but complement each other. The first one sets the stage for a project integrated in its environment, while the second is more operational and focuses on the cognitive processes that are at stake.

The process that leads to social acceptance is by no means natural. It requires dialogue and negotiations between the two main categories of project stakeholders: the project developer and its organisation on one side, the stakeholders that are "external" to the project, on the other. A successful outcome for this engagement phase obviously requires a high level of preparation in order to: (1) understand the project's environmental and societal context, (2) acknowledge the different stakeholder views and concerns about the project, and finally (3) identify the most important project-related issues (Figure 1). The term "Social Site Characterisation" (Wade S., Greenberg S., 2011) has been created to describe this process.

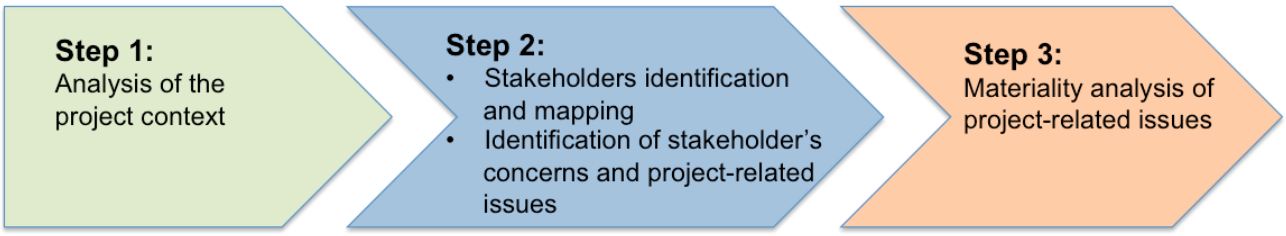


Figure 1: A three-step process for social site characterisation

This methodology is detailed step by step in the first three chapters and the results of its application to the ULCOS project are discussed.

The last chapter goes a step further and proposes a strategy for stakeholder engagement, targeted at fostering a consensus on a set of conditions to make a project acceptable. The engagement

process consists of group discussions, during which project design and implementation options are evaluated and discussed. A specific multi-criteria evaluation tool is used for that purpose.

The stakeholder engagement phase could not be run because the ULCOS project is currently on hold. Instead, the process was simulated using a small group of people who were well informed about the project. Each member of the group played the role of a specific project stakeholder and accordingly evaluated the different project options that were identified.

1. Context analysis

1.1. Context of the task

According to the Global CCS Institute's *Social Site Characterisation From Concept to Application* (Wade S., Greenberg S., 2011) and the Institute for European Environmental Policy (Desbarat J. & al., 2010), **the understanding of a specific context in which a CCS project takes place must be acknowledged** through "preparatory research of locally salient issues" (Brunsting S. & Al, 2010). Furthermore, the understanding of the local context and the recognition of project specific issues by the project developer will enhance its credibility and will facilitate dialogue with project stakeholders, helping to progressively build a relationship of trust. These are the conditions required to reach a consensus on the minimal conditions of acceptance for the project.

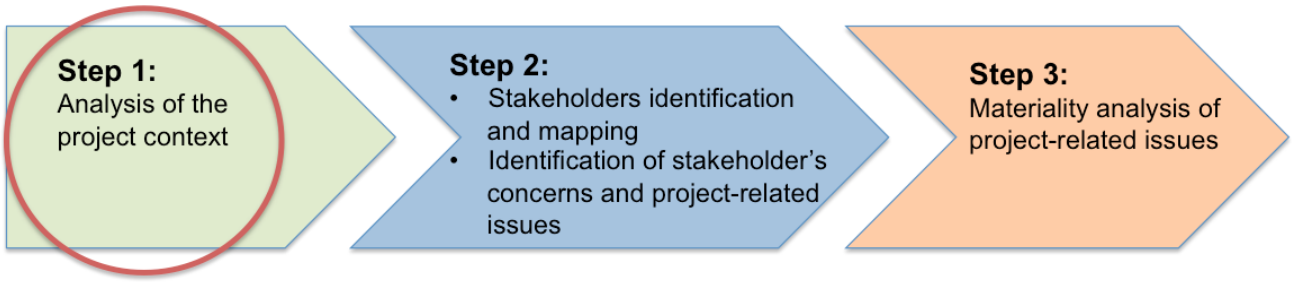


Figure 2: The analysis of the project context - the first step in the Social Site Characterization workflow

The context analysis should start at the site selection stage (GCCSI, 2012) (Mariette Pol & Al - NEAR CO2, 2011), and should be further refined during the site characterization phase, to later enable the identification of design options aiming at better integrating the project in its environment. It starts with a bibliographic review based on national sources (government issued statistics, newspapers, etc.) and regional data (from Chamber of Commerce, Regional and County Councils, etc.). The analysis is further nourished by information gathered during stakeholders' interviews, taking into account more subjective perceptions about the project context.

1.2. Methodology

Objective of the task

To identify the characteristics of the project's environmental and societal context

Effective stakeholder engagement, which aims to integrate a project into its environmental and societal context, obviously requires a deep understanding of this context. Indeed, project acceptance depends on the local and regional socio-economic conditions, the concerns of local communities, and local and regional political policies, among many other factors. A structured context analysis is generally recommended, which systematically investigates several well-identified key dimensions. To analyse the ULCOS project, an analysis methodology known as PESTEL was selected. (The Stationery Office, 2004).

Originally used for marketing purposes, this analytical framework has been modified to better account for the various elements (or factors) that make up the project context. These are:

The Political factors

The objective is to understand local and national political trends and their consequences in terms of territorial decisions. For instance: what is the composition of the local political landscape? Is the project in line with regional political priorities? Would the project concern government interests?

The Economic factors

The purpose is to identify the local and regional economic dynamics. For instance: how is the local economy structured? How wealthy and competitive is the local economy compared to national standards?

The Social factors

The objective is to understand social distinctiveness in terms of previously identified issues (excluding local employment conditions). For instance: What is the demographic representation compared with the national standard? Is there any specific regional culture? Does the region have a specific industrial background? Has the region suffered from severe industrial problems? These different questions should be addressed in an historical perspective.

The Technological factors

The purpose is to understand the regional clusters of technological development and local competitive advantages in terms of technical know-how. For instance: what are the region's main research and development programs? What are the regional competitive advantages that the area intends to promote? The objective is also to establish the current state of the art of the project-related technology (CCS for the steel industry).

The Environmental factors

The purpose is to characterize the ecosystems that may be impacted by the project's activities. For instance: are there any protected areas and species in the project area?

The Legal factors

The objective is to understand the regulations that may have an impact on project development. For instance: what are the applicable national regulations concerning CCS development? Are there specific local and regional regulatory policies?

To help the project developer understand the context in which they plan to implement the project, a bibliographic review is undertaken for each of these factors. Using national sources (such as newspapers or government statistics) as well as reliable regional sources (such as publications from

the Chamber of Commerce or the Regional Council), the analysis is performed to identify any information that could convey the uniqueness of the area.

1.3. Results

The ULCOS[2] project is to take place in eastern France in the Lorraine region, which comprises three *départements*: Moselle and Meurthe-et-Moselle, known for their industrial past in steelmaking supported by mining activities, and Meuse, a rural territory that was the site of a famous 1st World War battle (Verdun).

The CO_2 capture plant will be located in the Moselle *département*, in the ArcelorMittal Florange steel manufacturing facility. The CO_2 will be transported by pipeline to the storage site, located in the Meuse *département,* in the vicinity of the Verdun battlefields. The CO_2 pipeline will cross the Meurthe-et-Moselle *département*, which is located between Moselle and Meuse.

Since the context of the Lorraine region was a determining factor for the social acceptance of the ULCOS pilot project, detailed information and analyses of the local conditions are given in the following chapters.

1.3.1. Political factors

1.3.1.1. Lorraine positioning on national elections

It is possible to illustrate the political leanings of the *départements* of Meuse, Meurthe-et-Moselle and Moselle from the final results of the French presidential election (April-May 2012) and the legislative assembly election (June 2012),

In the first round of the French presidential election, Meuse and Moselle voted mainly in favour of conservative parties whereas the majority of Meurthe-et-Moselle citizens voted for socialist parties.

The results of the legislative assembly election that immediately followed the presidential election show that Lorraine's *départements* were inclined to support the socialist parties:

- Meuse: election of one Member of Parliament (MP) from the moderate conservative party (Parti Radical) and one from the PS.
- Meurthe-et-Moselle: election of two MPs from the main conservative party (Union pour un Mouvement Populaire – UMP) and four from the PS.
- Moselle: election of five MPs from the UMP and four from the PS.

1.3.1.2. Government concerns about the Florange case

Indeed, the global recession and its repercussions in terms of deindustrialization and unemployment were hot topics largely debated during the elections (Nouvel Observateur, 2012) and represent key governmental concerns (Le Figaro, 2012), the government being led by conservatives / liberals or socialists.

The Minister of Industrial Recovery, in charge of the "Florange case" during the year 2012, was expected to find a consensus between ArcelorMittal executive management, trade unions and national interests on maintaining as much activity as possible on-site. Given the national and local concerns arising from the recession, the government wanted to maintain activity in the Florange steelmaking facilities, hence were prepared to back any economically sustainable initiative that could maintain jobs at the facility.

[2] ULCOS stands for Ultra–Low Carbon dioxide (CO_2) Steelmaking. It is a consortium of 48 European companies and organizations from 15 European countries that have launched a cooperative research & development initiative to enable drastic reduction in Carbon dioxide (CO_2) emissions from steel production. The consortium consists of all major EU steel companies, of energy and engineering partners, research institutes and universities and is supported by the European commission. The aim of the ULCOS program is to reduce the carbon dioxide (CO_2) emissions of today's best routes by at least 50 percent. (Source: www.ulcos.org).

The ULCOS pilot project has finally been withdrawn from the first call for projects for the NER300[3] grants program (European economic support for innovation) and the project is currently on hold. New research directions are proposed instead.

1.3.1.3. Lorraine's positioning in local elections and its upcoming electoral timetable

Even though the Meurthe-et-Moselle local authorities are socialist by majority, the cities in Meuse are essentially run by moderate conservative parties, while the cities in Moselle tend to be managed by the main conservative party (Figure 3).

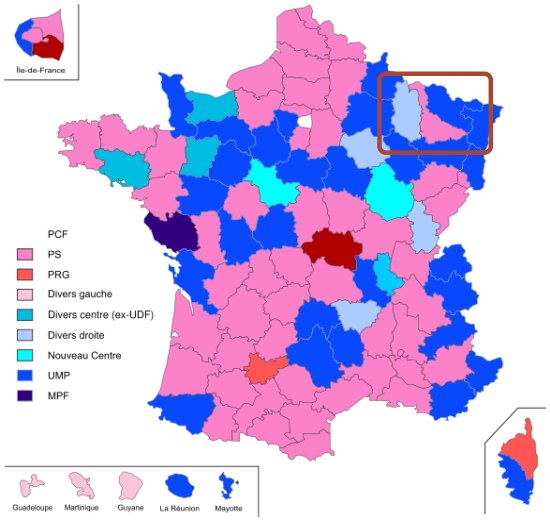


Figure 3: Results of the 2008 municipal elections per *département*

(Source: French Ministry of the Interior, 2008)

While this political distribution also applies to the County Councils[4] (Figure 4), the Regional Council[5], on the other hand, has a socialist majority. However, it is likely that the current political landscape will soon change:

- Cantonal elections and regional elections will take place in 2014.
- Municipal and European parliament elections will take place in 2014.

As a result of this political timetable, local projects that partially rely on political stability **may be affected by these upcoming election campaigns (due to the *Not in My Election Year – NIMEY* phenomenon)** that may change the political composition of the main local governmental authorities.

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[3] "NER300" is a financing instrument managed jointly by the European Commission, European Investment Bank and Member States, so-called because Article 10(a) 8 of the revised Emissions Trading Directive 2009/29/EC contains the provision to set aside 300 million allowances (rights to emit one ton of carbon dioxide) in the New Entrants' Reserve of the European Emissions Trading Scheme for subsidizing installations of innovative renewable energy technology and carbon capture and storage (CCS). The allowances will be sold on the carbon market and the money raised — expected to be around 2.0 bn EUR at current carbon prices — will be made available to projects as they operate. (Source http://ec.europa.eu/clima/policies/lowcarbon/ner300/)

[4] The **County Council** is the highest executive authority in a *département* and falls under the Regional Council's hierarchical guidance. The County Council is responsible for the administration of the *département* (incomes/expenses) and has specific competencies, such as local transportation infrastructure management.

[5] The **Regional Council** is the highest executive authority in a region, which means it manages the County Councils' orientations and the coherence of development among *départements*. The Regional Council is therefore responsible for the administration of the region (incomes/expenses).

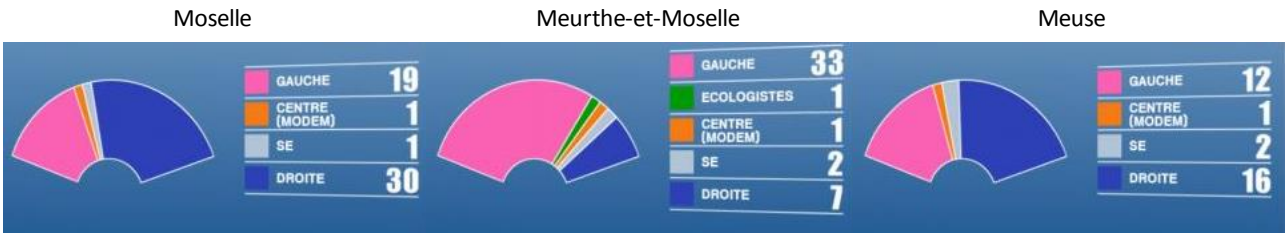


Figure 4: Results of the 2011 cantonal elections – County Councils (Source: France 3 Lorraine, 2011)

1.3.1.4. Lorraine regional strategy

The current political authorities are in favour[6] of the ULCOS pilot project since it is in line with the global regional development scheme (economic vitality, employment, projects contributing to bring départements closer, etc.).

Indeed, the regional political objective is "to build a strong region through its territories and their diversity". At the same time, the region aspires "to grow regional influence over the east of France and beyond, taking into account the European cross-border context" (Conseil Régional de Lorraine, 2012).

To do so, the Regional Council of Lorraine defined a roadmap and is implementing several initiatives, as discussed below.

The "Lorraine 2020" roadmap (Conseil Régional de Lorraine, 2012) was established to increase actions to further sustainable development. The Regional Council wishes to reinforce exchanges between the region's main cities, which would be based on a joint political effort at a local level as well as on the development of strong strategic partnerships between public institutions and the private sector (under Council coordination).

This territorial strategy is based on three sets of actions/initiatives:

Reinforced connectivity of Lorraine's territories: The Regional Council has developed a connectivity action plan based on two main priorities (Figure 5) to boost Lorraine's presence in the larger Metropolitan Decentralized Cross-border Region (*Grande Région Métropolitaine Polycentrique Transfrontalière - RMPT)*.

[6] According to C&S Conseils (C&S Conseils, 2010), there is a relative consensus among local politicians to support ULCOS with regard to capture (except ecologists). With regard to storage, the local authorities also support the project with minimal acceptance conditions regarding the project's ripple effects on local economic activity and environmental impacts.

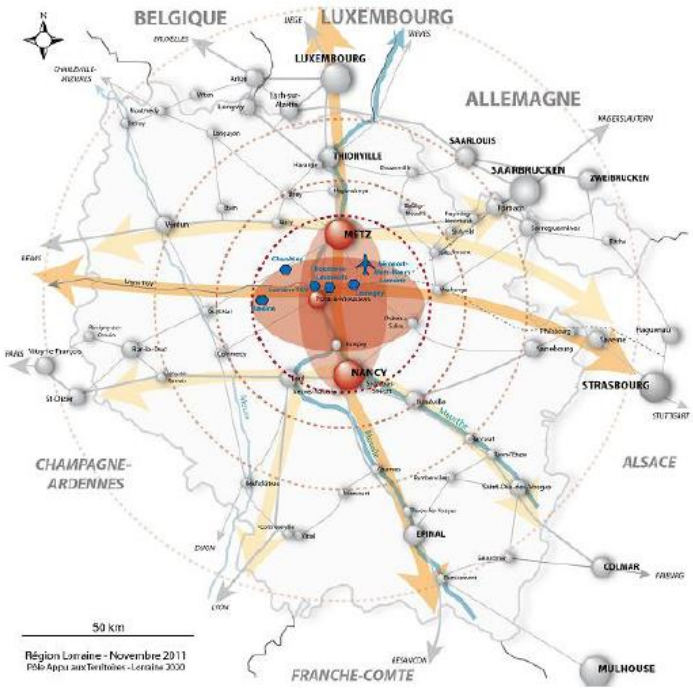


Figure 5: Strategic development of territorial connectivity focusing on two axes (Regional Council of Lorraine, 2012)

The West-East axis connects Meuse and the Lorraine coalfield with the region of Champagne-Ardenne and Paris, on one side, and Sarrebuck (Germany), Strasbourg and Eastern Europe, on the other. The North-South axis connects Thionville and Epinal to Luxembourg, the Franche-Comté region and the Rhône river corridor. According to the Council, this type of development would lead to:

- The strengthening of the historical Metropolitan centre of the "Lorraine line",
- The restructuring of post-industrial territories through tourism initiatives (Madine recreational area), transportation infrastructures (TGV and Chambley Planet'Air) and economic initiatives (creation of the Integrated Development Zone of Bouxières Lesménils).
- A "harmonious development" of rural and urban areas where the Council tries to encourage fair cooperation between *départements* rather than competition with each other.

Economic support: The Regional Council has identified twelve priority economic sectors that it intends to support. In addition to the chemical, aeronautical and automotive industries, the social and solidarity economy, eco-design and renewable energies sectors (supported by energy management policies concerning housing insulation, and geothermal, solar and biomass energy), the region also focuses part of its support on the manufacturing and steelmaking sectors. To this end, the region wants to enhance partnerships between research laboratories and the private sector to encourage new product designs to be sold to the health and transportation sectors.

Empowered associations, youth education and mobility: According to the Regional Council of Lorraine, territorial integration can also be achieved through social policy. Besides youth education and youth mobility that appear to be two of the Council's main social priorities, the Region encourages the development of associations. With 32,000 existing associations, the Region has created a consultation forum that takes place 4 to 5 times a year, where the associations of Lorraine and the Council work together on territorial issues.

Breakdown of the départements' political priorities

County Council of Moselle

The County Council of Moselle (General Council of Moselle , 2011) had the following priorities for 2010:

- 114 million euros were spent on the protection of children, social integration (employment support and adult education), and social housing.
- 156 million euros were spent on support to the elderly and disabled populations.
- 102.7 million euros were spent on infrastructure development for roads and building construction.
- 17 million euros on youth education.
- The *département* also has other priorities:
    - Culture and tourism
    - Protection of the environment and of natural and rural areas
    - Reinforcement of cross-border relationships, with focused support for projects involving Luxembourg.
    - Economy: support to entrepreneurship, competitiveness and project initiatives (the main one concerns eco-mobility: *Moselle Electromobile*).

Support for entrepreneurship is demonstrated in the development of the Sino-European technological complex ITEC (International Industry Trade Technology and Exhibition Centre) called *TerraLorraine*. This project, which will be located at Illange-Bertrange, is mostly financed through European subsidies. It has been promoted as a unique business spot, which will create new connections between European and Chinese companies that will ultimately benefit the region.

County Council of Meurthe-et-Moselle

According to the Meurthe-et-Moselle County Council, the main priorities of the *département* are the following (Conseil Général de Meurthe-et-Moselle):

- "Inter-generational solidarity": protection of children, social housing and support to the elderly.
- "Education and citizen innovation": education infrastructure maintenance and sport infrastructure development.
- "Professional integration and social and solidarity economy": employment support.
- "Fair territorial development": road infrastructure development.

Furthermore, the County Council developed specific political priorities for each territory. The territory of Briey, for instance, (which would have had a major part of the ULCOS pilot transportation infrastructure: the CO_2 pipeline) has two special tasks to work on: **construction and mobility**.

The County Council intends to support economic sectors recognized as innovative in both fields (projects regarding alternative transportation modes and specific attention to the mobility challenges of people in social difficulty). According to the Council, the concerted effort on construction and mobility contributes to "social territorial cohesion", considered as a regional and local priority.

County Council of Meuse

The Meuse County Council budget is the smallest of the three *départements* studied, with 228 million euros (more than four times lower than Moselle). Based on these limited resources, the *département* developed a policy addressing mainly social and infrastructure matters (Conseil Général de Meuse):

- More than 50% of the budget is allocated to social actions: family support, protection of children, support for the elderly, etc.
- 24% to road infrastructure, networks and various transportation expenses.
- 11% to culture, youth activities, sports and education
- The remaining 15% is allocated to economic development, environmental investments, territorial planning and security.

1.3.1.5. Concluding remarks

The local authorities have developed territorial strategies to strengthen their economic vitality through a broad interaction between their territorial assets, the feeding-in of technological potential via their competitiveness clusters' (on related industry and product innovations) and local and national subsidies to specific economic fields. Their main objective remains the safeguarding of employment prospects. This is one of the main reasons why the ULCOS project has been receiving full local and national political support.

To go a step further

Political analysis is a complex exercise. As a matter of fact, many more complementary relevant subjects could have been studied to further deepen this description of the project context. For example, the influence of the political relationship between Lorraine and its foreign neighbours on the project outcome:

- Is Lorraine pushing forward European policies?
- Given that the German CCS law leaves the final decision on CCS project implementation to the Landers (Region), could the opinions on CCS from nearby landers (Saarbrucken, Rheinland, Pfalz and Baden-Wurttemberg) have an impact on ULCOS project acceptance? Are those neighbours for or against CCS? Could their position influence the Lorraine region in terms of CCS support?

It is therefore important to properly define the fields of investigation to be covered in the PESTEL, according to the available resources in terms of time, knowledge and information channels.

1.3.2. Economic factors

1.3.2.1. Historical overview

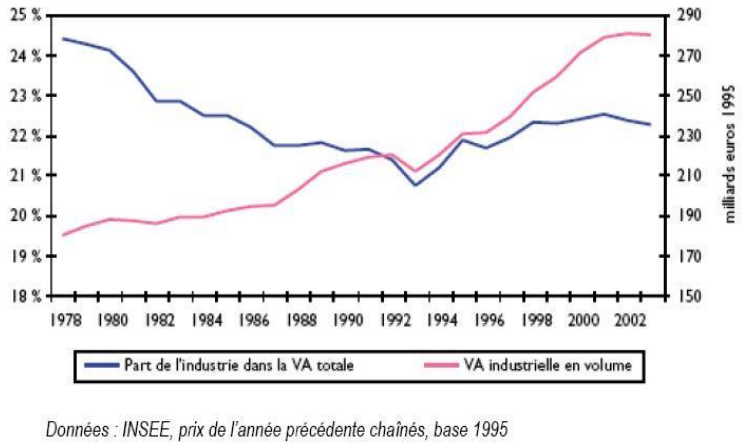


Figure 6: National decline of the industrial added value (Source INSEE, 2005)

Historically, the region of Lorraine built its economy on two main resources: coal and iron. From 1850 to 1950, the coal and iron mines were the key drivers of the local and even national economy. However, as of the 1950's, mines started to close down one by one with a sharp increase in the 1970's.

At the same time (1970's), industrial activities began to suffer from global competition, which led the country to new strategic orientations for its development (growing tertiary sector). Intense competition and the transformation of the economy resulted in a lower share of industrial added value (Figure 6) and the associated decline in iron mining.

The decline of the mining and metallurgy industries was the main cause of deindustrialization in Lorraine, with dramatic consequences on the unemployment levels.

1.3.2.2. Company presence

Since then, the region has adapted and diversified, even though its economy still partly relies on industry. As shown in Figure 7, the *départements* of Moselle, Meurthe-et-Moselle and Meuse are unequal in terms of company presence.

Moselle

DEN T3 - Nombre d'entreprises par secteur d'activité au 1er janvier 2011

	Nombre	%
Ensemble	39 907	100,0
Industrie	3 038	7,6
Construction	6 101	15,3
Commerce, transports, services divers	25 329	63,5
dont commerce et réparation auto.	8 812	22,1
Administration publique, enseignement, santé, action sociale	5 439	13,6

Meurthe-et-Moselle

DEN T3 - Nombre d'entreprises par secteur d'activité au 1er janvier 2011

	Nombre	%
Ensemble	27 636	100,0
Industrie	2 194	7,9
Construction	3 858	14,0
Commerce, transports, services divers	17 351	62,8
dont commerce et réparation auto.	5 742	20,8
Administration publique, enseignement, santé, action sociale	4 233	15,3

Meuse

DEN T3 - Nombre d'entreprises par secteur d'activité au 1er janvier 2011

	Nombre	%
Ensemble	6 714	100,0
Industrie	702	10,5
Construction	1 025	15,3
Commerce, transports, services divers	4 197	62,5
dont commerce et réparation auto.	1 463	21,8
Administration publique, enseignement, santé, action sociale	790	11,8

Champ : activités marchandes hors agriculture.
Source : Insee, REE (Sirène).

Figure 7: Number of companies according to their economic sector (INSEE, 2011 (INSEE))

Even though the three *départements* follow the same trends in terms of the distribution of economic activity (led by the tertiary sector with between 62.5% and 63.5% of total companies), Moselle and Meurthe-et-Moselle are way ahead of Meuse in terms of economic presence. Indeed, while Moselle and Meurthe-et-Moselle respectively have 39,900 and 27,700 companies on their soil, Meuse only

counts 6700 companies. The *départements* are similarly ranked when it comes to company creation (INSEE):

- Moselle company creation in 2011: 6500
- Meurthe-et-Moselle company creation in 2011: 4600
- Meuse company creation in 2011: 1000.

The unequal distribution in company establishment and company creation is also seen in the Lorraine Top100 (Vosges *département* excluded)[7]. Out of the 100 largest companies in the three *départements* (ranked by turnover from 60 million euros up to 3 billion euros):

- 59 of them are located in Moselle,
- 33 of them are located in Meurthe-et-Moselle,
- only 8 of them are located in Meuse, and 5 of which specialize in distribution and/or food processing and only one in steel transformation.

However, only 6 companies from the Top100 are located in the area corresponding to the project impact perimeter given by ArcelorMittal, (3 from Moselle, 2 from Meurthe-et-Moselle and 1 from Meuse)[8]:

Company Name	Code	City	Turnover
SOCIETE VEHICULES AUTOMOBILES BATILLY	54980	BATILLY	1,423,758,139 €
ARCELORMITTAL CONSTRUCTION FRANCE	55800	CONTRISSON	462,479,462 €
THYSSENKRUPP PRESTA FRANCE SAS	57190	FLORANGE	274,438,628 €
TATA STEEL FRANCE RAIL SA	57700	HAYANGE	255,013,646 €
LORRAINE TUBES	54720	LEXY	181,355,069 €
FIFAM	57290	FAMECK	73,941,199 €

Table 1: Companies from the Lorraine Top100 (Vosges excluded) that are located in the project perimeter (Source: verfi.fr and ENEA Consulting analysis)

Based on the previous figures, it is clear that the three *départements* do not have the same economic development prospects. While Moselle and Meurthe-et-Moselle have several pending projects, one of the most important being *TerraLorraine*, Meuse does not have many options to foster the local economy. In fact, the *département* of Meuse has only one big project, the underground nuclear waste management laboratory, which is located in Bure (C&S Conseils, 2010). This project is seen as an economic catalyst from which local authorities are receiving 30 million euros of tax revenue per year. Beyond this tax collection, the local authorities expect a partial industrialization due to the laboratory activities (C&S Conseils, 2010).

1.3.2.3. Agriculture vs. Industrial activities

Conversely, Meuse is more committed to agriculture than its neighbours (in 2009) (INSEE):

[7] List of the mentioned Top100 is available in the annex part of the report (source: verfi.com & ENEA Consulting).

[8] Note that this list does not include companies which operations may be affected by the injection operation because of their exploitation of underground resources.

- Moselle: agriculture represents **6.5%** of the total number of establishments[9] located in the *département*, vs. 6.7% for industry,
- Meurthe-et-Moselle: agriculture represents **7%** of the total number of establishments located in the *département* vs. the same percentage for the industry (7%),
- Meuse: agriculture represents **23.8%** of the total number of establishments located in the *département* vs. 7.3% for the industry.

1.3.2.4. Tourism vitality

With some 4,500,000 tourists in 2010, the tourism industry is active and employs 25,000 people in the region (Conseil Régional de Lorraine, 2012). However, despite the relative preservation of its landscapes and battlefields, symbols of the 1st World War, Meuse doesn't possess more tourist attractions than do the two other *départements*. This can be shown in the number of different types of tourist accommodation structures (Figure 8).

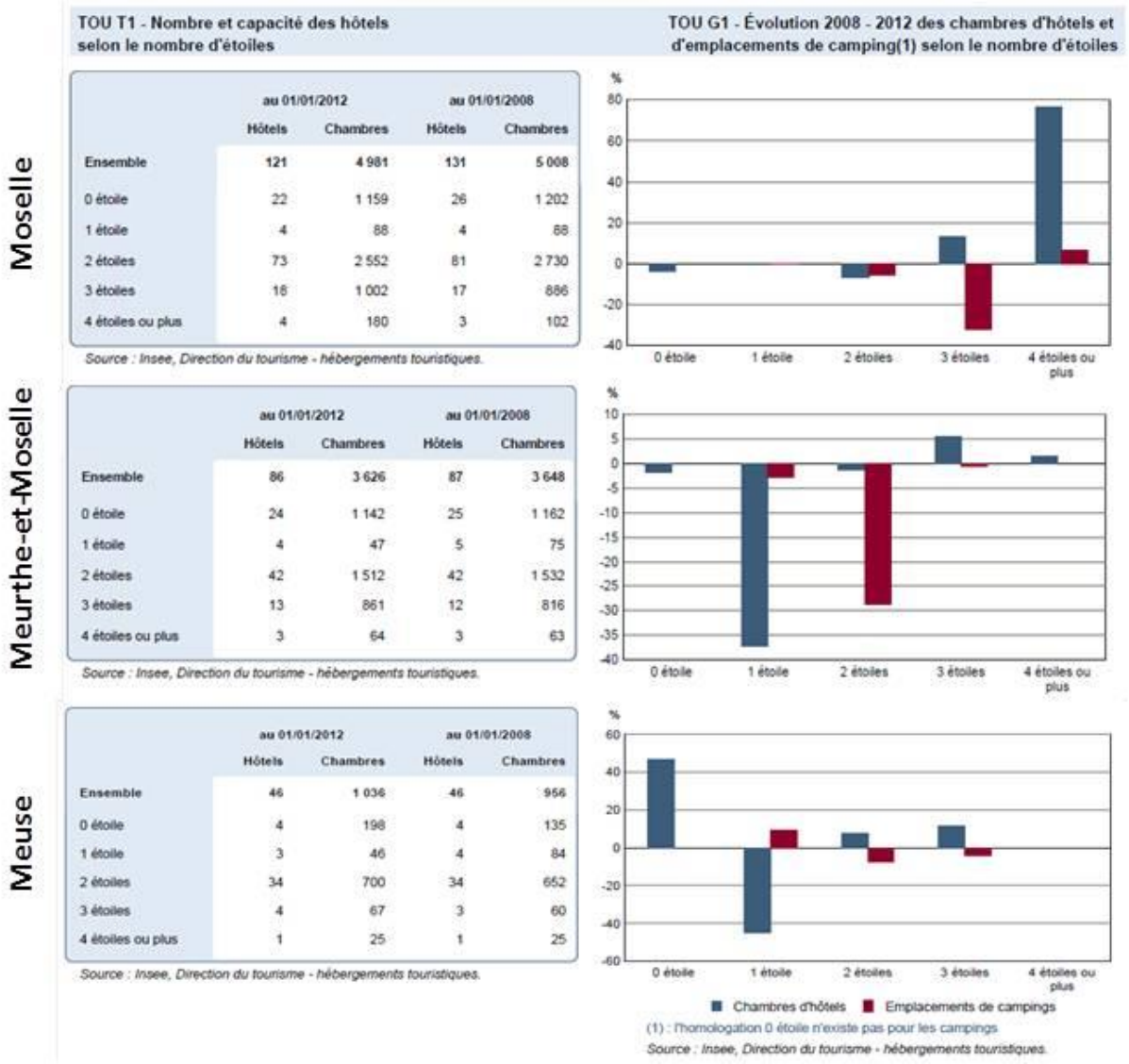


Figure 8: Tourism accommodations and their evolution (INSEE, 2012 (INSEE))

[9] An "establishment" is the smallest economic unit that is considered in statistics (such as a production unit). For instance, a company can rely on various establishments (according to the INSEE).

1.3.2.5. International trade vitality

In terms of international business activity, there are several noteworthy elements (Conseil Economique Social et Environnemental de Lorraine, 2011):

- Almost 30% of Lorraine's annual exports are to Germany (this percentage is evaluated at 4.7 billion euros vs. 6 billion euros in 2007). As shown below, regional exports (Germany included) are mainly products related to the steel and the car industries.

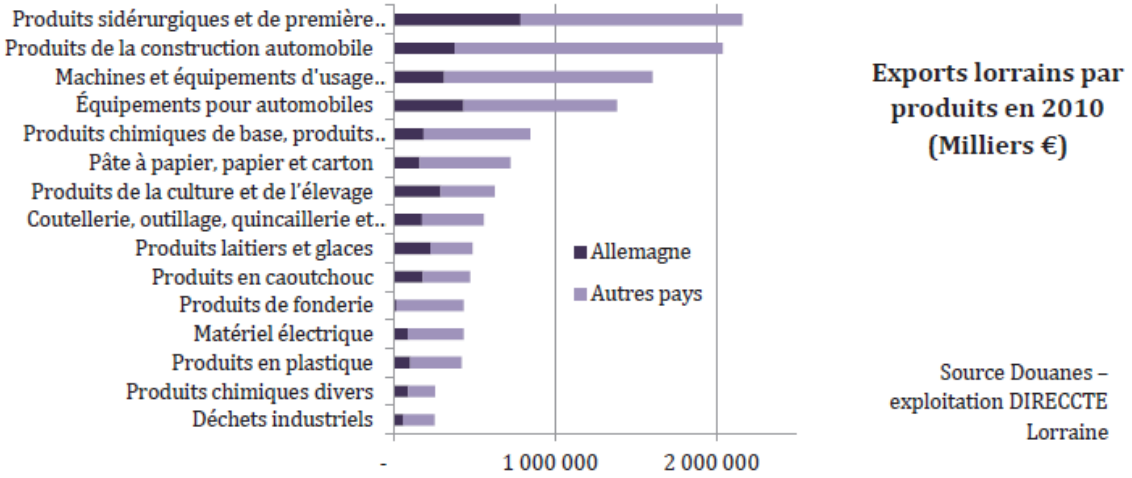


Figure 9: Representation of the Top 80% of regional exports in 2010 (source: French customs (Conseil Economique Social et Environnemental de Lorraine, 2011))

- 10% of Lorraine GDP is based on its exports to Germany (three times higher than the French national average),
- The regional export breakdown confirms the initial economic figures: Moselle is accountable for 62.5% while Meurthe-et-Moselle for 16.5% and Meuse for only 6.7%.
- The regional Foreign Direct Investment (FDI) breakdown from Germany has also been mainly concentrated in Moselle (see below) until 2004, with a slight preference for Meurthe-et-Moselle after 2004[10].

[10] Along with Germany, USA and Luxembourg are the biggest contributors in terms of FDI (Agoravox, 2011).

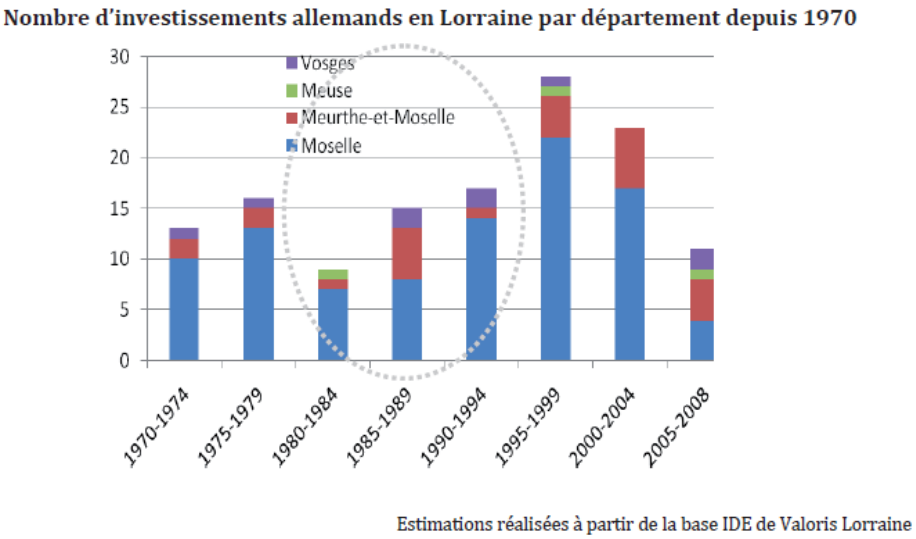


Figure 10: Number of German investment in the Lorraine region from 1970 to 2008 (Source: Valoris Lorraine (Conseil Economique Social et Environnemental de Lorraine, 2011))

In conclusion, **Moselle and Meurthe-et-Moselle are clearly leading the relative economic vitality of the region (including in terms of international business).**

1.3.2.6. Lorraine compared to other French regions

When compared to the rest of the country, the Lorraine region shows some very good performances:

- Lorraine is the 11th French region in terms of GDP with 55.4 billion euros in 2011 (out of 23 regions) (INSEE).
- Its trade balance is positive (119% for Lorraine whereas France is about 88%[11]) which positions the region in 3rd place (Conseil Economique Social et Environnemental de Lorraine, 2011),
- Lorraine is recognized as the 4th French region in terms of exports to France's primary trading partner, Germany (Conseil Economique Social et Environnemental de Lorraine, 2011).
- However, *département* debt levels[12] (Capital.fr, 2012) appear to be more worrying than the previous statistics:
  - Moselle: 409 million euros with an increase of 5400% between 2001 and 2010 (19th *département* of the country in terms of debt amount)
  - Meurthe-et-Moselle: 335 million euros with an increase of 51% between 2001 and 2010 (28th *département* of the country in terms of debt amount)
  - Meuse: 196 million euros with an increase of 131% between 2001 and 2010 (58th *département* of the country in terms of debt amount)

Despite its superior economic performance, Moselle is showing real difficulties in maintaining its development. Being in the top 20% of the most indebted French *départements*, **the 5400% increase in its debt over the last decade shows how badly the *département* has been affected by the crisis and deindustrialization**.

[11] Trade balance: Export volume / import volume

[12] Average debt increase among French *départements* is about 64%. The ranking is based on a group of 101 *départements*, the number one holding the highest amount of debt.

1.3.2.7. Concluding remarks

Although Lorraine shows good economic performances and leads French exports to Germany, its *départements* have suffered from the global economic crisis as well as from the plight of deindustrialization, which has impacted France. In Lorraine, **Moselle is the *département* that has suffered the most** in terms of exposure to the phenomenon of economic decline, while **Meurthe-et-Moselle shows a broader economic diversification and Meuse appears to be more focused on agricultural activities**.

Nonetheless, the lack of industrial prospects has affected the entire region and Meuse remains far behind its neighbours in terms of economic vitality, project development, innovation potential and ability to attract new residents.

1.3.3. Social factors

1.3.3.1. Demographic insights

As shown in Figure 11, the populations of Moselle and Meurthe-et-Moselle are respectively 5 and 2.5 times higher than that of Meuse. Moreover, the population of Meuse is the only one to have decreased over a period of 40 years (1968-2009).

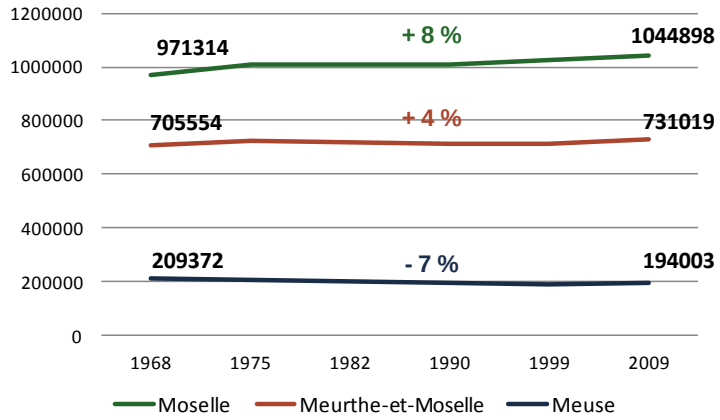


Figure 11: Demographic evolution in Lorraine (INSEE, 2010 (INSEE))

Since birth rates are higher than death rates in all *département*s (with at least a 1.5/1000 difference), the decline of the population of Meuse is due to a regional emigration phenomenon. This movement also explains the population density difference between the 3 *département*s (INSEE) (2009):

- Moselle has approximately 168.1 inhabitants per km²
- Meurthe-et-Moselle has approximately 139.4 inhabitants per km²
- Meuse has approximately 31.2 inhabitants per km²

There have not been any major disparities observed in the population pyramids despite two elements of interest (Figure 12):

1. Meurthe-et-Moselle shows the highest proportion of 15-29 years old citizens, while Meuse has the lowest of the three *département*s. According to information collected by C&S Conseils[13], this element could possibly be explained by the absence of higher education programs in the *département*, which may have generated a "brain drain phenomenon".
2. Compared to the two other *département*s, Meuse shows higher population rates over 60 years old.

[13] ArcelorMittal private communication

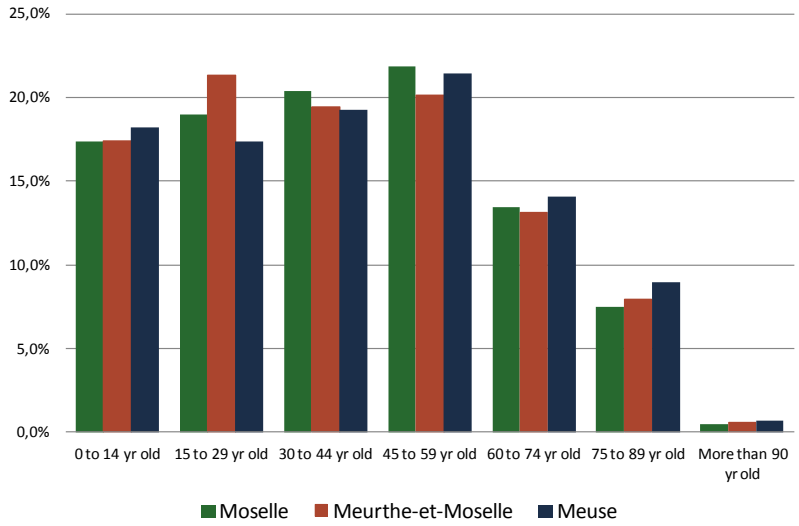


Figure 12: Population distribution in the *départements*, according to age segments (INSEE, 2010 (INSEE))

1.3.3.2. Employment issues

Lorraine is historically and without contest an industrial area, as shown by the *départements*' SEC[14] distribution (Figure 13). With 26.3% of blue-collar workers in Moselle, 22.4% in Meurthe-et-Moselle and 28% in Meuse, all of the *départements* are above the French average of 21.2%. Indeed, industry is still seen as a "structuring economic sector" where "1 job in the steelmaking industry generates 1 to 3 indirect jobs (service providers, businesses, etc.)", according to a local authority[15].

However, despite a high proportion of workers remaining in the agricultural and industrial sectors, the three *départements* suffer from deindustrialization and rural depopulation, as shown by the significant proportional decrease in workers and farm owners between 1999 and 2009. It appears that this decrease is offset by an increase in middle management and executive positions.

When comparing *départements* to each other, it can also be noted that Meuse has the highest share of workers and employees, while Meurthe-et-Moselle has the highest share of executives: 14.6% against 11.5% for Moselle and 8.7% for Meuse.

[14] SEC: Socio Economic Class

[15] See Note 13, p 33

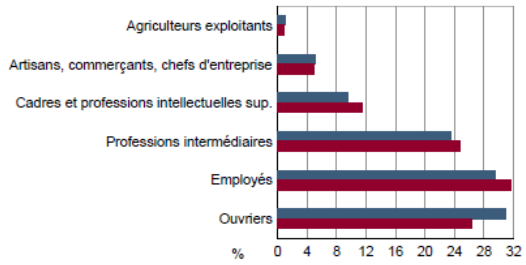
EMP T7 - Emplois par catégorie socioprofessionnelle en 2009

EMP G3 - Emplois par catégorie socioprofessionnelle

Moselle

	Nombre	%
Ensemble	377 359	100,0
Agriculteurs exploitants	3 174	0,8
Artisans, commerçants, chefs d'entreprise	18 269	4,8
Cadres et professions intellectuelles sup.	43 540	11,5
Professions intermédiaires	93 765	24,8
Employés	119 185	31,6
Ouvriers	99 425	26,3

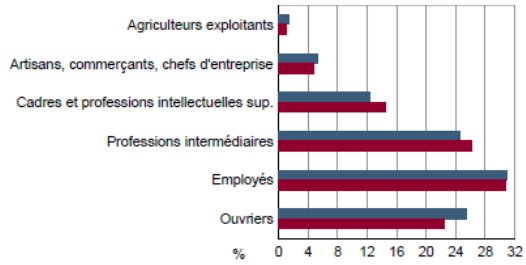
Source : Insee, RP2009 exploitation complémentaire lieu de travail.



Meurthe-et-Moselle

	Nombre	%
Ensemble	271 272	100,0
Agriculteurs exploitants	2 987	1,1
Artisans, commerçants, chefs d'entreprise	13 112	4,8
Cadres et professions intellectuelles sup.	39 535	14,6
Professions intermédiaires	71 176	26,2
Employés	83 625	30,8
Ouvriers	60 837	22,4

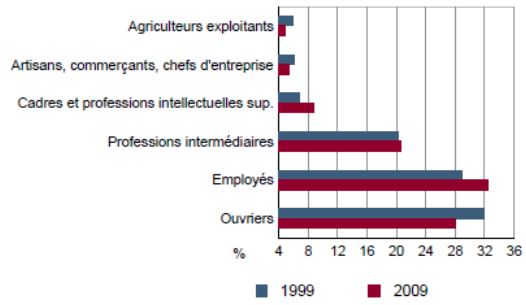
Source : Insee, RP2009 exploitation complémentaire lieu de travail.



Meuse

	Nombre	%
Ensemble	69 544	100,0
Agriculteurs exploitants	3 316	4,8
Artisans, commerçants, chefs d'entreprise	3 769	5,4
Cadres et professions intellectuelles sup.	6 041	8,7
Professions intermédiaires	14 382	20,7
Employés	22 545	32,4
Ouvriers	19 491	28,0

Source : Insee, RP2009 exploitation complémentaire lieu de travail.



Sources : Insee, RP1999 et RP2009 exploitations complémentaires lieu de travail.

Figure 13: Evolution of the SEC distribution (INSEE, 2010 (INSEE))

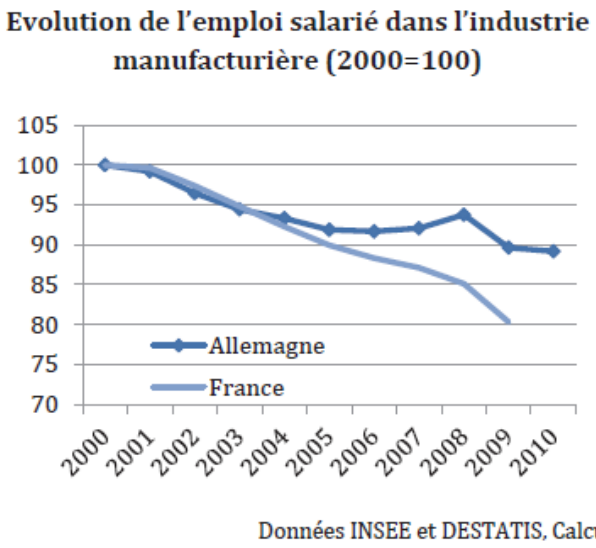


Figure 14: Employment evolution in industry in France and Germany (Source: CESEL (Conseil Economique Social et Environnemental de Lorraine, 2011))

The observed decrease in the proportion of blue-collar workers (Figure 13) in the SEC national employment distribution is another effect of the deindustrialization phenomenon (C&S Conseils, 2010).

Indeed, between 2000 and 2009, employment in manufacturing industries decreased by 20% in France, while it decreased by only 6% in Germany (Figure 14). Given that Lorraine is one of France's most industrialized regions, this phenomenon is a major concern for the local populations (C&S Conseils, 2010).

Furthermore, the lasting strength of German industry may be one of the main levers to maintain a certain level of activity in Lorraine.

The German share in Foreign Direct Investment (FDI) from foreign companies established in Lorraine corresponds to 33% of employment (i.e. more than 22,000 jobs). Even though these investments are no longer focused on industry and are currently decreasing in Moselle, they are still increasing in Meurthe-et-Moselle and largely contribute to maintaining jobs in the steelmaking and automotive industries (for instance: 19% of Thionville's jobs rely on FDI from various parts of the world).

Figure 15: Impact of FDI in terms of employment in the Lorraine region (Source: Valoris Lorraine (Conseil Economique Social et Environnemental de Lorraine, 2011))

Without taking into account any specific category, Lorraine is recognized as the leading region of France in terms of the number of jobs created or maintained through FDI flows (1.8 job for 1000 active people (Conseil Economique Social et Environnemental de Lorraine, 2011)). Since 2010, FDI has maintained or created 1820 jobs per year in average.

Consequently, a significant part of the local wealth is based on Lorraine's proximity to its foreign neighbours (Figure 16).

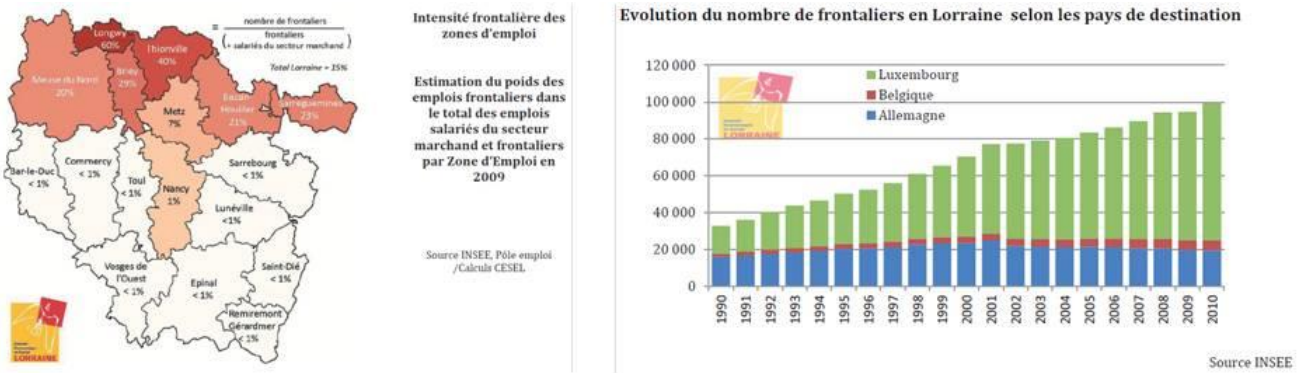


Figure 16: Employment resulting from Lorraine's border relationships (CESEL & INSEE (Conseil Economique Social et Environnemental de Lorraine, 2011))

Although it is true that fewer locals are working in Germany now than in 2001, the trend is reversed for Luxembourg. Almost 100,000 in total people are bringing foreign salaries into Lorraine (roughly 5% of the Lorraine population). Many jobs also depend on the daily presence of foreign visitors: 20% of the jobs in the Thionville area, 29% in the Briey area and 20% in the Meuse du Nord area depend on daily business relationships with foreigners. No matter how valuable FDI and border business opportunities are in terms of employment, deindustrialization has definitely affected employment in the region.

The three *départements* were below French unemployment rates [16] in 1999, but they are now above (Figure 17). Meurthe-et-Moselle and Meuse rates have decreased but more slowly than the national rate, while Moselle appears to be the region's most impacted *département* with a 0.1 point increase over the period.

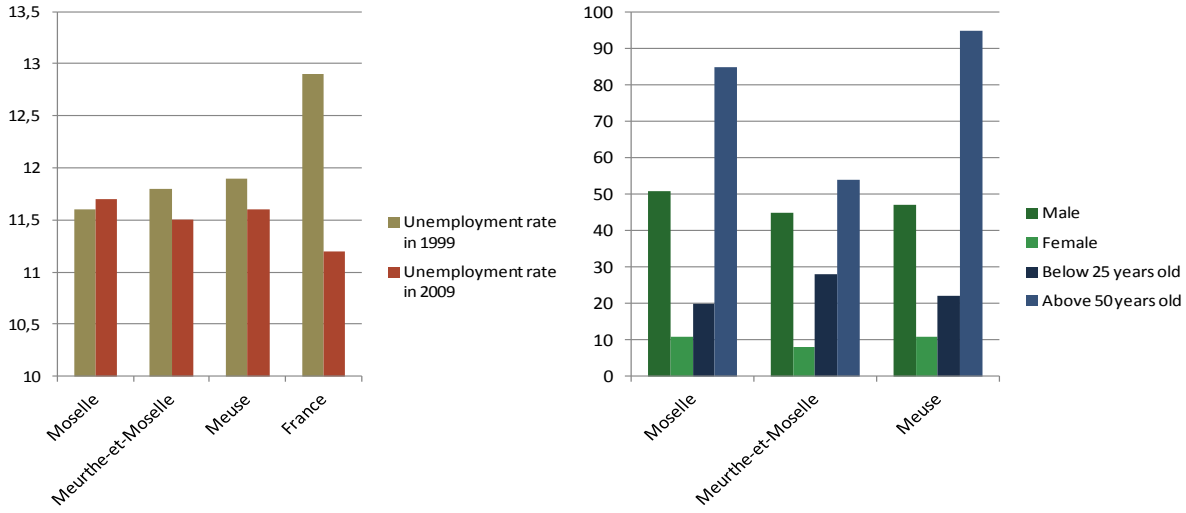


Figure 17: Unemployment evolutions

[Left: Unemployment rate evolution; Right: Unemployment increases 2001-2011] (Source: INSEE, 2010&2012 (INSEE))

Using a different calculation method[17], unemployment increased in Moselle by 30% and in Meurthe-et-Moselle and Meuse by roughly 26%. This second type of data shows how badly people above 50 years old have been affected by unemployment, and how women seem to be more resilient to unemployment. This last element can also be attributed to deindustrialization, which mainly affected the heavy industry sector, where industrial workers are essentially men. About 80% of Moselle workers are men, 84% in Meurthe-et-Moselle and 83% in Meuse.

Finally, it is important to highlight that Meurthe-et-Moselle is the *département* that is doing the best in terms of unemployment, as shown in both calculations.

1.3.3.3. Personal wealth

As shown on Figure 18, households from Moselle, Meurthe-et-Moselle and Meuse earn more revenue than the French average. Even though Meuse households appear to declare 8% less revenue than Moselle and Meurthe-et-Moselle ones, they appear to be 30% wealthier than the average French household.

[16] Rates are given by INSEE according to census standards. A person is considered unemployed when he/she is more than 15 years old, and has declared him/herself as unemployed (even though the person is not registered at Pôle Emploi, the French employment agency) and is actively seeking employment (INSEE).

[17] The calculation is provided by Pôle Emploi, based on the registrations.

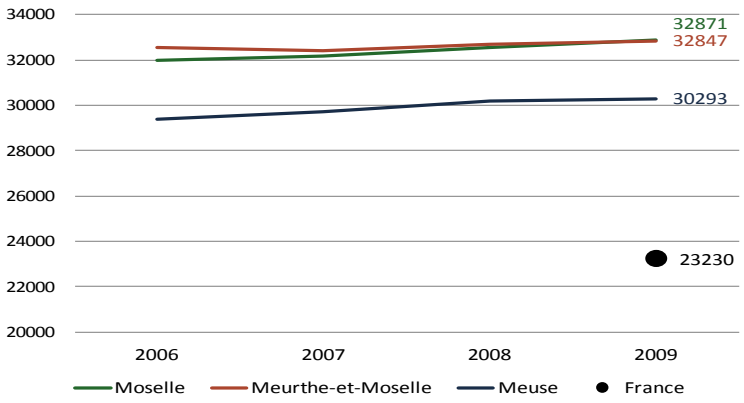


Figure 18: Declared revenues after taxes per fiscal household (INSEE, 2010 (INSEE))

Besides revenues, individual wealth can also be valued through property holdings. From this point of view, Moselle and Meurthe-et-Moselle reach the national average (57.8% of residents are homeowners in France vs. respectively 59.2% and 57.3% in Moselle and Meurthe-et-Moselle) whereas 66% of Meuse's residents are owners (likely because the *département* is much more agricultural). This situation is far from trivial as this statistic proves to be critical in a CCS context where **one of the main challenges to social acceptance is the local residents' fear of declining property values due to the presence of a CO_2 storage site** (World Resources Institute, 2010).

1.3.3.4. Education

According to Figure 19, the population of the three *départements* analysed per *département* shows higher education levels over time. However, Meuse appears to be the *département* delivering the smallest proportion of undergraduates, graduates and postgraduates. This situation can actually be directly related to an already-mentioned fact: there are no higher education programs in the *département*, which may generate a "brain drain phenomenon" (C&S Conseils, 2010).

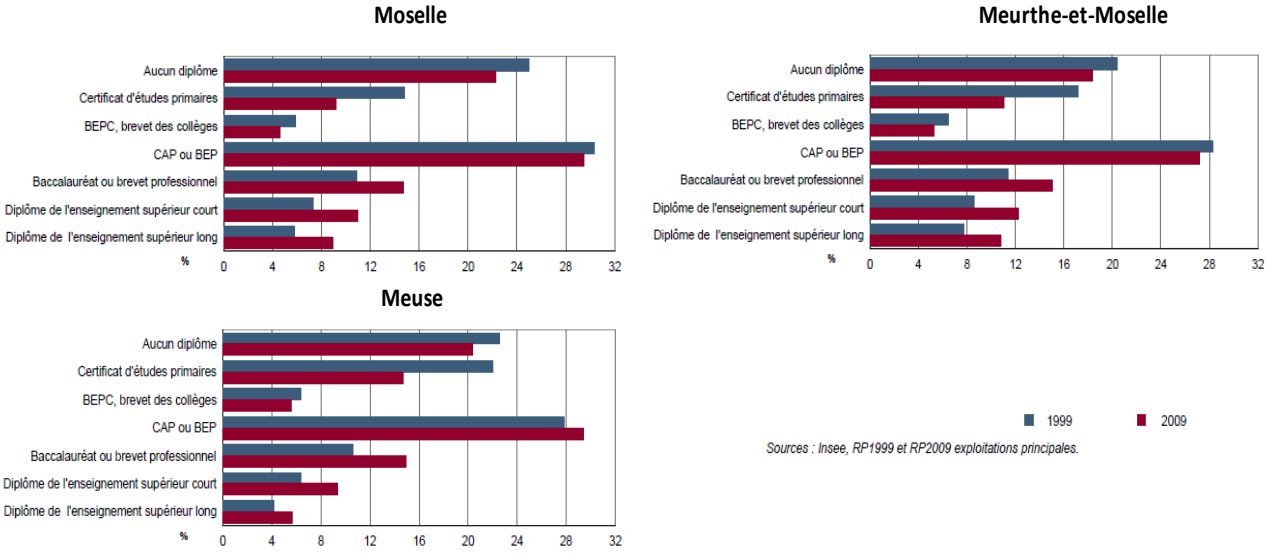


Figure 19: Distribution of the population according to their highest degree (INSEE, 2010 (INSEE))

1.3.3.5. Concluding remarks

The economic situation of the region directly translates into one of the main concerns among the local population: employment. Indeed, the strong industrial commitment of the region, which originally contributed to its success, is no longer synonymous with prosperity.

Lorraine citizens are increasingly facing local employment issues and often decide to work in neighbouring countries in order to maintain reasonable living conditions.

1.3.4. Technological factors

1.3.4.1. Overview

In 2010, Lorraine ranked 10th in terms of funding received from the French National Research Agency (ANR), with 13.65 million euros of public subsidies (Regional council of Lorraine, 2010). The breakdown of this funding by field is detailed in the table below. In 2007, Lorraine also ranked 10th in terms of funding from OSEO, which supports innovation within SMEs (small- and medium-sized enterprises) with a total apportionment of about 6 million euros (Regional council of Lorraine, 2010).

Fields	Funding (M€)	% of total allocation
Non-thematic or transverse topics	4.68	34%
Biology – Health	1.41	10%
Engineering, processes and security	1.36	10%
Information and Communication Science and Technology	1.13	8%
Sustainable Energy	0.85	6%
Social Sciences	0.32	2%
Environment and biological resources	0.13	1%
Total	9.88	72%
Partnership and Competitiveness	3.775	28%
Funding	**13.655**	**100%**

Table 2: Breakdown of ANR funding (French National Research Agency, 2011)

ANR is the most significant funding organization at the national level, supporting large integrated research projects involving both public and private research laboratories, while the FRIL (Regional Fund for Innovation in Lorraine, co-funded by OSEO and the Regional Council) acts at the regional level and supports development projects within small- and medium-sized enterprises.

		Value	***Rank***
Number of researchers	Lorraine total	4 240	12
	France total	217 582	
	Lorraine public (%of total)	62.8	3
	France public (% of total)	42.8	
	Lorraine private (%of total)	37.2	20
	France private (% of total)	57.2	
Research spending	Research spending in Lorraine (M€)	655	14
	Research spending in France (M€)	37,911	
	% Lorraine public	52.7	3
	% France public	34.7	
	% Lorraine private	47.3	20
	% France private	65.3	
	Research spending /GP Lorraine	1.1	14
	Research spending /GP France	2.1	
	Patents Lorraine	177	16
	Patents France	12 889	

Table 3: Key figures concerning research in Lorraine and in France (INSEE, 2012) (INSEE, 2012)

Compared to France, the Lorraine region relies much more on public research than on private research (see Table 2) due to its recent difficulties in maintaining its industrial vitality and appeal (see previous analysis on the economic factors).

Once again, there is a noticeable difference between Meuse and the two other *départements*. Figure 20 also shows that there have only been a few patents registered in Meuse in the past 4 years, which is an indication of low innovation. There is no identified laboratory from the main national research organizations in Meuse (for instance CNRS, Inserm, Inra and Inria).

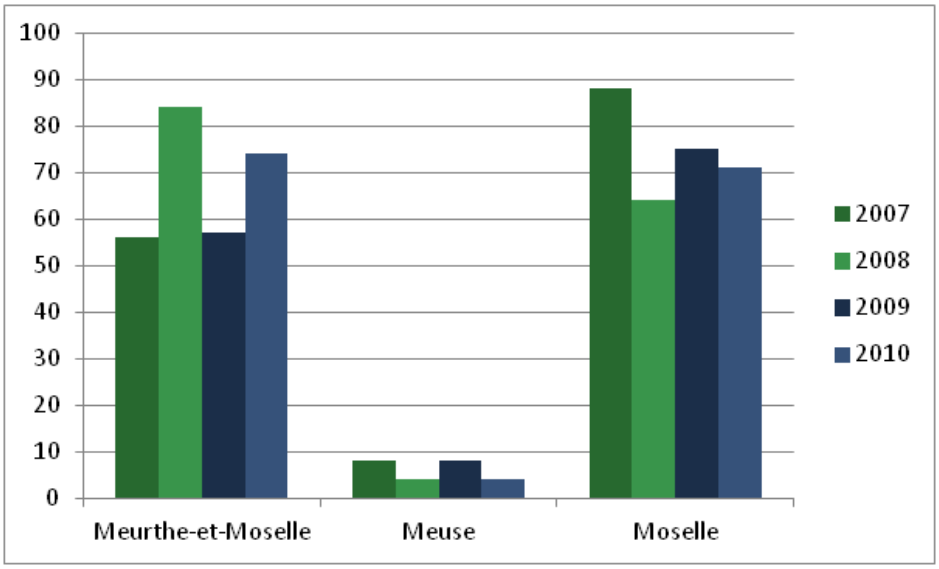


Figure 20: Number of registered patents

1.3.4.2. Regional strategy for Innovation (Regional council of Lorraine, 2010)

Out of the twelve regional priority sectors backed by the Region, five benefit from public research support:

- Bio-renewable resource conservation and utilization: plant chemistry, biomass recovery, water quality conservation, green building…
- Circular economy: by developing a recycling industry, promoting green construction, converting vacant industrial land…
- Functional materials—one of Lorraine's main assets—including metallurgy, plastics processes, mechanics, composites, wood, nanomaterials…
- Health technologies, including bioengineering, medical imaging, materials…with a focus on cancer-related applications.
- Information science and engineering: computer security, modelling, software for linguistics…

1.3.4.3. Regional public research organizations (Regional council of Lorraine)

Academic institutions and national scientific and technical institutes work together in Centres of Scientific and Technological Research (PRST in French), which aim to create networks and synergies between laboratories working in the same fields. There are 5 PRST in Lorraine:

- MEPP (Materials, Energy, Products and Processes): energy savings, recycling, clean processes, comprising 600 researchers from universities, engineering schools or CNRS labs. The organization is strongly linked to Materalia (see 0)
- ITM-S: Therapeutic and Molecular Engineering – Health
- SGE (Environmental Sciences and Engineering): main environmental issues, from water or soil pollution to CO_2 storage. It is in a partnership with Fibers (see 0)
- MISN (Modelling, Information and Digital Systems): mathematics, automation and computer science applied to systems modelling in various fields such as the energy, chemical, automotive and steel industries.
- Mankind and Society: humanities, sociology, working on the notion of borders, linguistics, and innovation in the production industry.

1.3.4.4. Competitiveness clusters and strategic sectors (Regional Council of Lorraine)

The Lorraine region has 3 of the 71 national competitiveness clusters launched in 2005 by the French government: Materalia, Hydreos and Great-East Fibers. They are all co-managed with adjacent regions (Alsace for Hydreos and Fibers; Champagne-Ardenne for Materalia). The purpose of these clusters is to bring people from academic institutions and private companies together to boost innovation.

Materalia

Materalia is a competitiveness cluster focusing on Materials and Processes, mainly working in the automotive, aeronautics, medical and energy industries. It aims to bring innovative materials or manufacturing processes to market. It includes 135 research units and 78 business-related entities, including major companies like PSA, Air Liquide, ArcelorMittal, EDF, Faurecia, Saint-Gobain, Schneider Electric, Safran… Some 1800 researchers associated with the cluster's topics work in the area.

More than a hundred projects have already been carried out, with the participation of 57 companies and 27 labs and for a budget of 75 million euros.

Fibres Grand-Est (Great-East Fibers)

This cluster is mainly located in the Vosges *département* (which is out of the project's geographical perimeter). It mainly focuses on the design of new fibers with enhanced abilities, better fiber sustainability and new production processes. It is quite small, with only 300 researchers and 15 laboratories.

Hydreos

Hydreos is the area's most recent competitiveness cluster, approved in 2010 with a budget of nearly 900 000 € in 2011. Its field of interest is the control of continental water quality, in relation to public health and ecosystem protection.

70 entities are currently members of Hydreos, including major companies like Nestlé Waters, Suez Environnement and Veolia Environnement, as well as academic institutions like the Universities of Lorraine and the University of Strasbourg. It relies on a pool of 350 companies and 2500 researchers.

Underground laboratory in Bure (ANDRA, 2009)

Under construction since 2000[18], this underground laboratory intends to provide a research platform for the long-term storage of nuclear waste. It lies 490 m below ground, enclosed in a clay layer. Until the end of 2011, it was used to show that the storage of long-lasting nuclear waste in deep geological layers is reliable, and also to develop the necessary geo-engineering skills, techniques and equipment.

However, it might develop into the status of a "very large experimental instrument" in the coming years, which would allow other researchers to carry out research in other fields related to Earth sciences. Even though this laboratory has significant political and symbolic status, less than a hundred researchers currently work there.

[18] http://www.andra.fr/andra-meusehautemarne/pages/fr/menu18/le-laboratoire-souterrain/l-histoire-du-laboratoire-souterrain-1512.html

Synergies

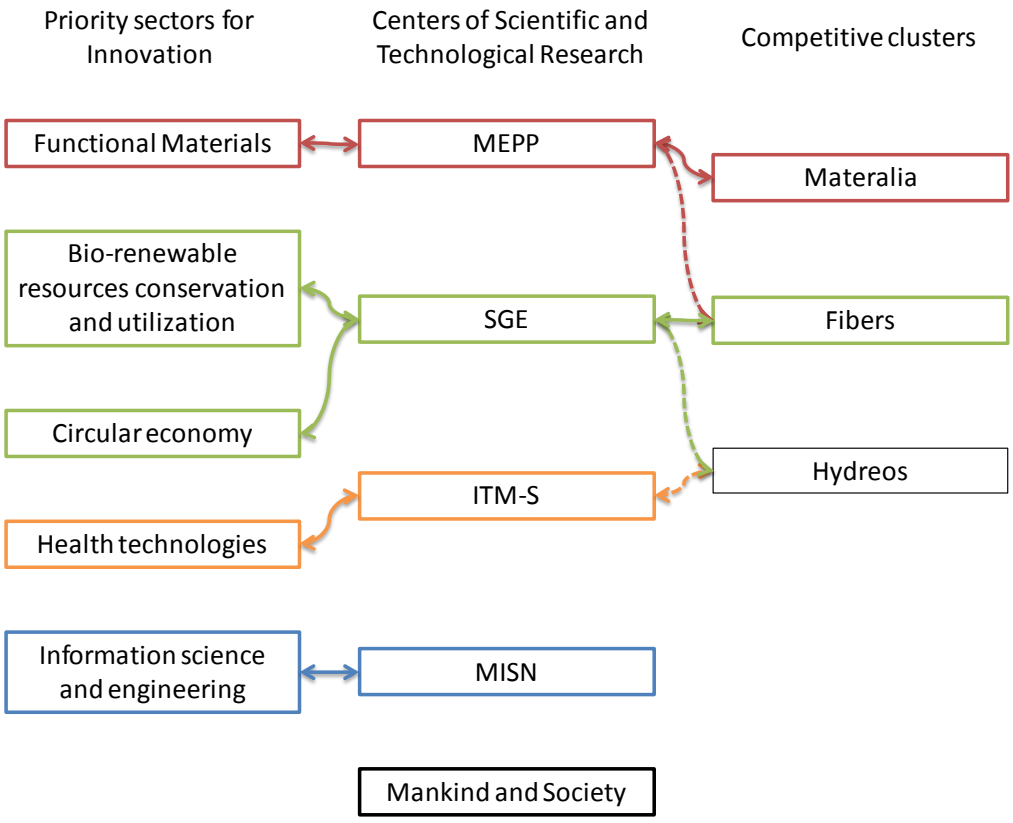


Figure 21: Synergies between Research, Innovation and Competitiveness clusters in the Lorraine region

Four technological sectors are highlighted in Figure 21: **Materials**, **Environment and Resources**, **Information sciences** and **Health**, which confirms the trends shown in the part 1.3.4 (Overview).

1.3.4.5. Concluding remarks

In line with the economic trends, Moselle and Meurthe-et-Moselle appear to concentrate the region's innovative capacities while Meuse lags far behind in terms of research and innovation (see the comparative analysis of published patents).

Mainly supported by public grants, regional innovation is under political influence and is therefore led toward 5 main axes:

- Bio-renewable resource conservation and utilization,
- Circular economy,
- Functional materials,
- Health technologies,
- Information science and engineering.

Technological focus on CCS and the steel industry: processes & issues

Mitigating carbon emissions from steel mills

Despite a recycling rate of around 85%, the high and still rising worldwide demand for steel makes it necessary to continue extracting and producing large volumes of iron and steel from iron ore, which is a very carbon-intensive process emitting around 2 tons of CO_2 per ton of steel produced. Today this represents about 2.3 Gt/yr of CO_2 for the whole sector, and is set to reach 2.6 Gt/yr of CO_2 by 2050 following a business-as-usual scenario (UNIDO & Arcelor, 2010).

In order to meet European Union and post-Kyoto objectives to reduce CO_2 emissions in the industrial sector, as well as to improve competitiveness, the steel industry has made it a priority to integrate environmental considerations into the traditional product design process and to make gains in energy efficiency.

Important progress has already been made over the past few decades, cutting energy consumption and associated emissions by approximately 50% in 30 years. The resulting drawback is that today's best practices offer little room for further cuts without radical innovation.

It should also be noted that there are various routes to produce steel, depending on the iron source, the reducing agent and/or the energy source. Each process emits more or less CO_2, has specific needs and therefore implies different mitigation technologies and solutions. The main process routes are (UNIDO & Arcelor, 2010):

- The Integrated Route based on Blast Furnace, BOF and using mainly iron ore as iron units as well as coal/coke as the reducing agent/energy source. It is therefore a primary, virgin iron route.
- The Electric Arc Furnace (EAF) route, which uses scrap, i.e. recycled steel, as iron units and electricity (plus some coal and oxygen) as energy source. It is a secondary route.
- The direct reduction of iron ore, most of which is based on the use of natural gas as a reducing agent (but some is still achieved with coal). The intermediate product, directly reduced iron, is melted in an EAF.

There are different categories of steel and even if carbon steel is overwhelmingly the largest category in terms of volume, specific alloys such as stainless steel, with its economic and industrial importance, have higher energy requirements and thus generate higher CO_2 emissions (UNIDO & Arcelor, 2010).

Technologies and solutions

Steel-related CO_2 capture is different from that applied in power generation or other energy-intensive industries, since carbon is not oxidized in a combustion process but through the metallurgical reduction of oxides. Therefore, "in-process" capture technologies can be applied to the mainstream process routes, with the expected benefit of improving energy needs and productivity compared to today's best practices. Compared with power generation and other industrial sectors where capturing CO_2 is often associated with a high-energy penalty, steel-related CCS is unique.

Various technologies and options are currently in development in order to reduce steel industry emissions. The main ones are briefly described below:

Improving the blast furnace and decreasing coal use

Most iron for steelmaking is currently produced in blast furnaces using coal in the form of coke and pulverized coal as the reducing agent to convert the ore into the raw metal. The first mitigation instrument is to increase the use of reducing agents other than coal. Several options are possible.

- Top gas recycling

This produces a gas mix of CO and CO_2. The idea here, and the principle of the "Top Gas Recycling Blast Furnace" (TGRBF) developed within the ULCOS project, is to separate CO from CO_2 using the same post-combustion capture technologies that are used in the power sector, and to recycle the CO as reducing agent into the furnace. This reduces the need for coal by 24% and associated CO_2

emissions by 15%, according to Luossavaara-Kiirunavaara ab (LKAB) research centre (Commission, 2009). As this option is easy to apply, it is likely to be the earliest approach adopted by the steel industry.

- Direct reduction or pre-reduction options

The first possibility is to use a gas-fired pre-reduction furnace followed by an electric arc furnace. Carbon from coal is then replaced as a reducing agent by hydrogen from methane, and electricity. However, this option is only economically viable in countries were natural gas is abundant and cheap, so it would apply to just 5% of worldwide steel production.

If natural gas is available, another possibility would be to use it to produce hydrogen through a steam reforming process. In fact, hydrogen is an effective reducing agent for iron ore, allowing the reduction rate at 800°C to be ten times higher than with CO (Commission, 2009). However, this reaction is endothermic, which prevents it from being cost-competitive.

The steel mill could also be locally associated with a coal or biomass gasification power plant, where part of the produced syngas could be by-passed from its power generation path to serve as a reducing agent in the steel production process.

- Use of electricity

The direct use of electrons to reduce iron oxides is also possible by applying the principle of electrolysis (project, 2012). This is already used to produce other metals, such as aluminium and magnesium, but it has never been used in the steel sector. It may be the most carbon-lean route, depending on the carbon content of the local electrical mix.

- HISARNA project

Another option to reduce the use of coal as a reducing agent is to combine a coal-based smelter with a smelt cyclone. As all the process steps are directly hot-coupled, avoiding losses from intermediate treatment of materials and process gases, energy efficiency is increased (Commission, 2009).

Capturing the output CO_2

In addition to “in-process” mitigation solutions that reduce the quantity of CO_2 emitted per ton of steel produced, the CO_2 can be captured, transported and recovered or geologically stored.

There are various well-identified technologies used to capture CO_2 from flue gas. They include absorption (using amines for instance), adsorption, membrane separation and cryogenic techniques, among others, each type involving a wide range of technologies at various degrees of maturity and demonstration. Some of these technologies are mature and have been used at a large scale in specific industrial applications related to CO_2 or other gases such as hydrogen. This is the case with amine scrubbing (based on AMDEA), and physical adsorption systems such as PSA (Pressure Swing Adsorption) or VPSA (Vacuum Pressure Swing Adsorption), complemented by a cryogenics unit designed to purify the CO_2 (UNIDO & Arcelor, 2010).

An important characteristic of iron-making gases is that the main streams are rich in CO_2 – from 25% to 98%, depending on the process (Commission, 2009). This content can be improved by introducing O_2 in the furnace as a reaction medium instead of air, through what is called an oxyreduction process.

Current status of CCS in the iron and steel sector

Major R&D programs are under way to develop specific technologies for the Steel sector. In the EU, the ULCOS program, supported globally by the Steel sector, is the most advanced one of them.

In the United Arab Emirates, Emirates Steel Industry also intends to retrofit a CO_2 capture unit at its Mussafah steel plant, with a projected start-up in the fourth quarter of 2015. The plant will capture around 800,000 tons per year of CO_2, which will be transported via a 50 km pipeline for use in an Enhanced Oil Recovery operation. The final investment decision was expected by the end of 2012.

1.3.5. Environmental factors

The assessment of the environmental context for the ULCOS Carbon Capture and Storage demonstration project is quite an intricate issue given its geographical scope. The project has a large footprint, from the carbon capture unit to the storage site, involving various ecosystems. Each of them has intrinsic ecological values and specific governance issues, and depends on local or transnational administrative contexts.

In the context of this project, Ecological issues are considered relevant even if the ecosystems are, or were, under anthropic pressure and altered environmental conditions.

For a comprehensive overview of the environmental stakes, the concerned area must not only cover the geological exploration permit area (about 3500 km², including the 100 km or so distance between the capture and the storage facilities), but should also include a large part of the hydraulic unit, as well as the capture and the transport areas.

To make a clear distinction between surface and subsurface environmental issues, we will consider:

- The ecological context for surface ecosystems located within the area where exploration and monitoring activities are conducted
- The environmental context for the subsurface storage sites, with a special focus on the Lower Triassic Sandstone (GTI) aquifer.

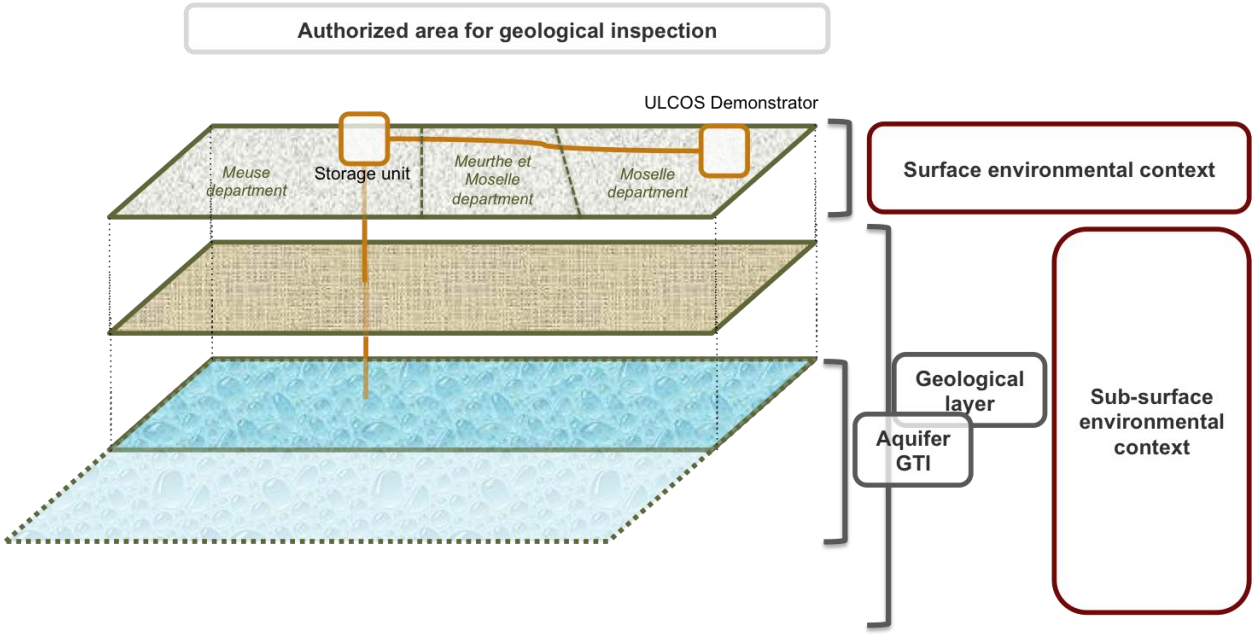


Figure 22: Environmental compartments of ULCOS perimeter

A synthetic review of the various compartments was carried out from an environmental perspective. It includes water systems and aquatic ecosystems, biodiversity and habitat, landscape, soils and air. To be complete, information on the various institutions in charge is also provided.

The area of concern shows contrasted environmental conditions resulting from specific natural and anthropic heritage. Moselle has a long industrial history and its environment has been significantly affected by human activities, whereas in Meuse, natural ecosystems have been much more preserved and deliver more environmental amenities.

1.3.5.1. Water and aquatic ecosystems

Groundwater and surface waters

The region of Lorraine covers the Eastern part of the Paris Basin. Due to its geographic position and semi-continental climate, annual pluviometry is between 700 and 1000 mm, with a number of rivers draining the area such as the Moselle and the Meuse Rivers, which are crossing the project area.

The end of iron and coal mining in Lorraine has had an impact on the hydrological conditions. For example, when the iron ore was extracted from the Aalenian, the overlaying Dogger limestones (middle Jurassic) were often fractured in the process, connecting both formations, leading to the draining of the Dogger water table into the mining galleries. The abandonment of the mines has led to their flooding, with modifications of the groundwater and river regimes, as well as the deterioration of water quality.

The formation targeted for the geological storage of the CO_2 is the Lower Triassic Sandstone. The Lower Triassic extends well beyond the region of Lorraine, north towards Luxemburg and Germany and east towards the region of Alsace. It dips towards the west where its thickness diminishes. This confined sandstone aquifer has been heavily modified regionally by coal mining and water extraction. Water salinity increases to the west where ages (carbon 14 dating) reach 30,000 years.

In Lorraine this sandstone reservoir has been used for water extraction, gas storage (Cerville east of Nancy), waste storage (Toul) as well as thermal spas and heat production[19].

Due to the intensive exploitation of this aquifer and the mining history of the region, tools were put in place to follow water levels, hydrodynamic characteristics of the reservoir and water quality, allowing since the 1980's for a transient regime management model. An exhaustive inventory of all existing wells (exploited or abandoned) was completed in the 1980's to avoid any contamination of the freshwater aquifers by the underlying mineralised aquifers.

The authorities administrating the Meuse and the Moselle-Sarre river basins, under the supervision of the Rhine-Meuse Water Agency, have put in place additional water surveillance networks, complying with the European Water Directive and Groundwater Directive.

As such, the project capture, transport and storage sites would be inscribed in a regional context where surface and groundwater bodies have been studied and monitored for decades.

Wetlands

One wetland of International importance, a Ramsar[20] site, overlaps the project area (about 7 km²). This wetland is called "étangs de la petite Woerve" ("Little Woerve pond"). This ecosystem hosts endangered species of fauna, such as birds (*Botaurus stellaris, Grus grus*), amphibians and even some *Felis silvestris*.

Biodiversity and habitat

The whole area contains important biodiversity resources and habitat for endangered fauna and flora species, as previously noted for the wetlands.

Governance issues

Several initiatives are now in effect to preserve these ecological assets.

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[19] « Aquifères et eaux souterraines de France » BRGM/AIH, 2006, directed by J.C. Roux http://www.unitheque.com/Livre/brgm_-_aih/Aquiferes_et_eaux_souterraines_de_France-12305.html

[20] The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories. Ramsar wetlands are considered to be *"Important for the conservation of global biological diversity and for sustaining human life through the maintenance of their ecosystem components, processes and benefits/services".*

Lorraine regional nature park

The main objective of this 318 km² area is to promote a global vision for land-use and environmental management, bringing together local actors.

1.3.5.2. National park project

A “national park” label recognizes an important ecological asset. This project should cover 330 km². Its objectives are to protect natural capital and biological diversity from any deterioration by setting specific restrictions to human activities (hunting and fishing, industrial activities, building and civil engineering, excavation activities…). The Meuse riparian forests in the Verdun area should be included in this national park.

Habitats Directive

The Habitats Directive (together with the Birds Directive) forms the cornerstone of Europe's nature conservation policy. It is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection. All in all, the directive protects over 1000 animal and plant species and over 200 "habitat types" (*e.g*. special types of forests, meadows, wetlands, etc.), which are of European importance.

14 Natura 2000 sites are located in or at the vicinity of the project area, which represent around 380 km². 4 of them are almost totally included in the area:

- *Marais de Chaumont de Devant Damvilliers*
- *Pelouses de Sivry-La-Perche et Nixeville*
- *Corridor de la Meuse*
- *Forêt domaniale de Beaulieu*

Areas for biotope conservation

Prefectural decrees for biotope conservation are focused on key natural areas for reproduction, nurseries and habitats of protected fauna and botanical species. Specific management rules are adopted to protect these areas: any kind of wildlife disturbance is legally forbidden.

4 areas are concerned (the possible 0.5 km² extension):

- *Tourbière de Chaumont (Montagu’s harrier & Lycaenidae butterflies)*
- *Héronnière de Pillon (Grey heron)*
- *Fort de Troyon (Rhinolophus ferrumequinum, Myotis myotis, Myotis emarginatus and Myotis Bechsteini)*
- *Upstream section of the Biesme stream (crayfish [Austropotamobius pallipes])*

ZNIEFF (Ecological zone of floral and faunal value)

ZNIEFF provides an extended inventory of fauna and flora diversity, with a special focus on endangered and exceptional species. An area registered as a ZNIEFF is an indicator of environmental quality.

Almost 63 ZNIEFF level 1 and 8 ZNIEFF level 2 are concerned by ULCOS program sites, which means around 490 km² of additional high quality environments.

IBA (Important Bird Areas)

These areas are registered on the Birdlife international program and identify the most appropriate areas for bird conservation.

5 IBA areas are listed in the project zone (around 310 km^2). Almost the entire Meuse alluvial corridor around Verdun is registered as an IBA.

1.3.5.3. Landscape

Landscape with remarkable scenic qualities

4 remarkable landscapes are impacted:

- Meuse border (north zone)
- Hattonchatel and Grand Couronné sector
- Meuse valley section
- Argonne sector

These areas could overlap with previously identified protected areas such as Natura 2000 network ("Forêts et étangs d'Argonne et vallée de l'Ornain") or the Lorraine National environmental park ("Hattonchatel and Grand Couronné" sectors).

Other listed or protected areas

8 areas are listed as heritage sites (around 14 km²). The most important ones are the Verdun and Eparges battlefields.

Some specific landscape elements (such as trees or rocks) are listed given their remarkable characteristics. Around 10 listed elements are included within the project area.

Moreover, 120,000 ha are listed as being in the "red zone" which corresponds to battle areas, areas that were physically and environmentally destroyed during the First World War. Restrictions still exist in the red zone today. Only forrestry activities, military activities and tourism are authorized in the red zone. Other activities are strictly forbidden.

Air

Atmospheric conditions are under pressure despite a consistent decrease in air pollution. Air quality is considered better in Florange now than it was 40 years ago.

Soil

In the CO_2 capture area, the soil quality is typical of post-industrial areas, with remnant soil and water pollution. However, over the last 40 years, significant efforts have been made to control pollution and to reduce its environmental impact.

There was a substantial amount of pollution inherited from Lorraine's industrial history. Some industrial wastelands still persist and require coordinated actions to be cleaned up. Soils have been polluted with oil, heavy metals and chemical compounds. In 2001, roughly 260 polluted sites were identified in Lorraine and only 21 have been cleaned up so far.

1.3.5.4. Concluding remarks

This overview highlights the complexity of the environmental context of the ULCOS pilot project: (1) project facilities and operations are very different in nature (CO_2 capture, transportation and storage), with specific characteristics and potential impacts; (2) there is a significant diversity in the ecosystems that are potentially affected by storage operations (specific ecological conditions and local heritage); (3) the environmental protection legislation has multiple layers (different levels of authorities and plans, different ecosystems focused on and different geographical definitions).

Moreover, the ULCOS project must comply with national and European Union legal guidelines on Environmental Impact Assessment (85/337/EEC) and Directives on the safe geological storage of carbon dioxide (2009/31/EC), as discussed below.

1.3.6. Legal factors

On June 25, 2009, Europe issued a specific directive for the geological storage of carbon dioxide (2009/31/EC, often referred to as the 'CCS Directive') to control CO_2 storage operations, and then

later amended the ETS directive 2003/87/EC in 2009 to account for emission reductions through CCS operations in the context of the European Carbon Trading Scheme. Although these two directives form the core of European legislation on CCS, several other directives apply selectively to parts of the project (Capture, Transport or Storage).

Member States had two years to transpose the CCS directive into their national, which was done with some delay by a few European countries, including France.

1.3.6.1. European legislation applicable to CCS

The **Capture** installations are regulated by the IPPC (Integrated Pollution Prevention and Control) Directive (2008/1/EC), with the purpose and scope extended to cover the capture of CO_2 streams (Art. 37). The EIA (Environmental Impact Assessment) Directive (85/337/EC) also applies.

For CO_2 **Transport**, risks are estimated to be similar to the transport of natural gas. Therefore, transportation is regulated by the EIA Directive (85/337/EC) for pipelines with diameters higher than 800mm and longer than 40 km.

The **Storage** operations are regulated by the European Directive on CCS (2009/31/EC). The CCS Directive provides a few important definitions such as:

- The storage site;
- The storage complex;
- The hydraulic unit.

And lists obligations related to

- The composition of the CO_2 stream;
- Monitoring and Verification;
- Abandonment and post-closure, including transfer of responsibility;
- Financial securities and mechanisms.

Four guidance documents have been published to help member states with the implementation of the directive in their corresponding national frameworks. They are also very useful documents for project owners to plan for various project phases and activities. The first guidance document presents the risk management framework for the life cycle of storage operations. The second addresses various issues such as the characterization of the storage complex, the composition of the CO_2 stream, monitoring and corrective measures. The third and the fourth, respectively, give criteria for the transfer of responsibilities to the member state and for financial security and financial mechanisms.

Finally, CCS projects fall under the ETS (European Trading Scheme) directive (2003/87/EC), which was modified in June 2010 to account for a CO_2 emission reduction option, within the context of the CO_2 European market. The establishment of Monitoring and Reporting Guidelines (Art. 14 of the EU ETS Directive) then followed, and annexes specifying protocols were added for Capture, Transport and Storage[21]. “Uncertainty supplements” were added to estimate CO_2 leakage volumes to account for uncertainties.

Regulations for CCS projects should also comply with a few additional directives:

- The Environmental Liability Directive (2004/35/EC), which has been amended to be applicable to CO_2 Storage (Art. 34);
- The Environment Impact Assessment Directive (85/337/EC).

[21] As far as Storage is concerned, all CO_2 entering the installation (storage complex) from the pipeline is assumed to be stored. There are requirements to monitor for leakage and quantify this leakage if it occurs, in order to surrender the corresponding amount of allowances, until corrective measures have been implemented and the leakage is not detectable anymore.

1.3.6.2. French national legislation applicable to CCS

In France, part of the CCS Directive has been transposed in the "Grenelle II" environmental laws. Article 80 modifies the Mining and the Environmental Codes to control the exploration and characterization of storage sites. An exploration permit is required to conduct these activities and the regulatory framework of reference is the mining code: targeted storage formations are considered as mines or mineral deposits.

Most of other requirements present in the CCS Directive already exist, either in the Mining Code or in the Environmental Code. Therefore, modifications of existing regulations are likely to be sufficient to cover CCS operations, with no need for a specific piece of legislation.

The first of a series of three decrees related to CO_2 storage, dated October 31st, 2011, was published in the "Journal Officiel" on November 1st, 2011. It aims at finalizing the transposition of the CCS directive into national law by introducing two new sections in the Environmental Code.

- The first one is related to the exploration and the characterization of underground formations for CO_2 storage. It relies heavily on the Mining Code and its implementing decrees as far as permitting and operations are concerned
- The second one concerns the operation of storage sites. It relies on the regulations related to Classified Installations for Environmental Protection (ICPE) to govern and control the development and the operation of storage sites. It also gives some provisions for the transfer of liabilities to the State and refers to the Mining Code for the property rights necessary for the exploitation of the underground.

The two other decrees will create a specific entry for CO_2 storage sites, in the enumeration of Classified Installations for Environmental Protection, and will submit these activities for general tax on polluting activities.

In essence, the Mining Code controls exploration and characterization activities. In cases of success, a prefectural decree will allow installations to migrate from the Mining framework to the ICPE framework.

A recent decision from the Constitutional Council considered that two recent provisions of the Environmental Code related to the registration of ICPE installations are against the Charter for the Environment. More specifically, the Constitutional Council considers that the publication of information related to classified installation projects is not sufficient to ensure that the principle of public participation is satisfied.

Furthermore, according to the Ministry of Ecology, Sustainable Development and Energy, **ULCOS would be expected to provide exhaustive information and facilitate a large public consultation** (Actu-Environnement, 2011). Indeed, referring to the article R.122-4 and R.123-1&2 of the Environmental Code (Compagnie Nationale des Commissaires-Enquêteurs (CNCE), 2011), a project such as ULCOS would be forced by law to conduct an Environmental Impact Assessment as well as a public consultation within the CNDP[22] framework.

Note on Alsace and Moselle specific legal regime

Alsace and Moselle benefit from a special local legal regime from when these territories were lost to Germany, before being returned to France.

This local regulatory regime is a mix between French and German provisions kept in favour of locals after conflicts. Consequently, Alsace and Moselle have particular provisions in their professional code, their social legislation, religious activities, relationship between the state and

[22] "Commission Nationale de Débat Public"

religious representatives, professional regimes and the organization of justice (for instance, non-profit associations cannot be recognized of any public use since the law 1901 doesn't apply in Moselle, as a consequence, associations cannot seek civil compensation in certain lawsuit cases being prosecuted by the State).

1.3.6.3. Concluding remarks

It is often perceived that a CCS project may have large and tangible impacts, which are often complex to determine. Furthermore, the lack of understanding[23] of the technology by the public may quickly lead to suspicion, even fear. In order to tackle these difficulties, CCS projects in France have to comply with a specific legislation based on participatory democracy principles. The project implementation process requires the Environmental Impact Assessment to be publicly available and the organization of public debates about the project.

The objective of successfully achieving these important steps should encourage the project developer to perform a detailed characterization of the project's environmental and social context, so that the project is designed and the operations are planned in order to minimize the impact on the environment, and to meet the conditions of acceptance requested by project stakeholders.

[23] Several studies show the common ignorance of people concerning CCS. For instance, the recognized polling organization SOFRES in France realized a perception study on CSC awareness at the national level. One of its outcomes was that "only 12% of people who answered declared knowing the meaning of CCS" (Michèle Gauthier (Mines Paris Tech / APESA), 2008).

1.4. Lessons learned and recommendations

This detailed context analysis allows the project developer to understand the characteristics of the territory in which the project is to be implemented. There are two main outputs from this analysis:

- A deep understanding of the main regional challenges, in particular those that are likely to influence the stakeholders' perceptions of the project.
- A preliminary identification of project stakeholders, for instance
  - people and organizations that may be impacted by project activities,
  - local actors who may prove to be influential.

Comprehensive information on the local context helps the project developer show concern about the area in which it plans to operate, and account for local specificities when deciding on project options (at the design stage or during the operation phase). An open attitude contributes to developing a relationship of trust with project stakeholders, which is vital for effective dialogue during the stakeholder engagement phase.

For the sake of comprehension, we recommend that the context analysis be conducted using the PESTEL methodology. However, this desk study is only a first step, which does not capture finer scale information, such as key individual subjective attitudes. The context analysis initiated here is naturally continued by a detailed analysis of project stakeholders.

Therefore, a limited effort should be made at this stage. The project developer should not be lost in a huge amount of data, preventing it from building a global and synthetic understanding of the project context. Furthermore, the process should not contribute to building stereotyped perceptions of the main actors in the territory.

Finally, if initiated in the early project development phases (for instance during site selection), it opens the possibility of excluding potential sites, which are revealed to be too complex and potentially threatening from a societal standpoint for the project development (GCCSI, 2012).

2. Stakeholder analysis

2.1. Context of the task

Through the context analysis detailed in Chapter 1, the project developer is able to obtain an in-depth understanding of the ecosystem[24] in which the project is to take place. This type of information is essential to ensure the proper integration of the project into its environment. Indeed, the implementation and operational phases will change the balance of this ecosystem, introducing disturbances that will be perceived either positively or negatively by the key actors of this ecosystem, be they individuals or organisations. The question is whether they will accept the resulting disturbances and with what conditions.

Integrating the project into its environment will necessarily require some level of negotiation between these actors and the project developer. This process will consist of a gradual mutual adjustment of both side's expectations, so that the conditions for social acceptance are finally obtained. An understanding of the following points is vital for this negotiation:

- The project characteristics and its impacts on the area
- The main societal issues that the area is facing
- The dominant system of values of the people living in the area

The actors of the ecosystem concerned by the project and with whom the project developer must deal are usually called "project stakeholders".

The notion of stakeholder originates from the pioneering work of the Tavistok Institute in London, in the late 1960s and early 1970s. However, most authors reference R. Edward Freeman as the founder of the stakeholder theory. Although it was originally developed for corporations, this theory has proven to be useful in other domains, especially in project management.

In his first book "Strategic Management: A Stakeholder Approach", Freeman defines the stakeholders of a corporation as an individual or a group that "can affect or be affected by the achievement of the organisation's objectives" (Freeman, 1984). By simply transposing this definition to a project context, a project stakeholder could similarly be defined as an individual, group or organisation that can affect or be affected by the project's activities. However, this definition is not precise enough to be operational. The notion of a project stakeholder must be further specified and will be discussed in the next chapter.

Once an agreement on the definition of project stakeholders has been reached, the first step is to use this definition to actually identify who the project stakeholders are. This task, called stakeholder identification, leads to the establishment of a register in which basic information about each stakeholder is listed. Since stakeholders are social actors involved in a type of relationship with the project, their identification requires the understanding of (1) the characteristics of the project's societal context (local socio-economic issues, dominant values) and (2) the specific key project characteristics (such as project scope in time and space and potential project impacts).

The next step, called stakeholder analysis or stakeholder mapping, refines the characterisation of each stakeholder and, more specifically, their relationship with the project. For instance: how and to what extent are they impacted by the project? Do they support the project or do they oppose it? How influential or powerful are they? Are they interested or not in the project? The outcome of this analysis is an evaluation of the positioning of each stakeholder with respect to the project. This relationship has to be characterised both qualitatively and quantitatively.

To achieve this objective, the use of a novel 3-dimensional stakeholder mapping technique is proposed; it takes into account the combined dimensions of power/influence, interest and attitude.

[24] The project ecosystem is defined as an analogy of the ecological meaning, that is to say a community of living organisms (stakeholders in our case) in conjunction with components of their environment (social norms, nature, etc.).

An estimation of the intensity of the relationship between the project and its stakeholders can be directly derived from this mapping.

These two steps are not always performed in sequence, as they are part of an iterative process. Investigations on (1) the identification of project stakeholders (Stakeholder identification), (2) their positioning with respect to the project (Stakeholder mapping), and (3) the identification of their project-related issues or concerns, start with an examination of the results of the context analysis, and are progressively refined through stakeholder interviews and less formal interactions. This process should be repeated regularly throughout the life of a project to take account of changes to the project context, project developments due to the characteristics of each phase (e.g. local impacts of operations) and in recognition that stakeholders are not static, logical beings.

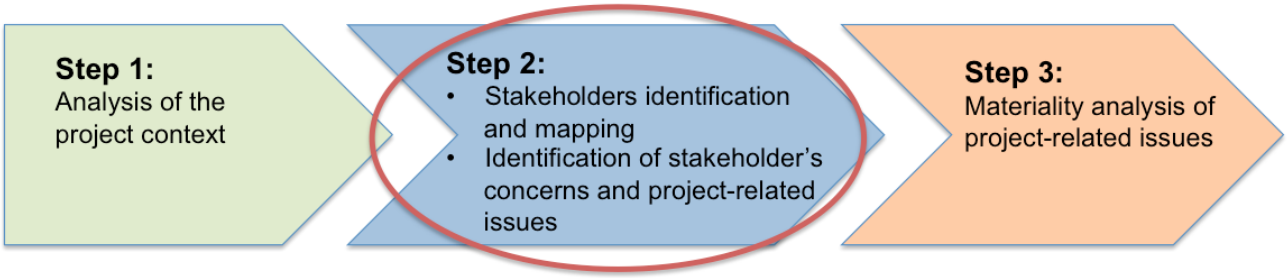


Figure 23: The second step in the Social Site Characterisation workflow: stakeholder analysis and identification of project-related issues

2.2. Methodology

Objectives of the task

- To identify the ULCOS project stakeholders that could later be considered for potential engagement because of their relationship with the project (stakeholder identification).
- To characterize the relationship of each stakeholder with the project in a qualitative and quantitative manner (stakeholder mapping).

These objectives are usually met through an iterative process, using the results of the context analysis to first identify potential key project stakeholders and conducting interviews with these stakeholders to gather additional detailed information about them and other possible stakeholders. These investigations lead to a gradual refinement of the project's context, which ultimately includes the list of all the project stakeholders, together with the characterisation of their relationship with the project.

2.2.1. Identification of stakeholders and project-related issues

As pointed out in the introduction, a simple variation of Freeman's definition of stakeholders is not precise enough to be operational. Furthermore, several definitions exist in the literature, adding confusion to the concept itself. The application of this notion to project management thus requires the adoption of a definition.

2.2.1.1. Definition of Project Stakeholders:

A few definitions of project stakeholders can be found in the literature related to project management, for instance:

"Any person or organisation that is actively involved in a project or whose interests may be positively or negatively affected by the execution or completion of the project".

This definition could be too restrictive, because it does not include people or organisations that may exert influence without being actively involved in the project, for instance international NGO's in the case of CCS.

"Anyone who has an interest in a project or who will be affected by its deliverables or outputs".

This definition refers to the two notions of stakeholder interest and impact on them, but again does not explicitly mention the possibility that the stakeholder may influence the outcome of the project.

A more precise and complete definition is given in "A guide to the Project Management Body of Knowledge (PMBOK® Guide (Project Management Institute, 2013)):

"A stakeholder is a person or an organization that:

- is actively involved in the project,
- has interests that may be positively or negatively affected by the performance or completion of the project,
- may exert influence over the project, its deliverables or its team members."

This definition will be adopted in the context of our study, although its obvious heterogeneity shows the lack of maturity of the stakeholder concept, which is essentially defined by the existence of a relationship with the project rather than by the nature of the relationship itself.

After agreeing on the definition of a stakeholder for the project, the first task is to build a comprehensive database of project stakeholders, also called a stakeholder register.

In order to proceed, several characteristics of the project and its environment should be specified: (1) the project scope (in space and time), and (2) the main societal issues in the project environment.

The identification of project stakeholders itself will start with a selection of categories of stakeholders, defined according to their roles, responsibilities and positions in the project context. These categories will be used as benchmarks to broadly classify the large number of potential project stakeholders.

2.2.1.2. Definition of the project scope (time and spatial boundaries)

The project scope comprises the project timeline and its geographical scope:

- ***Project timeline***: industrial projects are usually implemented using a phased approach (e.g. concept, feasibility, design, construction, operation and closure). Each phase has its own performance objectives and decision gateways are set between phases, based on the achievement of the said objectives. Operations conducted during each of the development phases may have tangible impacts on certain project stakeholders, which should then be identified (for instance a seismic survey in the characterisation phase).

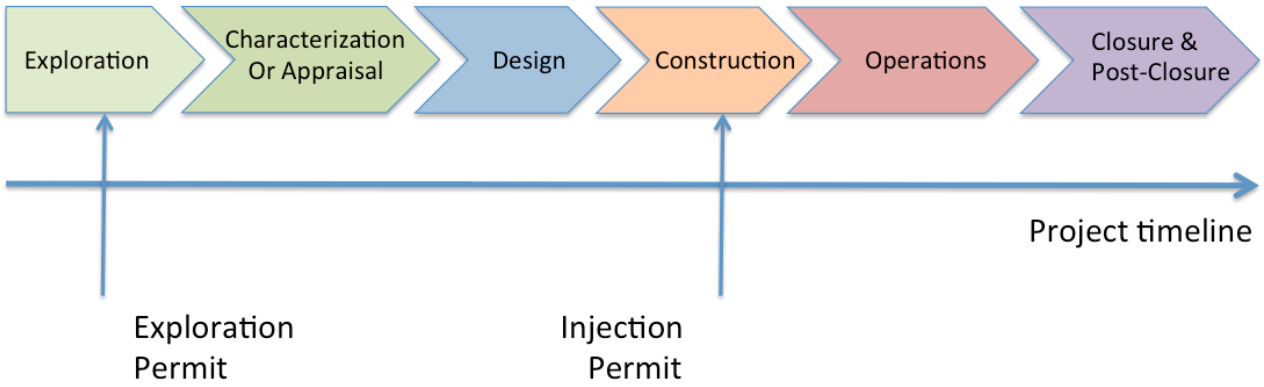


Figure 24: An example of a time line for a typical storage project

Results can be summarized in a table, as below:

Phase name / description	***Description of the activity***	***Start date***	***End date***

- ***Project spatial scope***: The area(s) in which project operations may have tangible impacts should also be identified for each project phase. While surface operations and facilities—for capture, transport and storage—have well identified impacts occurring at limited locations, disturbances underground may be much larger and, to some extent, more difficult to determine. The European CCS directive has introduced the notions of "storage", "storage complex" and "hydraulic unit"[25], which are useful to identify the nature of the

[25] The European 2009/31/EC directive often referred to as the "CCS directive" requires the operator to precisely document the "location and delimitation of the storage site and storage complex, and information concerning the hydraulic unit." (Article 9: contents of the storage permit):

- 'Storage site' means a defined volume area within a geological formation used for the geological storage of CO_2 and associated surface and injection facilities;
- 'Storage complex' means the storage site and surrounding geological domain which can have an effect on overall storage integrity and security; that is, secondary containment formations;
- 'Hydraulic unit' means a hydraulically connected pore space where pressure communication can be measured by technical means and which is bordered by flow barriers, such as faults, salt domes, lithological boundaries, or by the wedging out or outcropping of the formation.

potential impacts and associated stakeholders. By definition, pressure disturbances may impact human activities exploiting other resources of the hydraulic unit (water, heat, pore space), while impacts of CO_2 leaks would be more localized, and more likely to occur in the vicinity of the storage complex.

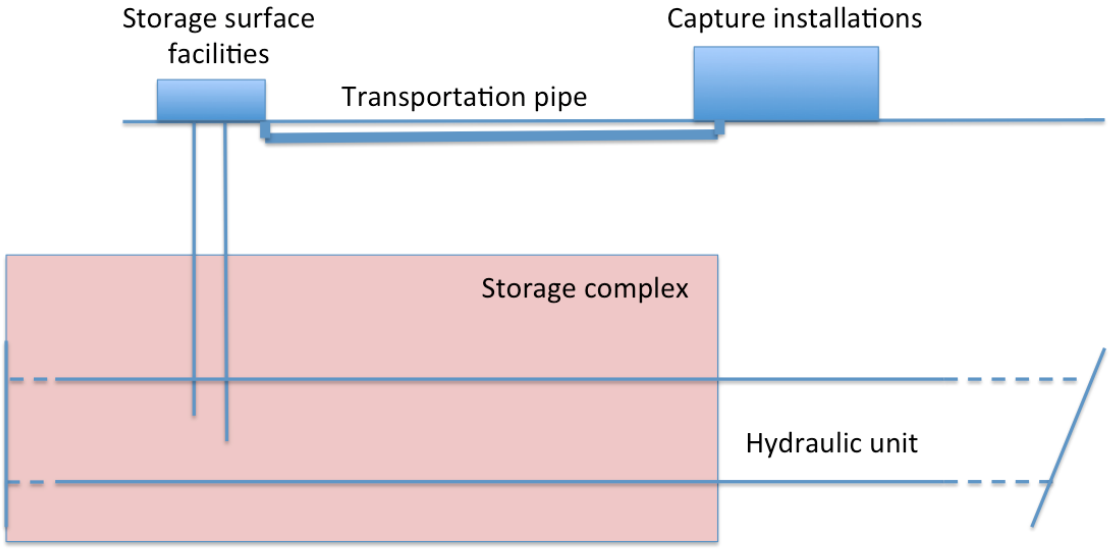


Figure 25: Components of the project spatial scope

Phase name / description	***List of impacted locations***

Table 4: Locations that are potentially impacted by project operations

2.2.1.3. Identification of the main societal issues in the project environment

- ***Project/area-specific issues***: This information will indicate the potential societal issues the project may face based on the available knowledge of the territory's specific characteristics. Such hypotheses are classified according to the following standard impacts classification (inspired by the ISO 26000 standard (AFNOR, 2010-11)). As a result of this information, the project developer can later identify additional actors that may be considered as stakeholders due to the impacts they may experience from the project.

Categories of issues	***Specific issues***	***Description***
Environment	Local impact	Local environmental impacts such as spills, discharges, pollution, nuisances such as noise, traffic

	Global impact	CO_2 atmospheric releases
	Environmental friendliness of technology	Legitimacy of CCS to mitigate climate change
Society and communities	Health and safety of population	Impact of project operations on the safety of populations
	Local economic development	Impact on local economic activity, job creation
	Local social and cultural impact	Impact on the image of the region
	Social equilibrium	Fair distribution of social and economic costs and benefits
Industrial sector, company and project	Project techno-economic feasibility	Demonstration of the techno-economic feasibility of the project component; research opportunities
	Project owner company image	Reputation of the company
	Quality of operating practices	Quality of operating practices and project management; health and safety of the workforce; compliance with regulations
	Communication	Quality of the outreach and the communication strategy

Table 5: Main categories of issues at stake

- ***Intangible scope (value zone)****:* A project may also have intangible impacts that should also be characterised because it may hurt values (biodiversity destruction provoking the reaction of a worldwide NGO defending biodiversity regardless of what is being impacted). The project developer can therefore use the information gathered in the following table to identify actors that may be stakeholders due to their interests, i.e. the causes they are defending.

Value at stake	***Description***

Table 6: Dominant values in the project territory, which may be at stake

In Chapter 3, we highlight that a project developer cannot identify all the project-related issues on his or her own without the risk of missing one or overestimating another. An iterative process should be followed, starting with a list of hypothetical issues that will help identify a first base of stakeholders, and then conducting interviews for validation, refinement and extension of both the list of stakeholders and the list of issues.

2.2.1.4. Stakeholder classification

Once potential stakeholders are identified according to the previous scoping criteria, it is necessary to register and classify them according to their nature/status.

Simple categories are often useful for a broad characterisation of project stakeholders. These categories can be used to assign basic attributes to each stakeholder group, which are related to the positioning or their role with respect to the project. Below are a few examples of categories found in literature:

- **Primary** (ultimately affected, positively or negatively, by the project activities) or **secondary** (indirectly affected)
- **Social** (employees, consumers), **public** (authorities, NGO, media), **economic** (shareholders, rating agencies) and **industrial & scientific** (industrial partners, business associations, research institutes)
- **Direct** (clients, employees, shareholders, suppliers, contractors, communities, public authorities) and **indirect** (media, NGO)
  According to the recommendations of CSIRO in a report supported by the Global CCS Institute (CSIRO, 2011), stakeholders could also be classified as followed: **Government** (policy makers, politicians, emergency response, public health officials), **Neighbours** (landowners, access holders), **media**, **NGOs** (environmental groups, community interest groups), **Education** (community colleges & universities), **Land use, Agriculture** (farmers, support groups for local parks and historical districts), **Business groups** (chamber of commerce, companies), and **Others** (indigenous or religious groups).

Inspired from the previous segmentations and several experiences in terms of social acceptance strategy, the following stakeholder categories suit any industrial project's stakeholders. They are therefore proposed for a CCS project:

- **Public actor**: organisations representing a public authority without core economic responsibilities.
- **Economic actor**: private or publicly-owned organisations whose main purpose is to generate turnover (e.g.: company) or to empower an economic segment or area (e.g.: chamber of commerce).
- **Institutes and academia**: organisations dedicated to research and/or comprising experts that may have an informed opinion on the technical aspects of the project, including its impacts.
- **Civil society organisation**: non-profit organisations whose raison d'être is to defend a societal cause (non-profit organisations dedicated to the promotion of an industry sector are excluded and registered among economic actors). Recognized as a strong lever for developing a relationship of trust (Pol & Al - NEAR CO2, 2011), any collaboration with NGOs[26] could positively impact project social acceptance, considering that most CCS projects suffer from a lack of trust in developers with regards to their interest in community welfare (Brunsting S. & Al, 2010), (Desbarats, J. & Al, 2010).
- **Local community**: represents groups of people sharing a common residential location (neighbourhood, village, city).
- **Company internal:** includes stakeholders from the project developer company: employees, top management, R&D, marketing & communication function, labour unions.

2.2.1.5. Referencing and filtering stakeholders

Using the context analysis detailed in Chapter 1 and the preparatory work mentioned above, project stakeholders can be referenced in a stakeholder register. This table must be regularly maintained

[26] For instance, a survey conducted in France by Institute TMO shows that 51% of French people trusted environmental NGOs while only 4% trust companies**Source spécifiée non valide.**.

and enriched to account for any new information gathered throughout the Social Site Characterisation process.

Name of actor	*Category*	*To be considered as a stakeholder?*	*Justification for consideration as a stakeholder*
		Yes or No	

Table 7: A simple stakeholder register

The project developer will indicate in the stakeholder register the name of individuals or organisations, the category they belong to, and the decision and motivation to consider them as a stakeholder, at a given time, as well as general information about them, for instance a website or contact email.

2.2.2. Stakeholder mapping

2.2.2.1. Scouting the stakeholder base

Once a first set of key stakeholders is identified, it is possible to follow through the investigation with a first round of stakeholder interviews. This first round of stakeholders' meeting will allow the project developer to:

- get a first impression of the stakeholders' characteristics and purposes,
- gather information on other stakeholders (for instance identify actors not identified at the context analysis stage),
- observe the stakeholder's perception of project issues and capture low signals (societal issues that can be found before directly discussing the project with stakeholders),
- very gently start to introduce key stakeholders to the concept of the project.

The project developer should start by interviewing stakeholders who are easy to reach. During the early stages of the consultation, one of the objectives is to deepen the understanding of the project context, so it may be wise to start with stakeholders who support the project. It is highly recommended if the firm has a poor legacy and reputation with regard to social acceptance matters.

This early involvement is crucial for the project's social acceptance and is presented as one of the key recommendations emerging from the post-Barendrecht project analysis (Brunsting S. & Al., 2010) and a success factor in the Ketzin case (Brunsting S. & Al, 2010), (GCCSI, 2012).

To be efficient, the meeting should be organised as a semi-directive interview[27]. Instead of pitching the project in an attempt to convince the stakeholder, the project developer (or a third party leading the interview on its behalf) should try to make the stakeholder provide as much information as possible on the following 3 areas:

[27] Semi directive interview: Interview method focused on gathering as much qualitative information as possible on a limited number of topics. To be effective, the interviewer must be directive enough to force the interviewee to stick its information delivery within the key interview topics, while being passive enough to not influence the messages the interviewee is giving.

Axes of discussion: key questions	Purpose
What is the stakeholder's raison d'être?	▪ Gather information on stakeholder identity ▪ Identify their activities in the area ▪ Identify their core motivations in day-to-day activities ▪ Identify the values they are defending ▪ **Evaluate their interests and concerns**
With which other stakeholders is the stakeholder interacting?	▪ Gather information on other actors and the social dynamics of the area (e.g. networks, domains of responsibilities) ▪ **Evaluate their sphere of influence** (power)
How does the stakeholder think it would be affected by the project?	▪ Capture part of their perceptions towards the project and the project developer ▪ **Capture low signals: potential non-identified societal issues** ▪ **Evaluate their attitude toward the project**

Table 8: Line of discussion for the initial stakeholders' meeting

2.2.2.2. Mapping according to attributes

This section discusses methodologies for stakeholder mapping. The aim of this task is to characterise the relationship between the project and its stakeholders in a qualitative and quantitative manner, and to learn whether the stakeholders are willing and able to impact the project.

This assessment is usually performed via a characterisation of the relationship between the project and its stakeholders according to a few well-chosen dimensions or attributes. The combination of these mono-dimensional evaluations, leads (1) to an accurate qualitative description of the stakeholder's position with respect to the project, and (2) to an estimation of the intensity (or strength) of the stakeholder-project relationship.

Most stakeholder mapping techniques use a combination of attributes such as power, support, influence, need, interest, attitude, legitimacy or urgency. For the sake of simplicity, common mapping practices are two-dimensional. Power/influence versus interest has been widely used since the initial development of the methodology at Imperial College and Ohio State University. There are a few other more complex approaches, such as the classification proposed by Mitchel (Mitchell et al, 1997 ; Agle et al, 1999), which accounts for three dimensions—power, legitimacy and urgency—at the same time. We believe that there is no unique combination of dimensions or attributes that fits all applications and contexts. On the contrary, the attributes should most likely be carefully selected depending on the objective and ultimate use of the stakeholder analysis, on company culture, and on possible public exposure and stakeholder engagement practices.

In the context of this study, we decided to follow Murray-Webster & Peter Simon (Murray-Webster R., Simon P., 2006) and use the most common power/influence versus interest mapping technique, with the addition of a third dimension: attitude, which is necessary to account for stakeholders' subjective positions. Although this 3-dimensional mapping technique is essentially empirical, it can be rooted in one of the key research areas in social psychology: the theory of attitude and the relationship between attitude and behaviour. The detailed definitions of the three dimensions or attributes are given below, followed by an attempt to relate these dimensions to existing models and concepts commonly used in social psychology.

- ***Attitude***

Attitude is related to the positive, negative or more neutral evaluation that the stakeholder has of the project. Attitudes are formed from our observations and experiences and guide our future behaviour. The stakeholder's attitude to the project is a measure of the extent to which it will 'back' (support) or 'block' (resist)" project activities. In Murray-Webster and Simon's original paper, the stakeholder's attitude was simply described as positive (collaborative) or negative (hostile), but it was found that this alternative does not allow the proper characterisation of quite a few stakeholder positions. It was therefore decided to add a third category, the neutral attitude, which was later split into two sub-categories (opportunistic and challenging). The opportunist has not yet decided whether to support or oppose the project and their final decision is likely to depend on their interests (the advantages it can derive from its positioning). The challenging stakeholder will not change their attitude based on their interests but rather based on sound and reliable information that it is currently missing.

Expressed attitude	
Collaborative	The stakeholder **shows complicity with the project** and/or the industry developing the project. It shows **commitment to this project** and wishes its success without a specific expectation regarding additional returns to the community.
Opportunistic	The stakeholder is not committed to the project but **wishes to be part of the project somehow or expects some positive ripple effects**, which would contribute to its growth or cause.
Challenging	Similarly to the latter, the stakeholder is **in favour or against the project as a matter of principle**. However, it **shows some hesitation and doubts** regarding the project's ability to properly serve the territory or its cause. It is not campaigning against the project for the time being but is ready to interfere in case the project doesn't comply with its minimal acceptance conditions.
Hostile	The stakeholder is **against the project** as a matter of principle or due to its damaging potential impacts to its cause, interests or any of its expressed minimal acceptance conditions.

Table 9: Semi-quantitative scale for estimating the attitude

Box 1: The concept of attitudes

The concept of "attitude" is central in Social Psychology as an intermediate variable between a stimulus (an object or a situation to which an individual is confronted) and a response (the resulting behaviour of the individual). The introduction of this concept was supposed to help predict people's behaviour in various situations, although the task turned out to be more complicated than expected. In this box, we describe the evolution of the concept and the current state of research.

In common speech, the term attitude has an ambiguous meaning. It refers either to a body posture or a mental state. In the first case, it is an observable behaviour, in the second, a state of mind that is hidden.

The origin of the concept

The concept of attitude emerges from the work of William Thomas and Florian Znaniecki (Thomas, W.I., Znaniecki, F., 1918-1920) on communities of Polish emigrants, in the early years of the twentieth century. For these authors, "any concrete activity is the solution to a situation that involves three types of data: 1) the objective conditions of the situation itself, 2) pre-existing attitudes of the individual or the group, and 3) the definition of the situation, that is to say a more

or less clear understanding of the conditions of the situation and the awareness of attitudes". An attitude is a state of mind with respect to an object: a feeling, a desire or a motivation, a position in favour or against... Attitudes influence the definition of the situation, which is the primary cause of the behaviour. The theoretical paradigm is interactionism, where behaviour is the result of the interaction of the subject with the situation. The Thomas theorem asserts the causal primacy of a person's subjective evaluation of a situation over any objective analysis of the situation: "If men define situations as real, they are real in all their consequences," (Thomas, W.I., 1923).

This theoretical approach is reflected in the work of Herbert Blumer (Blumer, H., 1969) who created the expression of symbolic interactionism, affirming the importance of the definition of the situation by individuals, as their behaviour with respect to objects and situations depends on the meaning (perception) that these objects and situations have for them. Blumer adds two principles to the initial interactionist framework: (1) people adopt the meanings they attribute to objects and situations in their interactions with others and (2) social reality results from a production / negotiation process of meaning by individuals.

Attitude in Social Psychology

The concept of attitude as used in social psychology owes much to the pioneering work of interactionist sociologists. It was first integrated into the dominant behaviourist paradigm: Watson defines Social Psychology as the scientific study of attitudes (quoted by Cook and Selltiz, (Cook, S.W., Selltiz, C., 1964)), and Gordon Allport proposes to define attitude as "a mental and neural state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations to which it is related" (Allport, G.W., 1935).

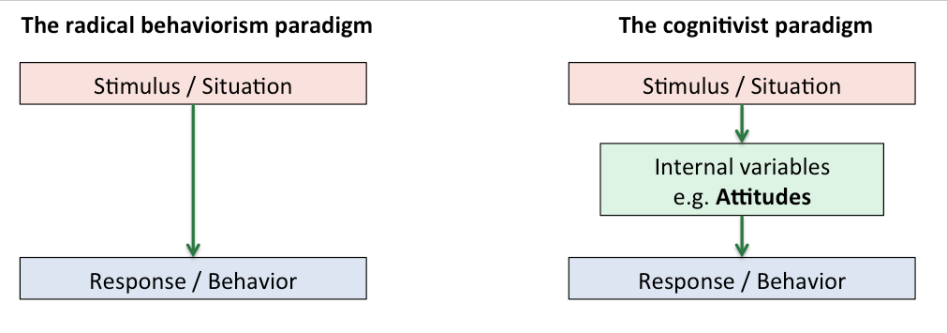


Figure 26: The introduction of the concept of attitude as an intermediate variable between stimulus and response

In the context of behaviourism, attitude becomes an intermediate and non-observable variable, between the stimulus (situation or object) and the response (behaviour), corresponding to a state of preparation of the response. The schema S ➔ R adopted by radical behaviourists becomes S ➔ A ➔ R. The concept of attitude is used to account for the variability observed in individuals' responses when exposed to the same stimulus. Little by little, social psychology took ownership of this concept and started research work to understand the content of these attitudes.

To Thurstone (Thurstone, L.L., Chave E.J., 1929), who designed several scales that are used in the evaluation of attitudes, attitude is essentially a positive or negative feeling with respect to an object or a situation. In an attempt to reconcile this definition with that of Allport, Osgood and colleagues (Osgood, C.E., Suci, G.J., Tannenbaum, P.H., 1957) forge the theory of representational mediation, in which the evaluative dimension is precisely the attitude.

Many researchers, such as Fishbein and Ajzen (Fisbein, M., Ajzen I., 1974), (Fishbein, M., Ajzen, I., 1975) and Bem, maintain a strictly one-dimensional definition of attitude: "Attitudes are likes and dislikes" (Bem, 1970). On the contrary, others expand the content of the concept by adding new dimensions. For instance, Rosenberg and Hovland (Rosenberg, M.J., Hovland, C.I., 1960), and also Zanna and Rempel (Zanna, M.P., Rempel, J.K., 1988), propose to distinguish three components: (1) the affective, (2) the behavioural and (3) the cognitive components of attitudes. The first is close to Osgood's evaluative component and usually corresponds to a positive or

negative feeling that an individual has towards the object or the situation: I like or do not like. Based on this feeling, they think about the behaviour they may have with respect to the object or the situation. These intentions of actions form the second component. The third one is composed of the knowledge and beliefs (and their associated credibility) that the individual has about the object or the situation. These three components or dimensions have a variable degree of consistency among subjects, which translates into variations in their responses.

The measurement of attitudes

As intermediate variables, attitudes cannot be directly observed but have to be inferred, either from the observation of behaviours or from interviews, relying on people's capacity for introspection. This interview technique is, of course, the only one that can be used to attempt to predict behaviours from attitudes.

Two main strategies can be used. The first and main one consists in asking only one question, as simple and as direct as possible. The second one, more complex, consists in asking several questions in relation to the attitude to be characterized, and inferring the attitude from the set of answers.

The scales commonly used for the evaluation of attitudes were designed in the first half of the twentieth century, by researchers such as Thurstone, Lickert and Guttman.

- ***Power***

The second dimension to consider is the power that a stakeholder may have over the outcome of the project. Mitchell and Agle (Mitchell et al, 1997 ; Agle et al, 1999) propose to define power as the ability "to make [the project developer] act differently than it would have done".

The expression of power may be more or less direct. In many cases, it has more of an influential nature but is nevertheless strong: "stakeholders can either use their own available resources to directly influence the behaviour of the company or go through their allies, who would use their available resources to affect the company" (Dubigeon, O. , 2011).

The level of power is the combination of the direct force and indirect force (see further details here below).

- The **level of direct force**: the purpose is to assess the stakeholder's ability to directly affect the project with their own means (without the support of a specific ally). For this, a normative scale must be set up. An example is suggested here below.

Power: Direct Force	
No/Low	The stakeholder has **low or no means to directly affect** the project due to its long physical distance from the project or to a lack of resources at its disposal.
Moderate	The stakeholder can **slow down or speed up project development** due to its contractual relationship with the project or its possibilities to physically intervene and/or as a result of the legal and economic resources at its disposal.
Strong	The stakeholder can **strongly encourage or stop project** development. It has a legal or contractual ascendancy on the project and possesses sizeable economic resources making it possible to interfere with the project.

Table 10: Semi-quantitative scale for estimating the direct force (power dimension)

- The **level of influence (indirect force)**: the purpose is to assess the ability of the stakeholder to indirectly affect the project (relying on the support of its

network).[28] To do so, a normative scale must be set up. An example is suggested here below.

Power: Indirect Force	
Low	The stakeholder has **few connections** at the local and/or national level and has insufficient legal and economic resources to interfere with the project.
High	The stakeholder is **well connected** at the local level with actors showing capacities to directly interfere with the project. Or, despite a low network at the local level, the stakeholder has strong connections with powerful actors at the national level able to strongly affect the project due to their legal or contractual relationship with the project and/or their economic resources

Table 11: Semi-quantitative scale for estimating the indirect force (power dimension)

Moreover, power levels may change during the development of the project "since the access to those means of pressure evolves, power is transitory. It can alternatively be acquired or lost by the stakeholder" (Olivier, 1992).

- ***Interest***

Interest is defined as a stakeholder's level of curiosity, concern or attention to the project. It is measured by the extent to which a stakeholder will be active or passive. It is used to evaluate whether the stakeholder's interest is high or low.

However, the expression of an interest toward the project or a concern about a specific impact is not enough for an actor to be considered as a project stakeholder. An actual stakeholder must be either directly exposed to the impact or, if they are not, be at least able to influence the project. In either case, the expressed interest becomes even more relevant if it is supported by the societal ecosystem: "when needs of stakeholders echo back at a societal level and when they are expressed toward the company, the company has to consider them" (Brulé, E., Ramonjy, D., 2010). For instance: an environmental NGO, which is concerned about the project's potential impacts on biodiversity in an area where natural resources are considered to be endangered, should be considered as a project stakeholder.

Interest in the project	
Low	Despite a natural curiosity, **the stakeholder doesn't pay much attention to the project** since it doesn't feel that the project will have an impact on its interests or cause.
High	The stakeholder is **interested in the project** since it sees an opportunity or threat in its development. The project may affect its territorial use, causes, interests or any expressed minimal acceptance condition that would justify its vigilance.

Table 12: Semi-quantitative scale for estimating the interest

[28] Weak stakeholders, who sometimes are not even capable of expressing their demands, may sometimes have their cause endorsed by more powerful organisations (for instance children's rights being defended by UNICEF). Nevertheless, they should be still classified as weak.

Box 2: Predicting behaviours from attitudes

The relationship between attitudes and behaviours was the subject of extensive research that Zanna and Fazio organized into three moments. During a first moment, the research essentially questioned the very existence of the link between attitudes and behaviours, and often concluded that there was a very low correlation between the two. In a second moment, the objective was to identify the conditions under which the knowledge of attitudes made it possible to predict behaviour. Finally, the most recent research topics have focused on studying how attitudes can generate behaviours.

Under what conditions does the knowledge of attitudes enable the predicting of behaviours?

After a critical review of research on the link between attitude and behaviour, Fishbein and Ajzen observed the lack of consistency between the measurement of very general attitudes and the observation of very specific behaviours. To address this issue, they proposed the correspondence principle, according to which the attitude predictive of the behaviour and the predicted behaviour itself should be measured at a similar level of specificity. The level of specificity can be identified using four markers: action, target, location and time. In other cases, the weak link between attitude and behaviour seemed to be due to the non-prototypical nature of the source.

Fishbein and Ajzen (Ajzen, I., Fishbein, M. , 1980) then proposed a general theoretical model for linking attitudes and behaviours, introducing between them the notion of behavioural intention, i.e. the motivational factors that lead to action. The first model, initially called the model of reasoned action, was subsequently modified by Ajzen, who added the concept of perceived behavioural control (self-efficacy), leading to the model of rational behaviour. This model is presented below:

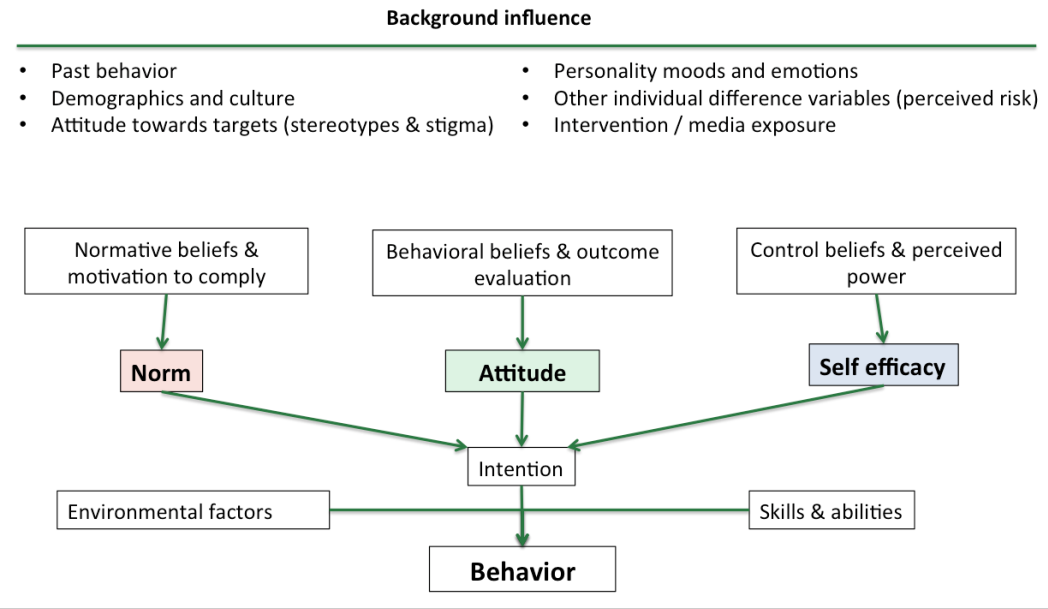


Figure 27: The model of rational behaviour

In the initial version of the model, behavioural intention depended on both the attitude towards the behaviour (beliefs about the consequences of the behaviour weighted by the evaluation of the consequences of this same behaviour) and the importance of the subjective norms (the perceived expectations of other individuals or groups and the intention to comply).

In the extended model of rational behaviour, Ajzen added a third influencing factor, perceived behavioural control (Ajzen, I., 1988) or self-efficacy (Bandura, A., 1977), which corresponds to the individual's perception of difficulties in performing the behaviour in question.

Finally, it should be emphasized that, for Fishbein and Ajzen, the object of the attitudes is the

behaviour itself and not a target or a situation.

How attitudes can generate behaviours?

Very recent research reconnects with the traditional concept of attitude towards an object or situation, by studying the factors that do or do not foster the attitude/behaviour relationship. These factors include, for example, the accessibility of the attitude, its temporal stability, the level of associated certainty, the direct experience of the attitude object, and the consistency between the affective and cognitive levels.

These characteristics may be partially encompassed in the concept of attitude strength: the stronger the attitude, the greater the probability of observing the behaviour.

The previous analysis translates into a 3-Dimensional (3D) map that can be graphically represented as shown below:

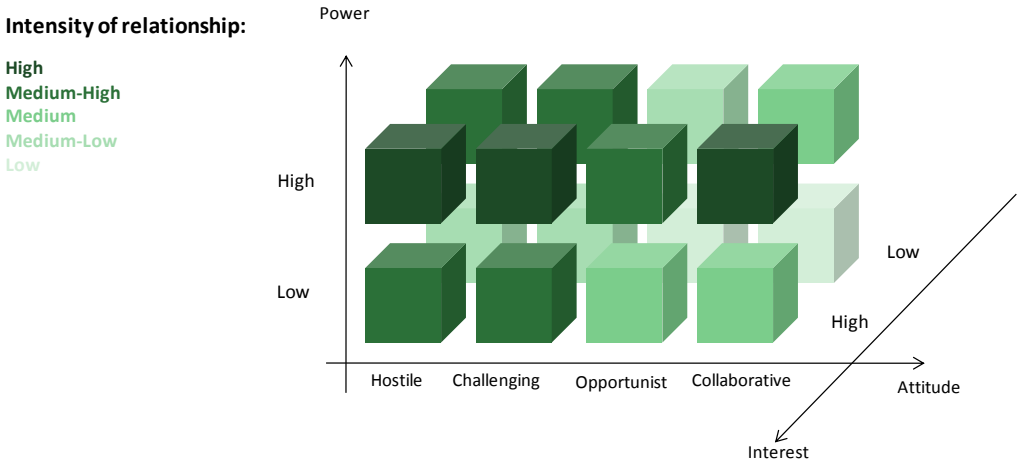


Figure 28: 3-Dimensional stakeholder mapping

Note that this 3D stakeholder positioning can be condensed into an estimation of the intensity of the stakeholder's relationship with the project. This intensity is evaluated on a 5-level scale ranging from low to high. It is indicated by the color-coding, the darkest corresponding to the most intense (or strongest) relationship to the project.

This extension of the model initially proposed by Murray-Webster and Simon (Murray-Webster R., Simon P., 2006) can be easily related to the key concepts presented in boxes 1 and 2.

1. The "Attitude" dimension, which was only evaluative in the original model (positive or negative), has been extended slightly with the addition of two "more neutral" positions, corresponding to two different behavioural intentions. Our notion of "attitude" thus includes two of the three components of Rosenberg and Hovland's model: the affective and the behavioural components (Box 1).
2. The "Power/influence" dimension relates to the perceived behavioural control introduced by Ajzen in his model of rational behaviour (or the self-efficacy concept used by Bandura) (Box 2).
3. Following the most recent theoretical developments on the link between attitude and behaviour (Box 2), the "Interest" dimension is introduced to account for the degree of attitude accessibility

This model accounts for all essential factors to be accounted for in predicting stakeholder behaviour vis-à-vis the project. The only component that has to be treated separately is the cognitive component of attitude, i.e. the knowledge that individuals have about the technology and the project.

Once each stakeholder is positioned according to these three dimensions, a "profile" (see table below) can be assigned to each stakeholder category. These profiles encompass the characteristics of the category and are automatically derived from the 3D stakeholder mapping. They correspond to a specific state of readiness to take action, or a behavioural intention.

The qualification of a stakeholder in a specific profile category is very useful as an *a posteriori* check of the relevance and quality of the mapping itself.

Power	Interest	Attitude	Profile	Intensity of the relationship
High	High	Collaborative	***Sponsor***	High
High	High	Challenging	***Punisher***	High
High	High	Hostile	***Opponent***	High
Low	High	Challenging	***Watchdog***	Medium-High
Low	High	Hostile	***Ambusher***	Medium-High
High	Low	Challenging	***Cynic***	Medium-High
High	Low	Hostile	***Time Bomb***	Medium-High
High	High	Opportunist	***Mercenary***	Medium-High
Low	High	Collaborative	***Cheerleader***	Medium
Low	High	Opportunist	***Crossed finger***	Medium
High	Low	Collaborative	***Sleeping giant***	Medium
High	Low	Opportunist	***Walking his way***	Medium-Low
Low	Low	Challenging	***Silent doubter***	Medium-Low
Low	Low	Hostile	***Whisperer***	Medium-Low
Low	Low	Collaborative	***Second cousin***	Low
Low	Low	Opportunist	***Silent gambler***	Low

Table 13: Categories for Stakeholder mapping

The various "profiles" can be characterized in the following way:

- **"Sponsor"**: this actor appears to be your best asset by supporting the project with its large resources and sphere of influence.
- **"Punisher"**: this actor is not yet convinced of the benefits the project would bring. Even though it keeps a neutral posture for the time being, it is ready to use its extensive power to move against the project if it doesn't meet with the expressed minimal acceptance conditions.
- **"Opponent"**: this actor is currently the main direct threat to the project since it is both powerful and hostile to the development of the project.
- **"Watchdog"**: this actor is not yet convinced of the benefits the project would bring. Even though it is not powerful enough to affect the project in case it decides to move against it, it will stay alert to the project development in order to notify the societal environment in case of a potential threat stemming from the project.
- **"Ambusher"**: this actor is against the project but not strong enough to cause any direct trouble. Therefore it may be planning a "guerrilla campaign" based on its small resources.
- **"Cynic"**: this actor appears to be sceptical regarding the cost/benefit ratio for the overall environment's interests. However, it doesn't seem to pay a lot of attention to the project for the time being since the project doesn't threaten its key interests.
- **"Time bomb"**: the project's industry doesn't meet the minimal conditions of the stakeholder's acceptance, which justifies its basic opposition. However, the stakeholder

doesn't feel concerned by the project for the time being but will represent a threat to the project the day it does.

- **"Mercenary"**: this actor has proven to have important resources at its disposal and is concerned by the project. At this point, the actor shows a neutral attitude; it is waiting for an opportunity in line with its interests to take any part in its promotion.
- **"Cheerleader"**: while being supportive, this actor is not powerful enough to have a strong positive impact on the project. Its play is therefore to promote the project in its network.
- **"Crossed finger"**: this actor wishes to benefit from any ripple effect from the project. It cannot be involved yet and hopes at one point that the project will contribute to its growth.
- **"Sleeping giant"**: this powerful actor supports the project for the benefits it would bring to the territory even though it does not have much interest on the project itself.
- **"Independent thinker / Walking his way"**: this actor has important resources and may expect a positive ripple effect from the project at one point, even though for the time being it doesn't really pay attention to the project development.
- **"Silent doubter"**: this actor is not yet convinced of the territory's interest in hosting this type of project. Even though it looks powerless and only slightly interested for the time being, the actor may get involved for or against the project once it has cleared its doubts.
- **"Whisperer"**: this actor is against this type of project in the territory but has no power or large network, they thus can't do anything but spread its opinion to whoever may be inclined to listen.
- **"Second Cousin"**: this powerless actor is not really interested in project development since they don't see any direct benefit for their organization. On the other hand, it shows support for its development.
- **"Silent gambler"**: this powerless actor is not quite interested in the project since it doesn't see any direct benefit for its organization. On the other hand, it might be inclined to grab any possible opportunity provided by the project.

These profiles are not only indicators of the positioning of the stakeholders with respect to the project; they can also be interpreted as behavioural intentions.

The objective of the engagement phase will be to create conditions that could possibly lead to a change in the attitude of the project opponents. It is also to ensure that supportive stakeholders remain satisfied with the project development. Without entering into the details of Chapter 4, which covers the stakeholder engagement strategy, some references on mechanisms governing attitude change are given below:

Box 3 presents the main theories of cognitive consistency, which explain attitude change by the introduction of dissonant cognitions or behaviours.

Box 3: Cognitive consistency and attitude change

Theories that are now grouped under the term "theories of cognitive consistency" emerged in the 50s. They all start from very similar premises: individuals will seek to maximize the consistency of their cognitive system. Examples are Heider's Balance Theory (Heider, F., 1958), Osgood and Tannenbaum's Congruity Theory (Osgood, C.E., Tannenbaum, P.H., 1955) and, the most famous of all, Festinger's Cognitive Dissonance Theory (Festinger, L., 1957).

Balance Theory

Heider's Balance Theory is strongly influenced by Gestalt psychology, which, in the field of physical object perception, shows that there are more or less stable figurative units, as well as forces of cohesion and disintegration. Heider assumes that this is also true in the field of social

perception, where the components of units (cognitive this time) are people, objects or events. These components can be in a relationship, which is either affective (positive or negative) or connective (they are connected or not). For example John admires Mary, Mary enjoys cycling (affective relation), Mary has a bike (union relationship): that is a balanced unit. If Mary buys a painting and John hates painting, the unit becomes unbalanced.

A unit is in a harmonious balanced state when the elements that constitute it and the feelings they evoke all go well together, without producing tension. Otherwise, the state will be more or less imbalanced, unstable, and disharmonious. In the latter case, the assumption is that a change will occur, to return to a more balanced state: there is preference for balanced states, the states of "good gestalt (shape)". Numerous studies have focused on dyadic or triadic relationships, showing, for example, that triads in which all relationships are positive are generally preferred, compared to those with negative relationships, even if they are balanced. Furthermore, all balance conditions are not equal. The effect of imbalance is actually quite complex and is not limited to a change in the polarity of relationships. Different cognitive mechanisms may be triggered, as Abelson showed: (1) denial (reaction of disbelief vis-à-vis inconsistent information), (2) bolstering (addition of elements in memory and consistent with the attitude, to dilute the inconsistency) or (3) cognitive differentiation (modification of the inconsistent information to make it consistent).

Congruity Theory

Congruity Theory, attributable to Osgood and Tannenbaum, also sets out to explain changes in attitude. This theory is derived from Balance Theory that focuses on a situation where a person has a well-defined attitude with respect to a source and an object or concept. If the person and the source share the same opinion or judgement on the object, there is congruity. Otherwise, there will be pressure on the person to change their attitude, with respect to the source, to the object or both. The most interesting research carried out on this theory concerns resistance to propaganda: is it worth acting before the persuasive attack (by developing immunization against attitude change) or after, once the person has been put in a situation of incongruity? Results clearly support the first strategy.

Cognitive Dissonance Theory

This theory, attributable to Leon Festinger, is without any doubt the most famous. Again, the basic elements are cognitions, namely the opinions, beliefs and knowledge that people have about themselves, their behaviour or emotions, about others, or the world... There may be no relationship between these cognitions, but they can also be consonant or dissonant. Again, the existence of dissonance in a set of cognitions causes pressure to change towards a more consistent state. A person has many possible strategies to reduce dissonance: they can change their behaviour, change their beliefs, their relationships, and develop new cognitions…

Even if these two major theories start with common assumptions, they are strongly influenced by the very different points of view of their authors:

- On the nature of the force that pushes back to a state of consistency: dissonance is a source of discomfort for Festinger, whereas for Heider, the motivation lies in the search for harmony.
- On the fields of research themselves: in the case of Balance Theory, the focus is put on how the subject sees the situation before acting, while in the framework of Cognitive Dissonance Theory, it is more on the reorganization of cognitions, after an act from the subject.

This chapter provides the project developer with a useful methodology to accurately profile project stakeholders. The mapping technique leads to qualitative and quantitative evaluation of the positioning of stakeholders vis-à-vis the project, together with the acknowledgement of their motivations and concerns. This evaluation opens the possibility to develop strategies targeted at progressively modifying the attitudes of stakeholders who are critical of the project towards more supportive–or at least neutral–ones.

2.3. Results

The following sections present the results of the previous methodology applied to the case of the ULCOS CCS project in Florange.

2.3.1. Identification of stakeholders and project-related issues

As discussed in the methodological section above, the identification of the project stakeholders starts with the specification of the project scope (in time and space). For this project, the analysis of the project development plan led to the following results.

2.3.1.1. Project timeline

The table below lists the different project phases during which field activities may impact people (mainly inhabitants) or the environment[29] (indicative dates are given for illustrative purposes only and do not correspond to the actual project schedule). Only storage project-related activities are considered in the table below:

Phase name / event	***Description***	***Start date***	***End date***
Exploration	Seismic survey	Jan 2013	June 2014
	Exploration well(s) drilling, logging, completion		
	Baseline monitoring		
Construction	Installation of surface storage facilities	Nov 2013	Dec 2014
	Baseline monitoring		
	Pipeline construction work		
Operation (injection)	Field test (geological surveys, etc.)	Jan 2015	Dec 2024
	Monitoring activities (operational and assurance)		
Closure	Well plugging and abandonment	Jan 2025	Dec 2025
	Decommissioning of surface facilities		
	Monitoring activities		
Post-Closure	Monitoring activities	Jan 2025	Dec 2054

Table 14: Project phases and field activities

[29] Project phases with no operational activities (such as site selection, pre-characterization or design) have been omitted

2.3.1.2. Project geographical scope

The table below lists the locations and type of stakeholders that will be impacted by project activities.

Phases	***List of locations***
Research	Maizières-lès-Metz (Moselle), Nancy
Exploration	Storage: Meuse
Construction	Capture facilities: AM site in Florange (Moselle)
	Transport: Meurthe-et-Moselle
	Storage: Meuse
Operation	Capture facilities: AM site in Florange (Moselle)
	Transport: Meurthe-et-Moselle
	Injection: Meuse
Closure	Capture facilities: AM site in Florange (Moselle)
	Transport: Meurthe-et-Moselle
	Storage: Meuse
Post-Closure	Storage: Meuse

Table 15: Locations potentially impacted by project activities

The potentially impacted locations are not precisely identified, given the state of the project; they are given at the *département* level only. However, more precise information should be documented (at the township level).

2.3.1.3. Intangible scope (value zone)

Value at stake	***Description***
Environmental friendliness of the technology	Concerns that the flora, fauna and water resources may suffer from severe damage because of the operations and/or CO_2 leaks.
CCS Sustainable principles	Belief that CCS is not an appropriate solution to address climate change issues, mainly because it prolongs the life of fossil fuels at the expense of the development of renewable energies.
Attachment to the 1st World War heritage	Concern that the project will impact Verdun battlefields, which are considered as an important heritage to be protected.

Table 16: Table of potential values at stake

2.3.1.4. Potential project/territory issues

The table below summarizes the main challenges or issues that the project and the territory are facing:

Categories of issues	***Specific issues***	***Description***
Environment	Local impact	Improvement of the environmental quality at the capture site (atmospheric releases)
		Environmental impact of operations at the storage site
		Environmental impact of CO_2 releases from the storage complex
		Environmental impact of the CO_2 transportation pipe
		Long-term storage impacts
	Global impact	Contribution to climate change mitigation
	Environmental friendliness of technology	Development of an environmentally friendly steel industry
		Greener alternatives to CCS
Society and communities	Health and safety of population	Impact of a CO_2 transportation pipe failure on populations
		Impact of CO_2 releases on the population's health
		Impact of a resulting seismic event
	Local economic development	Preservation of the industrial activity thanks to innovation and modernization
		Job preservation (capture site)
		Job creation (storage site)
		Development of local competitiveness and appeal
	Local social and cultural impact	Image of Meuse (France's garbage can)
		Improvement of the image of the Lorraine region
		Loss of property value (Meuse)
		Preservation of the cultural heritage (Verdun battlefields)
	Social equilibrium	Fair distribution of social and economic costs and benefits
Industrial sector, company and	Project techno-economic feasibility	Demonstration of CO_2 capture technology for the steel industry

project		Demonstration of CO_2 storage feasibility
		Project economics and financing
		Research opportunities
	Project owner company image	Reputation (leadership, green, responsible, etc.)
	Quality of operating practices	Quality of project management
		Workforce health & safety
		Compliance
	Communication	Quality of the outreach and the communication strategy

Table 17: Project and territory issues that are at stake

2.3.1.5. Referencing and filtering stakeholders

In a first step and using the methodology previously described, **183 actors were identified,** from among which **34 were considered as stakeholders** to be mapped, given their relationship to the project (either because they're located in the project area or because they could influence the project outcome). 10 main stakeholders are described for the purpose of illustrating the mapping technique. Stakeholders belonging to different categories were selected and their roles or responsibilities described below:

Name of actor	***Stakeholder classification***	***To be considered?***	***Consideration justification***
Regional Directorate for the Environment, Town Planning and Housing	Public actor	Yes	This government department is responsible for implementing environmental and land use policy at the regional level. It will be following the project throughout its lifetime and will be particularly concerned about impacts on the environment and on the health and safety of populations. As for the storage operations, it is responsible for delivering the exploration and injection permits.
Regional University	Academic	Yes	This regional university encompasses a Department of geology (with research and education activities). As it is located in Meurthe-et-Moselle (Nancy), it is not *stricto sensu* in the project scope. This department has conducted a few research studies related to the project implementation (exploration and characterisation). Its geologists have in-depth knowledge of the regional geology and the local uses of the subsurface. They will likely be asked to be independent experts on the project.

Energy & Utility company (underground energy storage branch)	Economic	Yes	The Energy & Utility company does not belong to the consortium supporting the project implementation but belongs to the geographical scope of the project given that it operates a natural gas storage site located in the same hydrogeological unit (Meurthe-et-Moselle). The operational efficiency of this facility could be affected by CO_2 injection activities (physical and timeline scope)
Union of Private Rural Properties (local branch)	Local community	Yes	This organisation represents and defends the interests of land and home owners in the rural *département* of Meuse. Properties belonging to some of its members are located within the storage project area. This is the local branch of a national organisation.
Environmental Alliance	Civil Society Organization	Yes	This organisation is an association of several environmental NGOs whose raison d'être is the protection of biodiversity and the environment. This organisation is publicly against this project and refuses to engage in any dialogue.
Global environmental NGO	Civil Society Organization	Yes	This organisation is a major worldwide player among the Environmental NGOs. It published a report against CCS mainly because it prolongs the life of fossil fuel at the expense of the development of renewables. Furthermore, it does not believe that the industry is able to guarantee a level of quality of operations sufficient to avoid any accidents, especially when numerous projects are implemented. This organisation is famous for actions against large industrials.
Regional Council	Public actor	Yes	This organisation is the highest political authority of the region. It positions itself as a partner of the project, providing a large amount of direct subsidies. As such, it can directly influence the project.
Local Company-internal trade Union	Company internal	Yes	This organisation receives a lot of media exposure when it makes a move. It is in favour of the project because it believes that project activities will help maintain local employment.
Representative of the industrial sector (steel) European Labour Union	Economic	Yes	The organisation brings together all the major stakeholders in the European steel industry. Although it supports the industry (steelmaking), it shows a high level of concern about CCS applied to such industry regarding its potential impacts on the environment and humans. One of its members violently opposes the project accusing project proponents of "wanting to kill our children"

Table 18: Table of selected stakeholders

To keep the stakeholder mapping practical, it is often useful to group together stakeholders who have similar characteristics, although they may be once again considered individually during the stakeholder engagement sessions. For instance, the associations that are members of the Environmental Alliance all claim to be against CCS. Even though all 13 associations have initially been identified and differentiated from one another, it is enough to map the alliance and consider it as representing its members.

However, this list of stakeholders could potentially be modified at any time, depending on the findings during interviews. For instance, if a category of stakeholders shows some degree of heterogeneity, it should be split into several groups.

Stakeholders not included on the first list but who could potentially be considered for engagement, are referenced as “TBC” (To Be Confirmed).

2.3.2. Stakeholder mapping

2.3.2.1. Stakeholder scouting

As discussed in the methodological section, the exploration of the stakeholder base has to proceed gradually.

The first step is obviously a desk-based search, analysing available documentation, including the context analysis documented in Chapter 1.

The second step consists in organizing a series of initial meetings with stakeholders who are familiar with the project and, at least to some extent, in favour. The objectives of this first round of interviews are three-fold:

- Precisely evaluate the stakeholders’ characteristics and their positioning with respect to the project (both their role and responsibilities and subjective point of view)
- Identify actors that were not pinpointed during the context analysis stage and gather information on them
- List and understand the stakeholder’s perception of project issues and capture low signals (i.e. societal issues that could not be referenced without a direct discussion with stakeholders).

A lot of information about external stakeholders can be obtained from representatives of the project developer’s organization, especially from the representatives of the corporate functions that are in contact with these external stakeholders (R&D, Communication, Legal…). However, be wary because limiting the investigations to gathering information from these limited and indirect sources often results in biases, both in the selection of stakeholders and in the evaluation of their positioning with respect to the project. The range of interviews must be extended to a representative sample of stakeholders.

Unfortunately, given the current stage of the ULCOS project, meetings with external stakeholders were considered premature. Only internal stakeholders and stakeholders from the research community could be interviewed.

2.3.2.2. Mapping according to attributes

As discussed above, project stakeholders were mapped using as sources of information (1) available documentation, (2) employees of the project developer organization, and (3) a very limited number of external stakeholders. As presented in the methodological section, the stakeholders’ relationship with the project was evaluated according to three dimensions: power, attitude and interest. A sample of the results is presented in the table below:

Name of actor	*Power*	*Attitude*	*Interest*	*Stakeholder profile*	*Intensity of the relationship*
Regional Directorate of the Environment	High	Challenging	Low	Cynic	Medium-High
Regional University	Low	Collaborative	High	Cheerleader	Medium
Energy & Utility Company	High	Challenging	High	Punisher	High
Union of Private Rural Properties (local branch)	Low	Challenging	High	Watchdog	Medium-High
Environmental Alliance	Low	Hostile	High	Ambusher	Medium-High
Global Environmental NGO	High	Hostile	Low	Time-Bomb	Medium-High
Regional Council County council	High	Collaborative	High	Sponsor	High
Local company-internal Labour Union	Low	Opportunist	High	Crossed-fingers	Medium
Representative of the industrial sector (steel) European Labour Union	Low	Hostile	High	Ambusher	Medium-High

Table 19: Extract of the stakeholder mapping table

Comments given below attempt to illustrate and justify the choice of stakeholder mapping:

Direct Force (First of the two power dimension components)

- **Low**: The local branch of Union of Private Rural Properties and the Environmental Alliance prove to have few ways of directly impacting the project. They are local or regional actors with insufficient economic resources to directly affect a large industrial group such as the ULCOS project consortium. Furthermore, their legal resources and expertise are too low to come up with strong claims against the project.

- **Medium**: The Energy & Utilities Company has legal and economic capacities that it may use to affect the development of the project; if it is proven that the CO_2 storage operations have a negative effect on their activities (natural gas storage). The regional University has expertise on geology that is used in the context of the project.

- **High**: The Regional Directorate for the Environment has strong regulatory power and traditionally delivers the permit (or not) for this type of project. The Regional Council County council is providing public subsidies to the project, and therefore will consider the project developer accountable for the way it uses the money. The Global environmental NGOs have strong human, legal and economic resources to oppose to the project.

Indirect Force (Second of the two power dimension components)

- **Low:** Based on the available information, the local branch of the Union of Private Rural Properties, the Environmental Alliance and the Regional University seem to have too low an influence to curb the development of this project. They may decide to initiate actions in favour or against the project but would have first to convince their Headquarters where the power to influence is. On the other hand, Meuse is one of the districts with the lowest population density in France, which does not give weight to the arguments of the local branch of the Union of Private Rural Properties.

- **High:** The remaining actors prove to have developed strong local roots while having powerful connections at the national level that may be able to influence project development.

Attitude

- **Collaborative:** The Regional University participates in the project through some of its R&D activities. Furthermore, geoscientists from the Geological Department are in favour of CCS. These are the main reasons for its collaborative attitude.

- **Opportunist:** the Company-internal Labour Union will support the project so long as it contributes to maintaining local employment.

- **Challenging:** The Energy & Utility Company may consider that the ULCOS project will have a negative impact on its activities, with consequences on its performance. The project will have to demonstrate that this will not happen. Similarly, the local branch Union of Private Rural Properties is suspicious about the project because it believes that the value of real estate may be impacted. If this were to occur, the Union would likely request some kind of compensation. The Regional Directorate for the Environment is originally considered as challenging because of the role it has in controlling the implementation of all industrial projects. It will ensure compliance to regulations.

- **Hostile:** Because it believes that the project is directly affecting its values (environmental protection), the Environmental Alliance is publicly against it. It is willing to oppose its development. Although links to this specific project are not established yet, the Global Environmental NGO is openly against CCS technology while the representative of the industrial sector (steel) European Labour Union publicly attacked the project regarding its potential impact on human health and environment.

Interest

- **High:** Most of the selected stakeholders have a strong interest in the project due to their raison d'être, their direct involvement or their likelihood of being impacted.

- **Low:** It is of the duty of the Regional Directorate for the Environment to be concerned about the potential impact that this project could have on the environment. However, in this particular case of a First-Of-A-Kind CCS project, part of its roles, responsibilities and decision-making power have been transferred to the central government: the President's Office and the Ministry of Ecology. Consequently, its interest in the project became limited.

This mapping of stakeholders and the estimation of the intensity of their relationship with the project can be graphically represented in 3 dimensions, as shown below:

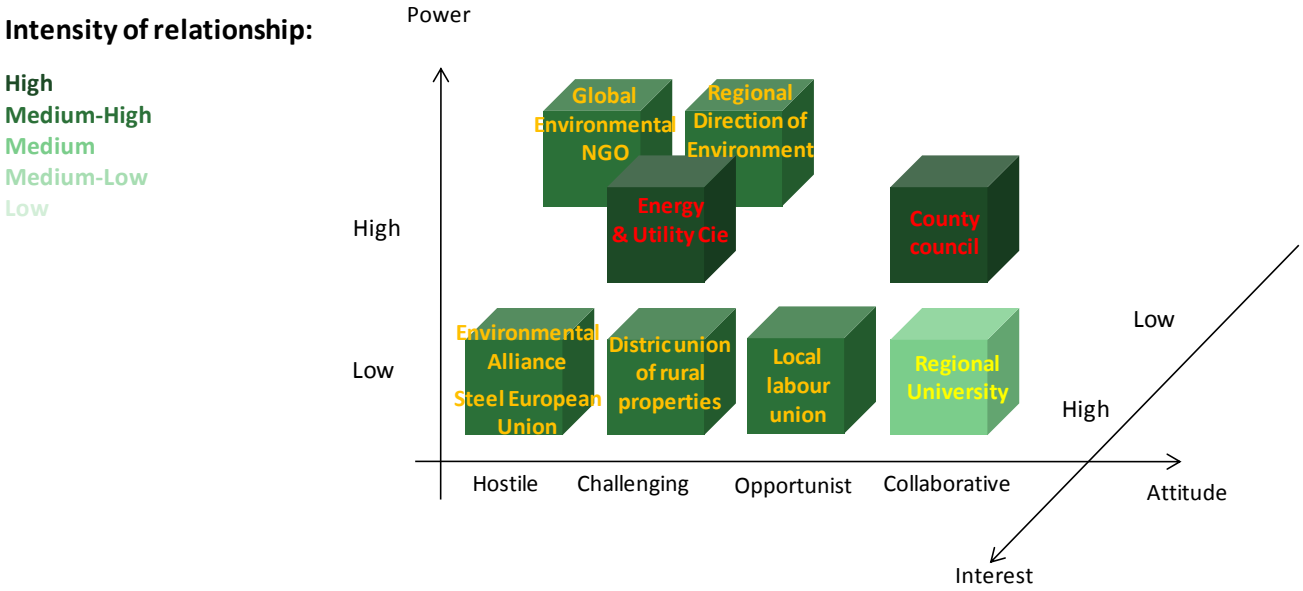


Figure 29: Graphical representation of the 3-Dimensional stakeholder mapping

As pointed out in the methodological section, the assignment of a stakeholder profile, derived automatically from the 3D mapping, is very useful for quality control. Profile names resonate more with people than do single-axis evaluations, and allow validation or adjustments during discussions with interviewees.

Furthermore, a careful completion of a detailed mapping of stakeholders brings interesting possibilities:

- An easy identification of the most likely moves. Indeed, the most likely changes in stakeholder positioning correspond to adjacent “boxes”. For instance “challenging” stakeholders could easily become “hostile”.
- The design of an optimum stakeholder engagement strategy (1) to avoid a change towards a less favourable positioning with respect to the project, and, when possible, (2) to reinforce the relationship with supportive stakeholders.

2.3.2.3. Recommendations for stakeholder engagement modes

Some basic recommendations concerning the mode of stakeholder engagement can also be drawn from the previous analysis. The first basic recommendation is to engage stakeholders proportionally to the intensity of their relationship with the project, for example:

Intensity of the relationship Project - Stakeholder	***Recommended mode of engagement***	***Example of stakeholders***
High	Manage closely	▪ Energy & Utility Company ▪ Regional Council
Medium-High	Monitor & Consult	▪ Regional Directorate of the Environment ▪ Union of Private Rural

		Properties ▪ Environmental Alliance ▪ Global Environmental NGO ▪ Company-internal Trade Union ▪ Representative of the industrial sector (steel) European Labour Union
Medium	Keep satisfied	▪ Regional University
Medium-Low	Keep informed	
Low	Monitor	

Table 20: Recommended engagement mode as a function of the intensity of the relationship between the project and the stakeholder

Furthermore, the modes of engagement should also take into account the stakeholder profile. Examples are given below to illustrate:

- ***Energy & Utility Company (Manage closely)*** is part of the "p=Punisher" group since it has enough power to impact the project should it prove to be detrimental to its business. Therefore, the project developer should investigate any possible conflicts of interest in the exploitation of the subsurface as soon as possible. It should also initiate bilateral discussions with this company, possibly involving geoscientists from the Regional University and/or a representative of the Public Authority (Regional Directorate for the Environment).
- ***Regional Council (Manage closely)*** is part of the "Sponsor" group since it is providing public subsidies to support the project. The project developer should interact regularly with this public body to ensure that it remains satisfied with the project outcomes (results and impact).
- ***Regional Directorate for the Environment (Monitor & Consult)*** is part of the "Cynic" group. It stays in an independent role, with the power to impact the project, for instance if it is not satisfied with the operating practices and project's compliance with regulations. The project developer must maintain a close relationship with this administration, fulfil its legal obligations, and communicate regularly on the project progresses.
- ***The Union of Private Rural Properties - local branch (Monitor & Consult)*** is part of the "Watchdog" group. This stakeholder is not yet sure of the potential damages from the project to its interests and is not strong enough to effectively act against the project implementation. But it stays on alert. The project developer should consult its representatives and regularly monitor its positioning to avoid a shift to a hostile attitude.
- ***The Environmental Alliance (Monitor & Consult)*** is part of the "Ambusher" group. It is against the project but doesn't have the strength to affect it. However, this stakeholder is on the lookout for an opportunity to curb the project. The project developer should therefore track its public statements and consider its point of view by engaging it when possible.
- ***The Global environmental NGO (Monitor & Consult)*** is part of the "Time bomb" group. It is against CCS and has published articles against the technology. It has the power to directly affect the project but for the time being, it is not showing a strong interest in this particular project. However, it could represent a threatening actor if it starts to show some concern about this specific industrial implementation.
- ***Company-internal Labour Union (Monitor & Consult)*** is part of the "Mercenary" group. As long as this stakeholder has the perception of a potential benefit from the project development, it will contribute to its promotion. This support is opportunistic,

which means that it could disappear in case of a disappointment, particularly with regard to the preservation of local employment.

- ***Representative of the industrial sector (steel) European Labour Union (Monitor & Consult)*** is part of the "Ambusher" group. He is against the project but is not powerful enough to block the project. However, his positioning could influence other stakeholders and his participation in public meetings could seriously affect the quality and usefulness of debates. For that reason, he should first be engaged through an interpersonal relationship, perhaps with the help of an independent third-party.
  Regional University (Keep Satisfied) is part of the "Cheerleader" group as it doesn't have strong power or influence to impact the project. Because of its activities and its convictions, it supports the project and is ready to serve as an ally in the public engagement phase. Nevertheless, its positioning is first and foremost determined by scientific facts. The project developer should maintain an honest and open relationship with this stakeholder, without hiding any facts or data on the project performance.

Once the stakeholders are mapped, it is useful to further characterise the issues they are particularly interested in, so that the engagement strategy is directed to the topics of concern for particular stakeholders (refer to Chapter 3).

2.4. Lessons learned and recommendations

The main objectives of the stakeholder analysis step are (1) to characterise the project stakeholder base (internal and external), and (2) to identify the main issues that the project is facing in its environment.

A novel method for stakeholder mapping helps address the first objective, by providing an accurate evaluation of the relationship that the stakeholder has with the project. This relationship is characterised in both a quantitative and qualitative manner.

The second objective is met through progressive investigations, which start with the characterisation of the context in which the project takes place, and continues with interviews of project stakeholders. Issues are classified in three categories: (1) Environment, (2) Society and Communities and (3) Industrial Sector, Company and Project. These issues will be further analysed for their relevance (refer to Chapter 3).

Finally, the acknowledgement of the stakeholder positioning combined with the understanding of their main concerns about the project, makes it possible to optimize the stakeholder engagement strategy for maximum efficiency.

Several preliminary conclusions can be drawn about the manner in which the methodology is deployed in the context of a project:

- The characterisation of the project environment and the identification and mapping of project stakeholders are **iterative processes**, which start with a detailed analysis of the context in which the project takes place. Results are progressively refined with information gathered during stakeholder interviews.
- **Stakeholder interviews are vital** to better understand the societal ecosystem in which the project is implemented and to characterise the relationship that they have with the project, including their subjective positioning. Desk studies are not sufficient. Furthermore, these interviews establish a first form of stakeholder engagement.
- Stakeholder interviews should be **semi-directive** and conducted with an **open-minded** attitude. Attention should be paid:
    - Not to pitch the project: just explain the necessary details without trying to convince,
    - To show stakeholders that some level of co-construction is possible, especially when it comes to addressing their most important concerns about the project implementation. This is a central piece of the social acceptance process (Breuker, S. & Al, 2011), (Brunsting S. & Al, 2010), (Brunsting S. & Al., 2010).
    - To listen to any expressed preoccupation even if it appears irrational,
    - To acknowledge any expressed recommendation even if it appears unfeasible.

These are preliminary methodological requirements to ensure that social acceptance is the **result of a process** in which the stakeholders and the project developer together define the conditions for social acceptance, which is the purpose of the main stakeholder engagement phase.

Content analysis and stakeholder analysis (Chapter 1 and 2) form the first two steps of this process (the Social Site Characterisation). Chapter 3 details the final step: materiality analysis of project-related issues.

3. Materiality analysis of project issues

3.1. Context of the task

This task concludes the Social Site Characterisation phase, and involves identifying the most important concerns and/or expectations expressed by the stakeholders (both external to the project and belonging to the project developer organisation).

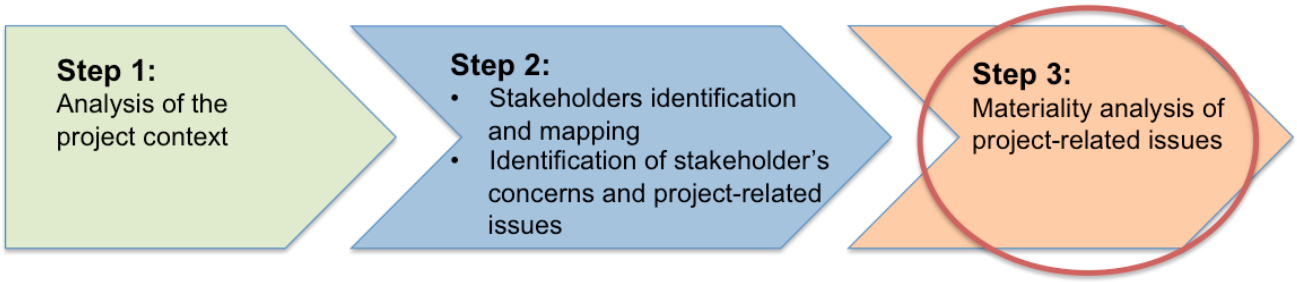


Figure 30: The third step of the Social Site Characterisation workflow: materiality analysis of project-related issues

To this end, it is useful to remember the recurring categories of project-related topics that are mentioned in the main social and environmental impact management standards (such as ISO 26000 or IFC's Performance standards[30]). These topics often correspond to issues of importance for project stakeholders, which should be discussed with them and then dealt with according to their importance, in order to ensure a harmonious integration of the project into its environment. The main categories of performance factors are:

- **Environment**: "a project's activities will inevitably have an impact on the environment, regardless of where a project is located" (AFNOR, 2010-11).
- **Community health and safety:** the risks generated by project activities are expected to be mitigated so as to not impact the safety of populations.
- **Local content**: positive socio-economic impacts are expected to counterbalance the nuisances created by the project's implementation.
- **Land acquisition and forced displacement**: project implementation may require a change in land use and people impacted by this change should be compensated for.
- **Ethical practices**: stakeholders impacted by the project should be treated fairly, particularly when it comes to the distribution of costs and benefits.
- **Cultural heritage**: local cultural values and impacts on natural and architectural assets should be considered during project implementation.
- **Human rights**: human rights should be respected when dealing with both the project stakeholders and project workforce.
- **Native/indigenous populations:** Recognized by the IFC as "the most vulnerable population segment" (IFC, 2006), impacts on indigenous people must be carefully monitored by strong NGOs and government.
- **Project governance and management**: the project developer is expected to be exemplary when it comes to project management, operating practices and workforce health and safety.

[30] International Finance Corporation (IFC) is a member of the World Bank, providing investment, advisory and asset management services to foster private sector development in developing countries. The organization is known for its guidance on environmental and social management of industrial projects. This management guidance stands as a prerequisite for investment and grants eligibility from multilateral organizations (such as development banks).

More specifically, according to the World Resource Institute (World Resources Institute, 2010), the following elements can be considered as recurring issues for CCS projects:

Standard issues	***Relating CCS issues***
Local community Development	Potential electricity rate increases for citizens
	Landowner compensation
	Requests for royalty payments to the community
	Educational benefits to local students through project-linked programs (internships, research grants, etc.)
	Impact on property values
	Media coverage and increase/decrease in tourism potential
	Increase in local economic activity
	Job creation potential
Health - Security - Safety	Emergency response
	Long-term safe storage
	Groundwater contamination
	Ground stability and effects of underground movements
Environment	Groundwater contamination
	Local contribution to addressing global climate change[31]
Project developer	Operator liability[32]

Table 21: CCS project general issues, according to WRI

The social acceptance of a project depends on the perceptions that the stakeholders will have of the project. Perceptions are subjective and sometimes irrational: stakeholders may overemphasize a

[31] CCS arguments about being a climate change mitigation option do not usually generate a large consensus in civil society. For instance, two Dutch surveys conducted in 2006 and 2008 showed that the population was "not very enthusiastic about CCS as a mitigation strategy" (Brunsting S. & Al., 2010)

[32] A project developer's track record of responsible relationships with its stakeholders is a key asset to build trust and therefore project social acceptance (Mariette Pol & Al - NEAR CO2, 2011)

specific project issue, while its "objective" importance is not that high. Indeed, stakeholders' concerns about a potential impact depend on the level of perceived risk. Concerns often "rely on emotional and irrational elements that are associated with a subjective representation of the risk. This perceived risk is in turn influenced by beliefs, values, feelings and social norms that build the way people think and act and that don't necessarily correspond to the reality of the risk itself" (ENEA Consulting, 2010).

As explained below, the materiality analysis methodology accounts for stakeholders' subjective perceptions in the selection of project issues to be addressed, when they are rated along the so-called "stakeholder axis". But it also accounts for the project developer point of view, which can be more factual or scientifically based.

3.2. Methodology

Objectives of the task

- Assess stakeholders' concerns about the ULCOS project and compare them with the project developer's point of view.
- Highlight the most important project issues to be addressed during the stakeholder engagement phase.

The methodology presented here aims at answering the question, "what really counts and for whom?" in the context of CCS project implementation. The process used to answer this question is a "materiality analysis" of the main issues that the project is facing.

Materiality analyses initially came from accounting practices and aim to determine what information or figures are important enough to be accounted for in a specific context. In the context of the development of a large industrial project like a CCS project, a materiality analysis consists in a comparison between the external stakeholders' concerns or expectations about the project and the project developer's point of view. It basically compares "what is relevant to the stakeholders" with "what is relevant to the company".

This comparison reveals the different perceptions of project issues and opens up the possibility of dialogue—to some extent negotiation—between the stakeholders and the project developer. Project issues that pass the materiality test are the main topics to be discussed during the stakeholder engagement phases.

3.2.1. Project issues from the developer's point of view

The project issues to be considered are the stakeholder concerns that were identified previously. These include issues brought by both the project developer and its organisation, and external stakeholders.

The project developer is asked to rank these issues from the company's perspective on a scale from 1 to 10.

- 1 being a non-relevant issue due to the fact that its existence is hypothetical or due to the lack of a clear link to the project
- 10 being a strong issue directly related with the development of the project.

3.2.2. Assessment of stakeholders' perception of project issues

Similarly, the level of concern that stakeholders have about project issues are rated on a 3-level scale:

Importance of the issue for the Stakeholder	
Low	**The issue is acknowledged but it is of little importance for the stakeholder**. It doesn't trouble the stakeholder in its day-to-day life or activities. It does not offer any opportunities either.
Medium	**The stakeholder is concerned about the issue**, which may impact its life or day-to-day activities. It could also represent an opportunity for a positive change. However, the issue is not of major importance.
High	**The issue is a major concern for the stakeholder**. It will strongly affect its activities, raison d'être or values. It could be a very significant opportunity or threat.

Table 22: Assessment scale for the stakeholder perception of project issues

3.2.3. Materiality analysis - Comparing stakeholder and project developer points of view

Stakeholder and project developer perceptions of project issues are compared using a "materiality analysis" cross-plot, with the following definition of axis and coordinates:

- The X-axis is the project developer axis, called "relevance to project/company". The X-coordinate measures the importance of a specific issue for the project developer.
- The Y-axis is the stakeholder axis, called "relevance to stakeholder". For a better evaluation of this dimension, the level of concern that a stakeholder has on a specific issue is weighted by the importance of this stakeholder for project (the intensity of the relationship between the stakeholder and the project). The distribution of stakeholders' positioning is then represented with an arrow: the smaller the arrow, the bigger the consensus on the importance of the concerns and stakeholders' proximity with the project.

The interest of this cross-plot is to point out potential mismatches between stakeholders' expectations or concerns and the project developer's perception of issues surrounding the project (Jim Hammond & Simon Shackley [Scottish Centre for Carbon Capture, University of Edinburgh], 2010). The cross-plot takes the following form:

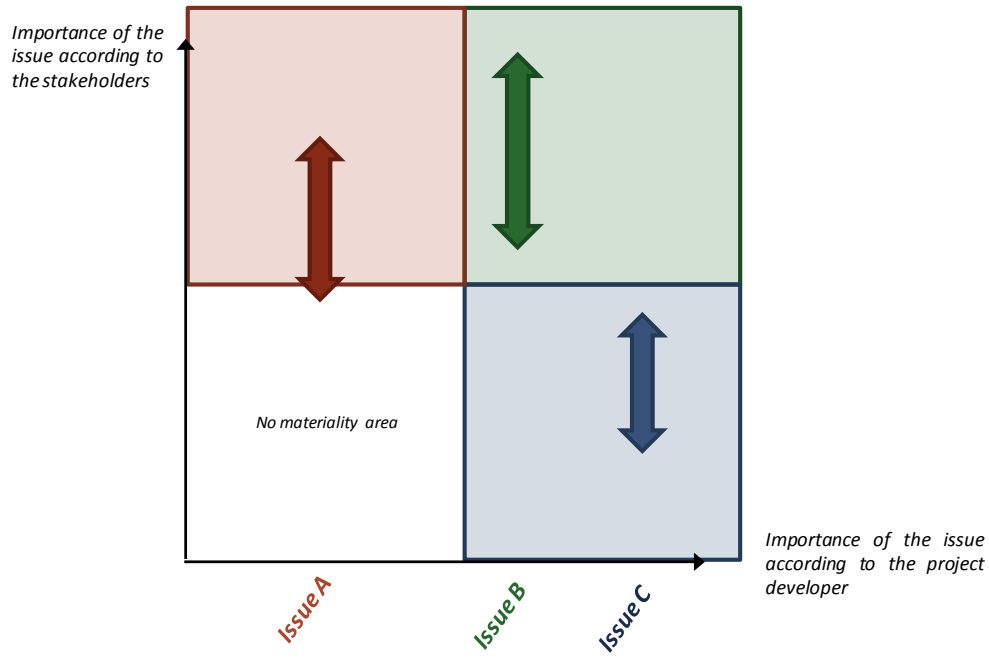


Figure 31: Materiality analysis

On the above figure, the arrows represent the dispersion in stakeholder positioning's. Issues that are material are located in the three coloured quadrants, corresponding to three different types:

- **Type A**: These issues are considered to be critical for external stakeholders while they are of low concern for the project developer. These issues should be addressed because the social acceptability of the project depends on a consensual agreement about their treatment. The difference in perception is a factor of potential conflict and opposition to the project, so the level of attention to these issues should be high in the project developer's organization. Category A also includes stakeholder concerns stemming from a lack of knowledge or misunderstandings about the CCS technology or the characteristics of CO_2 "*Is CO2 dangerous – can it kill me?"* (Max Prangnell, 2013).
- **Type B**: Both the stakeholders and the project developer consider these issues as critical. The agreement on their importance does not imply an agreement on how to address them, even less on how to solve them. However, the shared recognition of their importance lays

the grounds for a discussion, whose objective would be to establish (1) a common diagnostic, (2) a way of tackling the issue agreed upon by all parties, (3) the agreement on the definition of indicators of success for solving the issues.

- **Type C**: This corresponds to issues of no importance to stakeholders but that matter to the project developer. These concerns should also be communicated to external stakeholders to balance the dialogue by clarifying the minimum conditions at which the project proponent accepts to develop the project. At a first sight, these issues wouldn't affect project social acceptance, unless the perceived low importance on the stakeholders' side is due to a lack of critical information. If this is the case, it is recommended that the project developer inform the stakeholders about these "unknown" issues, before any other source does so. It is the project developer's perceived reliability that is at stake.

Conducting this materiality analysis allows a project developer to identify the main social, environmental and economic challenges that the project is facing. The output of this key step is a list of important issues that must be addressed during the stakeholder engagement phase, in order to build mutual respect and trust among the parties (Bradbury & Al, 2011). This collaborative spirit is an essential prerequisite for constructive discussions about possible options in the project design and development.

3.3. Results

The methodology presented above was applied to the ULCOS project. The results are discussed below.

3.3.1. Project issues from the developer's point of view

Project issues were first evaluated from the project developer's point of view, using a ranking from 1 (according little consideration or considering the risk is low) to 10 (high consideration or valuation of the issue). Results of the analysis are given in the table below:

Categories of issues	***Specific issues***	***Description***	***Rating***
Environment	Local impact	Improvement of the environmental quality at the capture site (atmospheric releases)	1
		Environmental impact of operations at the storage site	7
		Environmental impact of CO_2 releases from the storage complex	
		Environmental impact of the CO_2 transportation pipe	
		Long-term storage evolution	8
	Global impact	Contribution to climate change mitigation	7
	Environmental friendliness of technology	Development of an environmentally friendly steel industry	
		Greener alternatives to CCS	2
Society and communities	Health and safety of population	Impact of a CO_2 transportation pipe failure on populations	10
		Impact of CO_2 releases on the population's health	
		Impact of a resulting seismic event	
	Local economic development	Preservation of industrial activity thanks to innovation and modernization	6
		Job preservation (capture site)	
		Job creation (storage site)	
		Development of local competitiveness and appeal	

	Local social and cultural impact	Image of Meuse (France's garbage can)	4
		Improvement of the image of the Lorraine region	
		Loss of property value (Meuse)	
		Preservation of the cultural heritage (Verdun battlefields)	
	Social equilibrium	Fair distribution of social costs and benefits	3
Industrial sector, company and project	Project techno-economic feasibility	Demonstration of CO_2 capture technology for the steel industry	8
		Demonstration of CO_2 storage feasibility	5
		Project economics and financing	10
		Research opportunities	9
	Project owner company image	Reputation (leadership, green, responsible, etc.)	8
	Quality of operating practices	Quality of project management	10
		Workforce health & safety	
		Compliance	
	Industrial integration	Conflict of use	4
	Communication	Quality of the outreach and the communication strategy	5

Table 23: Ranking of the project issues according to the project developer

It can be observed that in the "Environment" and "Society and Community" categories, *Heath-Security-Safety* issues are considered to be the most important. They are followed by *Impacts on the environment* (which are seen as threats). As expected, the project developer will rate quite highly some issues that can be considered as only concerning the industrial sector, its company or the project itself, among which are: the *Economics and financing* aspects of the project, the quality of operating practices (*Health & Safety for the workforce, Compliance, Project Management*) and the company's *Reputation*.

Although mentioned by a few external stakeholders, the *Improvement of the environmental quality at the capture site* is not seen as a material issue since, in the opinion of the project developer, the capture of local CO_2 emissions will not change the air quality.

At the same time, possible impacts on the inhabitants' property value, and more generally the social and cultural impacts of the project, are not rated highly by the project developer.

3.3.2. Assessment of stakeholder perception of project issues

The next step in this task consists of an evaluation of the same issues discussed with the project developer, but this time they are discussed with project stakeholders. In the context of this study, these evaluations were essentially derived from the results of a preliminary public opinion survey, and information available on Internet or in the literature.

As the ULCOS project is on hold (at the time of this study), it was not possible to conduct interviews with external stakeholders, except those from the R&D community.

For the sake of consistency, the same sample of stakeholders that were mapped (refer to Chapter 2) was also used to rate stakeholder concerns (rated from 1 to 3):

Name of stakeholder	*Stakeholder mapping*	Improvement of the environmental quality at the capture site	Local environmental impacts	Long-term storage evolution	Contribution to climate change mitigation & cleaner steel industry	Greener alternatives to CCS	Health and safety of population	Local economic development	Local social and cultural impact	Social equilibrium	Project techno-economic feasibility	Project owner company image	Quality of operating practices	Industrial insertion	Communication
Regional Directorate for the environment	Cynic	1	2	3	2	2	2	2	2	1	2	1	3	2	2
Regional University	Cheerleader	1	1	3	2	1	3	2	2	1	3	2	3	2	1
Energy & Utility Company	Punisher	1	1	3	1	2	2	3	1	3	2	2	2	3	1
Union of Private Rural Properties (local branch)	Watchdog	1	2	3	1	2	3	2	3	3	1	2	2	1	2
Environmental Alliance	Ambusher	2	3	3	2	3	3	2	1	3	1	2	3	1	2
Global environmental NGO	Time Bomb	2	3	3	2	3	3	1	1	2	1	2	2	1	3
Regional council County council	Sponsor	1	2	2	2	1	3	3	2	2	3	2	3	2	2
Local labour Union	Mercenary	2	1	1	1	1	2	3	1	1	2	2	3	1	3
European Steel Union	Punisher	1	2	3	2	2	3	3	1	2	2	2	2	1	2

Table 24: Ranking of the project issues according to stakeholders' concerns

The following elements can be observed:

- The Regional Directorate for the Environment, the Environmental Alliance, the Global Environmental NGO and the European Steel Union focus their interests on underground impacts and their potential ripple effects on human safety.
- The Energy & Utility Company proves to be mainly concerned with conflicts of use underground with ULCOS that may jeopardize its activities.
- As an academic stakeholder, the Regional University concentrates its concerns in its area of expertise: environmental impacts, health & safety issues, conflict of use, etc.
- As a project finance source and a regional authority, the Regional Council is preoccupied for the impacts on local economy, citizens' welfare and successful project development.
- The local Labour Union is focused on one goal that dictates its concerns: maintaining jobs in the steelmaking factory. As a matter of fact, it is interested in the success of the demonstrator due to its ripple effects on the factory and the local economy.
- The Union of Private Rural Properties is focused on issues corresponding to its mandate: the preservation of property value.
- The European Steel Union is concerned about technical improvements to steelmaking. It is therefore interested in the technical findings while being worried about safety and environmental issues.

The profiling of concerns indicates which are the main areas of interest for each stakeholder and therefore **allows the project developer to target its communication.**

For illustrative purposes, the concerns of the Global Environmental NGO and the Internal Trade Union are developed in the Figure 32. Their concern profiles confirm the following:

- Global Environmental NGO: this stakeholder is mainly concerned with environmental issues while paying little attention to project and industrial challenges. Therefore, it will be expecting solid information on the environmental aspects of the project.
- Internal Trade Union: as an internal actor, the trade union is preoccupied by industrial matters. However, the local actor's raison d'être is to solve social issues. As a consequence, this stakeholder is preoccupied by local economic development (maintaining the employment level in the factory).

The spider charts that are shown below are very useful to pinpoint the dominant positioning of a stakeholder: whether it is more "Environment", "Society" or "Project" focused. Concerning the two stakeholders considered below, the Global Environmental NGO is of the first kind, while the Internal Labour Union is balanced between "Society" and "Project":

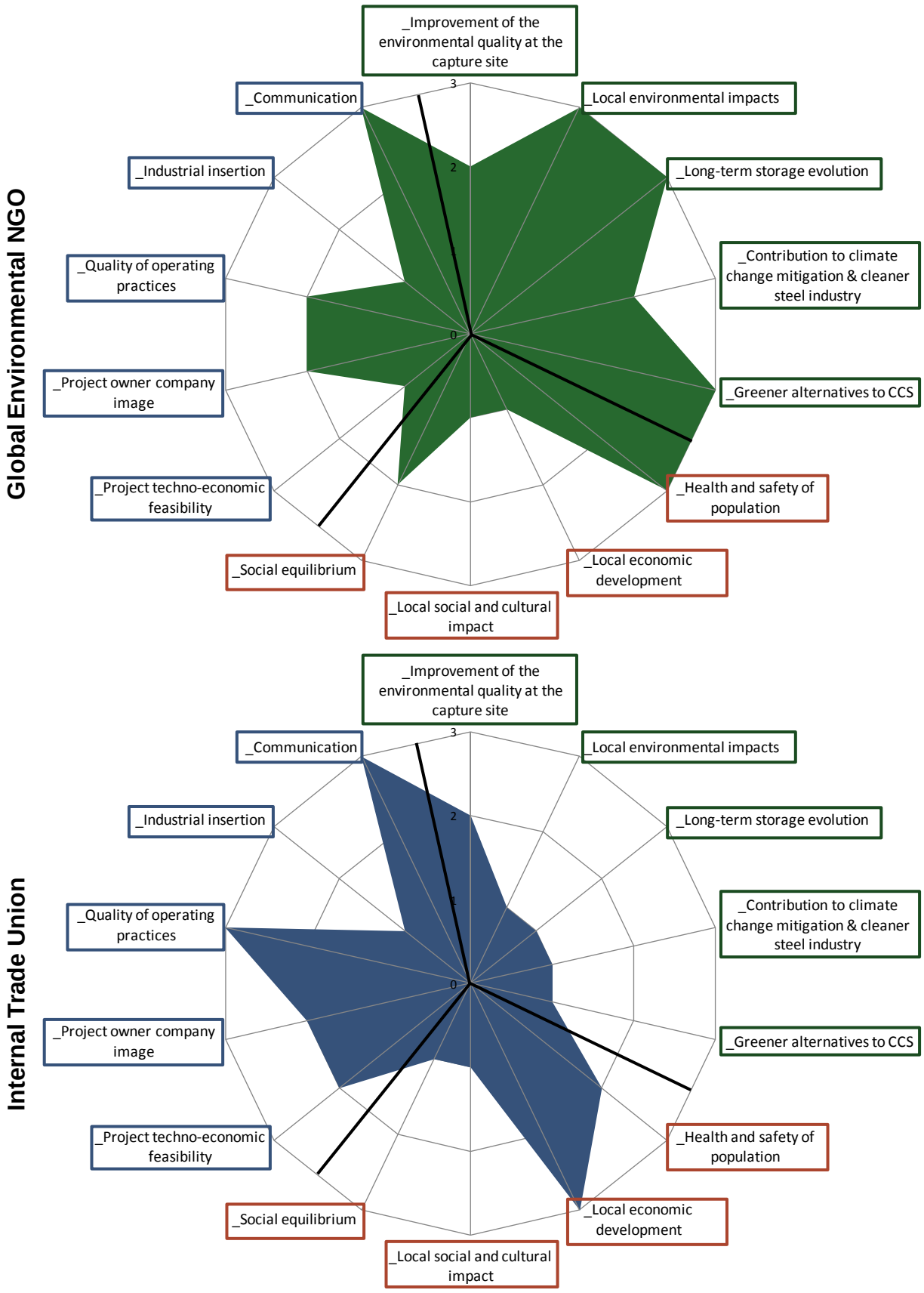


Figure 32: Representation of the concerns of the Global Environmental NGO and the Internal Trade Union

(Environmental issues are framed in **Green**, Society and Communities issues in **Red** and Industrial and project issues in **Blue**)

The next step consists in comparing stakeholders' concerns with the project developer's opinion on the importance of the issues. An example of the materiality analysis is presented below for four issues typically raised.

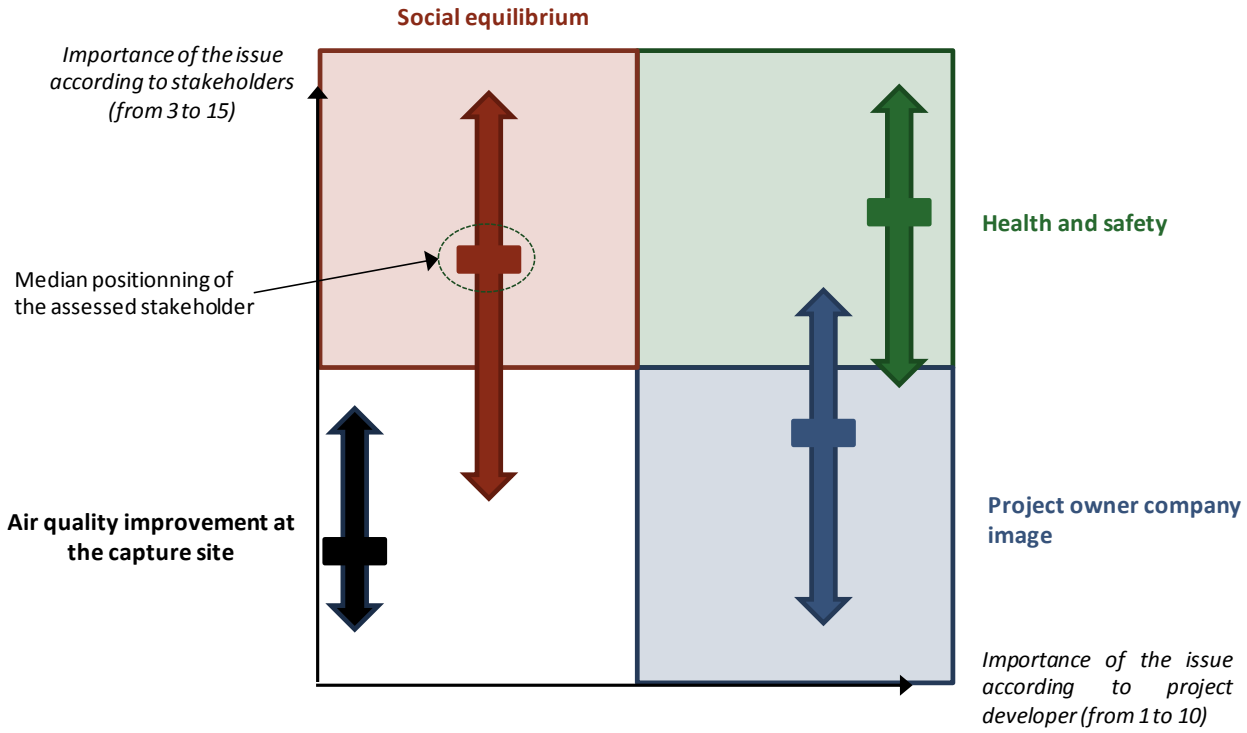


Figure 33: Sample of issues materiality analysis

- **Social equilibrium (fair distribution of costs and benefits)**: while it is not an important concern for the project developer (3/10), it is a serious concern raised (3/3) by important project stakeholders. Indeed, without any alignment of concerns between stakeholders and the project developer, this issue might cause serious social acceptance problems for ULCOS.
  - → **Recommendation available at this stage:** The project developer should consider how to better distribute advantages and disadvantages, either by providing some benefits to stakeholders located close to the storage site (for instance related to local development) or by mitigating the nuisances or the risks caused by project implementation.

- **Community safety at the storage site**: Both the stakeholders and the project developer are concerned about this issue. Since it is recognized as a priority for both parties, this matter should not threaten social acceptance unless the project developer's answers do not match the stakeholders' expectations.
  - → **Recommendation available at this stage:** since every actor shares the same level of concern on this point, it should be one of the first topics discussed with the community. By reaching a consensus on this point, the project developer would be able to build up trust, thus facilitating future "negotiations" on more controversial issues.

- **Project owner company image**: this issue has a low importance for stakeholders whereas it matters to the project developer. Unfortunately stakeholders are not sensitive to the project branding and/or have mixed opinions about the project developer.

→ **Recommendation available at this stage:** the project developer should make sure that the decisions taken in relation to the project (design options, willingness to communicate) do not affect the Company image.

- **Air quality improvement at the capture site**: the issue has a low importance for both the stakeholders and the project developer. No one appears to be concerned about this point, which means it should be declassified to a "non-issue".
  → **Recommendation available at this stage:** the project developer should exclude this element from the global project communication or just mention it as a marginal characteristic of the project (in case it is a proven argument).

Once the material analysis of all project issues has been completed, the project developer has all the necessary information to prepare an engagement strategy (Chapter 4):

- They are aware of the key facts regarding the societal context in the territory,
- They have identified, met with and qualified the stakeholders according to their importance to the project,
- They have recognised the main concerns of the most important stakeholders,
- They are aware of key topics on which stakeholders should be engaged, and have indications about possible adjustments or actions that would help answering the most salient concerns brought by stakeholders.

3.4. Lessons learned and recommendations

The materiality analysis concludes the Social Site Characterisation, which started with the analysis of the project context, followed by the analysis of project stakeholders and the identification of the main concerns they have about the project.

The materiality analysis allows the most important project-related issues to be addressed. These issues are now to be discussed and likely negotiated with the project developer and stakeholders in order to build the conditions of social acceptability. This will constitute the main objective of the stakeholder engagement phase.

The stakeholder mapping methodology coupled with a project issues materiality analysis makes it possible to precisely identify "what counts and for whom", i.e. the main topics of concern for the most important project stakeholders. Next, the stakeholder engagement strategy must be established to properly deal with these issues through an informed selection of:

- The most adequate engagement modes (level and form),
- The choice of the most efficient source and vehicle for the message.

In other words, the project developer is now able to target its messages to each stakeholder (one of the key success factors identified for a successful engagement strategy (GCCSI, 2012)). The objective of the engagement is to build a common ground of perceptions[33]. This "consensus" building strategy is the main topic of Chapter 4.

[33] Indeed, as highlighted by the Global CCS Institute (The global status of CCS 2012, Part *10.2 Public engagement factors* (GCCSI, 2012)), building a shared vision is a critical step toward project social acceptance.

4. Stakeholder Engagement

4.1. Context of the task

Once the social site characterization has been completed following the three-step methodology described in the previous chapters, a project proponent is ready to effectively implement the stakeholder engagement phase. However, what will make the stakeholder engagement phase successful?

From the project developer's point of view, it is the possibility to implement the project and plan related actions in accordance with internal policies and objectives, while avoiding blockage from external stakeholders.

From the external stakeholder's point of view, it is the possibility to express its view and influence the project development in a way that makes its implementation acceptable, in other words, to verify the project developer's ability to demonstrate (Miller M.A., Vaughan E., 2012) (Desbarat J. & al., 2010) (Prangnell M., 2013):

- Tangible **benefits,** for individuals and/or local groups, at the local, regional or national level (e.g. local economic development). Positive impacts should be sufficient for external stakeholders to compensate for an inevitable degree of intrusion (e.g. nuisances due to project implementation).
- **Assurance** that the stakeholders concerns are heard and dealt with seriously, namely allaying fears and concerns about health, safety and environmental protection.
- **Truthfulness** and confidence**:** the project developer must be perceived to be telling the truth to build a sustainable, trusting and successful relationship with other project stakeholders.

Axiom 1

Earning the trust of external project stakeholders is vital to successful stakeholder engagement i.e. that leads to the final social acceptance of a project.

As the European CCS Demonstration Project Network underlines in its public engagement best practice (CCSNetwork.eu, 2012), the process that is used to communicate is often more important than the content of the message. Listening to stakeholder concerns and opinions and dialoguing about the project are more important than excessive focusing on technicalities. Indeed, a first requirement to build trust is that basic communication rules are followed, to ensure that every stakeholder can express him/herself comfortably.

- **R1 – Everyone has the right to be heard.**
- **R2 – Any expressed concern must be noted down and considered, even though it may seem irrational or unfeasible. Therefore do not disregard any comment before it has been discussed any further with the audience.**
- **R3 – There should be no ostentatious display of a final project design that has not yet been endorsed.**

The main challenge is to ensure that these three basic rules are followed all along the stakeholder engagement process.

In practice the "Stakeholder engagement" phase consists of a series of events such as public consultations, meetings, seminars, workshops, open-house days, site visits, etc. This process uses appropriate communication tools to inform stakeholders about the project, but can also benefit from specific technological tools, as it is shown below, for instance to define, evaluate and compare the possible options for a CCS project.

The objectives of this case study are:

- To introduce a stakeholder engagement methodology, which proposes to consider project design and implementation options that reflect both project proponent and external stakeholders concerns, opinions and constraints. These options are then evaluated for their performance, compared and discussed among all project stakeholders, to try to reach a consensus on the acceptable conditions for project implementation.
- To adapt this stakeholder engagement methodology to the ULCOS project, taking into account the results of the analyses performed during the Social Site Characterisation phase (context analysis, stakeholder identification and mapping, materiality analysis of project issues),
- To test this methodology through a simulation step, in a small group composed of project team members and stakeholders who are close to the project, and using role-playing techniques. Findings from this simulation step make it possible to adjust the methodology and make final recommendations on the implementation of a full stakeholder engagement phase.

Substantial literature already exists to support this process (Ashworth P. & al., 2011) (Hammond J., Shackley S., 2010) (Wade S., Greenberg S., 2011) but the objective here is to detail both the methodological steps and the supporting tools and techniques, to provide guidance for effective stakeholder engagement.

The stakeholder engagement methodology described below puts into practice the main public engagement rules stated above, to be considered when developing a project.

Thus, this section discusses the current experience in stakeholder engagement in the context of CCS projects, to draw some basic rules and recommendations on how to conduct the engagement. It also introduces two theories of social psychology that could help provide some methodological and conceptual insights on the dynamics of engagement.

4.1.1. Lessons learned from past and present CCS projects

The reasons that are put forward when a project is cancelled may differ greatly from one project to the next. According to the Global CCS Institute publication on the strategic analysis of Carbon Capture and Storage (GCCSI, 2009), four different types of challenges can impede the deployment of a CCS project:

- Regulations
- Social acceptance
- Costs
- Financing

In addition, as a more recent Global CCS Institute publication underscores (GCCSI, 2011), project cancellation may also be motivated by political will.

Thus, even if social acceptance is not strictly speaking a technical or economic dimension, it cannot be underestimated. A source of difficulty is that there are no hard-and-fast rules or solutions to deal with this psycho-sociological aspect. Each case is unique and it has been observed that a same stimulus can have different effects on different individuals or communities, leading to different behaviours towards the project. For this reason, the main challenges to successful engagement are to define an appropriate roadmap and to gather local forces into a helpful and fitting process. Without such a process, misinformation and misunderstanding can rapidly lead to delays, persistent *status quo* or a crisis situation.

Furthermore, although some basic principles should be systematically followed to foster social acceptance through stakeholder engagement practices, many conditions are unique to a project and require a customized approach. Reasons for failure or success vary a lot depending on the project context, and can change during the project development phase. Conditions for social acceptance

also depend on stakeholders' perceptions of technological and environmental risks, as well as their awareness and concern about societal issues, which depends on their cultural background, their level of education, etc.

4.1.2. Feedback from existing Stakeholder Engagement Strategies

Each CCS project has developed its own engagement strategy, with various difficulties in the implementation and contrasting results depending on the local socio-economic context[34]. Opposition can arise anytime during the early lifecycle stages of CCS project deployment, but are likely to start during the Selection and Characterisation phase. Indeed, almost one third of the cancelled projects are abandoned during the Selection phase and an additional third during the Characterisation phase (GCCSI, 2009). These results underline the necessity for the stakeholder engagement strategy to focus on early lifecycle phases. As shown below, the proposed methodology addresses this point, allowing discussion on project design and implementation options.

According to the European CCS Demonstration Project Network's public engagement work stream (CCSNetwork.eu, 2012), stakeholder engagement strategies suffer in most cases from a lack of consistency in engagement practices and tools. Furthermore, stakeholders are often listened to, but not really involved in the decision-making processes. Although limiting engagement with communication activities can sometimes be enough for the project to pass the early phases, as some projects have demonstrated, it is unlikely that favourable conditions will remain as soon as more intrusive, or even simply visible, operations are conducted. Limiting the engagement strategy only to communication will, most likely, exacerbate a projects failure to maintain stakeholder engagement.

Different stakeholder engagement strategies and their results are illustrated below (CCSNetwork.eu, 2012):

- Bełchatów project (Poland): Supporting stakeholders such as local and regional authorities, scientists, the Polish geological Institute and Bellona are invited to all dissemination events, are consulted for brochures and take part in brainstorming sessions concerning public engagement strategy…. [The opponents] are also invited to all events and kept permanently informed of events concerning the project. Any questions or accusations made by these stakeholders are responded to directly by an expert. The project also monitors media and tries to keep journalists happy by being available for comment.
- Porto Tolle project (Italy): Strong collaboration with the "CCS observatory" and an NGO launched by the Italian Sustainable Energy Foundation that aims to promote the scientific collaboration, dissemination and the communication concerning CCS in Italy, as well as local and national authorities, scientific associations and CCS support groups. Enel participates in events and supports communication materials on CCS.
- Compostilla project (Spain): Most stakeholders are supportive. The main strategy with the stakeholders is communication and dialogue, preferably before the media gets involved. Information needs to go first to local authorities who have to be properly engaged. Key messages and key stakeholders needed to be identified as a first step and a suitable local presence is desirable (a scientist in the storage area). Communications need to be based on transparency. National government support is essential and it is useful that the positive messages about the project come from a respected research institute.
- Don Valley project (UK): approaches are different depending on the different stakeholders. A formal approach is made for Government Departments, MPs and NGOs. Thematic groups have been set up for Executive Agencies, Local Parish councils and NGOs and they are involved in the preparation of the Environmental Impact Assessment. All are invited to exhibitions and consultations. Individual meetings are held with landowners that are concerned by the pipeline.

[34] At the Longannet project (Scotland, UK), commercial issues caused the project to halt, whereas the Jänschwalde project faced opposition from the local community with regard the chosen storage site, which was exacerbated by the lack of a clear, policy-driven regulatory framework (GCCSI, 2011).

- ROAD project (The Netherlands): primary stakeholders were divided into four categories depending on their level of interest and level of influence. Each of the categories is handled differently. The stakeholders with the high interest and highest influence are "closely managed". Those with high interest but relatively low influence, including a number of civil and environmental NGOs, are "kept satisfied". The high interest/low influence group is "kept informed" while the low interest/low influence group is "monitored".
- Jänschwalde project (Germany): Vattenfall has developed a "stakeholder engagement model" which had proved useful. It was generally accepted that "direct contact with affected stakeholders provides new and valuable information for the project, with possible new ideas for solutions and procedures". The biggest mistake by the project had been to underestimate the local opposition in the proposed storage area.

Thus, a few key points can be pointed out from previous project experiences:

- **An early stakeholder engagement strategy doesn't ensure public acceptance.**
- **Public opinion cannot be rushed - to try to do so only raises resistance** (CCSNetwork.eu, 2012)**.**
- **Educating the public does not always increase acceptance** (CCSNetwork.eu, 2012)**.**

4.1.3. Recommendations for an effective stakeholder engagement phase

From an operational perspective, the prerequisites for an effective stakeholder engagement strategy are summarized as follow (Prangnell M., 2013):

1. **A social site characterization needs to be completed.**
2. **An early and meaningful engagement is necessary.**
3. **A proactive and direct engagement is essential.**

These recommendations must be followed when the project developer plans the engagement phase. The proposed project evaluation-based methodology clearly makes it possible to achieve points 2 and 3, and its implementation requires accounting for the results of the social site characterisation for maximum efficacy.

4.1.4. Theoretical basis for effective stakeholder engagement

Before presenting this methodology in extensive detail in the following sections, it is useful to recall some of the basic references regarding attitude change through engagement, which can be found in the social psychology corpus.

As discussed before, referring to its "psychological" definition, social acceptance comes from a judgmental process by which individuals impacted by—or able to impact—a project (1) compare the perceived conditions in which a project is to be implemented with the current situation and alternatives and (2) decide whether these conditions are acceptable or not. If the existing conditions are judged to be insufficient, an individual will initiate a behaviour (often, but not always, within a constituency group) that is believed likely to shift conditions toward a more favourable alternative (adapted from Brunson (Brunson, Mark W., 1992)).

An efficient stakeholder engagement strategy (i.e. targeted at creating the conditions for social acceptability) should propose a framework in which such a judgmental process can occur, even more, in which stakeholders can take the initiative to propose new alternatives that will also be discussed, evaluated and compared with others.

As demonstrated below, the methodology that is proposed for the ULCOS project meets these requirements, largely through the utilization of a dedicated multi-criteria assessment tool that can be used for option evaluation and comparison. Its efficacy in creating conditions leading to social acceptance can be understood in reference to the theory of engagement (refer to box 4).

However, before discussing the very specific details of the engagement methodology and the specificities of the multi-criteria evaluation tool, it is worthwhile pointing out that the very simple fact that engaging stakeholders in activities in relation to the project will contribute to the creation of favourable conditions for social acceptance, as explained by the theory of commitment (refer to box 4).

Why does engaging stakeholders help in gaining social acceptance? What are the psychological mechanisms that are at stake? How does one frame an engagement strategy for maximum efficacy? The two theories mentioned above can help answer these questions. They are quickly presented below with this in mind.

Box 4: The theory of Commitment and the theory of Engagement

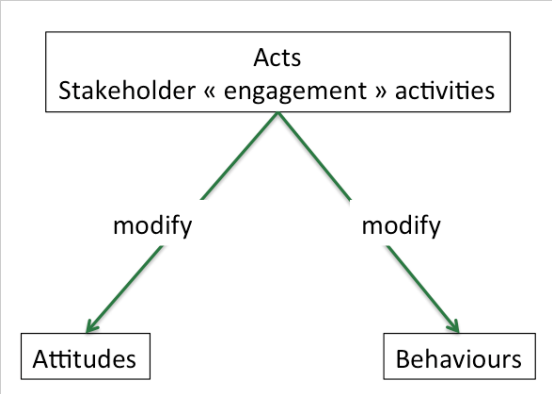
The theory of Commitment

"I don't sing because I'm happy; I'm happy because I sing" - William James

The Theory of Commitment gives an original answer to the question of how to get people to change their attitudes, ideas and behaviour. Indeed, it offers an alternative to the direct exercise of authority or persuasion, both of which have their limitations.

The idea here is to get people to perform certain acts, which may seem trivial, but that will result in getting them to think and act differently in the future. In this context, acts are not derived from ideas but precede them. Such acts generate changes in attitude and in behaviour.

The first definition of commitment comes from Kiesler and Sakumura (Kiesler, C., Sakumura, J., 1966): "Commitment is the pledging or binding of an individual to behavioural acts." What's interesting in this definition is that it firstly addresses the act; it is not the ideas or the beliefs that create commitment, but the act.



The level of commitment varies with the sense of freedom one has when performing the act, the number of commitment acts, and the characteristics of the commitment act (public or private, reversible or irreversible, costly or not).

The effects of the commitment act can be inferred using, for instance, Cognitive Dissonance Theory (see box 3). Indeed, if the act brings some level of dissonance to the cognitions, strategies to reduce this dissonance will be put in place, such as (1) rationalization strategies through the addition of consonant items or the minimization of the importance of dissonant items, or (2) the reduction of the importance of dissonant items through a modification of attitudes and behaviours.

In our context, it is assumed that stakeholder engagement—first in the definition and the discussion of project design and implementation options, then in the implementation of the selected options—will create commitment and consequently modify stakeholders' attitudes and behaviours towards greater support for the project.

The theory of Engagement

The theory of Engagement comes from the field of education and more specifically, relates to technology-based teaching and learning. “The fundamental idea underlying engagement theory is that students must be meaningfully engaged in learning activities through interaction with others and worthwhile tasks. While in principle, such engagement could occur without the use of technology, we believe that technology can facilitate engagement in ways, which are difficult to achieve otherwise. So engagement theory is intended to be a conceptual framework for technology-based learning and teaching.” (Kearsley, G, Schneiderman, B, 1999)

“Engagement theory is based upon the idea of creating successful collaborative teams that work on ambitious projects that are meaningful to someone outside the classroom. These three components, summarized by Relate-Create-Donate, imply that learning activities:

- Occur in a group context (i.e., collaborative teams)
- Are project-based
- Have an outside (authentic) focus

“The first principle (the "Relate" component) emphasizes team efforts that involve communication, planning, management and social skills” (Kearsley, G, Schneiderman, B, 1999). A collaborative environment such as a focus group forces participants to clarify and verbalize their opinions and concerns, facilitating consensus building. Furthermore, teamwork with participants from different background and perspectives fosters the understanding of diversity and the acceptance of different perspectives.

“The second principle (the "Create" component) makes learning a creative, purposeful activity” (Kearsley, G, Schneiderman, B, 1999). Participants have to consider a specific project context and identify solutions (project options) according to that very specific context, while taking into account a series of multiple constraints. These conditions further foster consensus building regarding acceptable conditions by framing the creative potential of each participant.

“The third principle (the "Donate" component) stresses the value of making a useful contribution while learning. Ideally each project has an outside "customer" that the project is being conducted for” (Kearsley, G, Schneiderman, B, 1999). Here the “customer” can be of a different kind, depending on the topic which is considered and debated: it can be society at large if CCS is considered, or local communities when discussing storage safety issues or local economic development

4.2. Methodology

"A genuine dialogue is much more important than education - to give the Public the opportunity to provide feedback" (Derek Taylor (CCSNetwork.eu, 2012)).

Objective of the task

To provide a guidance methodology and analysis framework to organize the stakeholder engagement strategy, in order to build consensus-based options for the CCS projects.

This section introduces the stakeholder engagement methodology and puts it directly in the context of the ULCOS CCS project, building on the results of the analyses conducted during the Social Site Characterisation phase. It starts with a general overview of the methodology and continues with detailed discussions of each implementation steps.

4.2.1. Introduction to the methodology

The methodology involves all project stakeholders in the definition of possible versions of the project, called **project design or implementation options,** in short **options** or **scenarios**. It is expected that these group discussions will help build a consensus on the project option that best meets the acceptance criteria. This process can be implemented through the following steps:

- Design and organisation of the Focus Groups, based on stakeholders' interests and concerns;
- Identification of project design and implementation options by the project developer and external project stakeholders;
- Agreement on a basic set of performance evaluation criteria, which corresponds to the different categories of project implementation issues (strategic issues);
- Assessment of the performance of the different options using Multi-Criteria Analysis (MCA) evaluation techniques;
- Comparison of these options (or scenarios), graphical display of results and discussion.

These various steps are displayed in the Figure below.

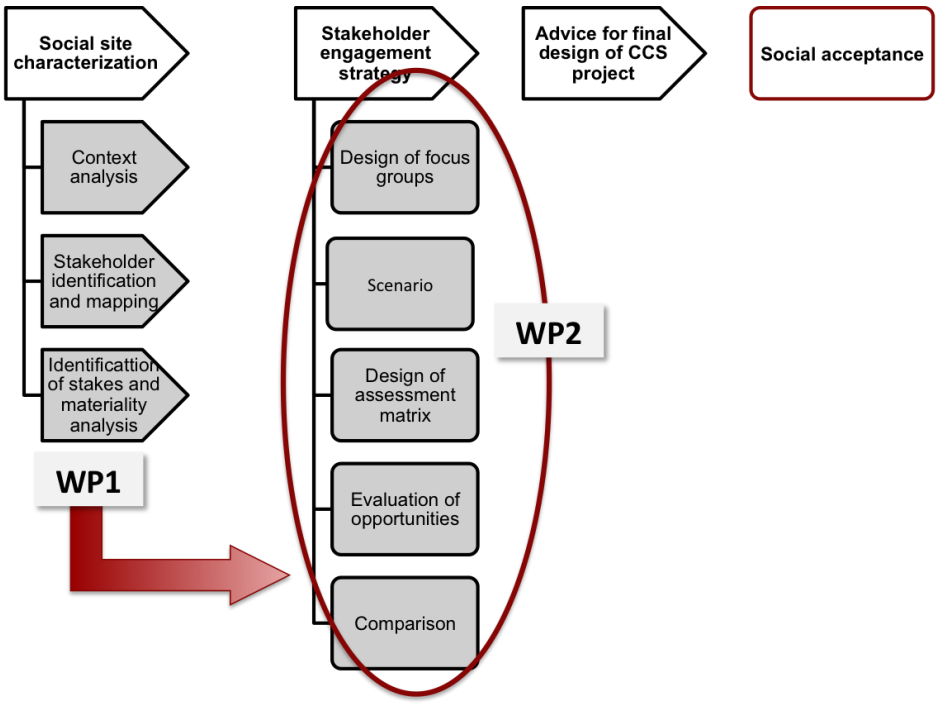


Figure 34: Stakeholder engagement follows Social Site Characterisation as part of an overall strategy to foster social acceptance

This process is expected to foster the achievement of a consensus on acceptable conditions for project implementation, by applying the key communication rules that were identified above:

- The process of project design option evaluation and comparison allows stakeholders to make their preferences and expectations clear. It particularly addresses engagement rules **R1** and **R2.**
- A vital aspect of the proposed methodology for public engagement is the assurance that the project developer will consider and evaluate any suggestions that a stakeholder makes, according to rule **R2.**
- Social acceptance is not only a matter of communication. Social acceptance requires local stakeholders to be involved in a proactive process. It requires that stakeholders feel confident that their concerns will be heard, and that it will always be possible to discuss the project's technical specifications **R3.**

Axiom 2

The clarification of stakeholder preferences through an agreed-upon evaluation process provides a means to compare options and foster dialogue between stakeholders with different points of view and sensitivities.

Furthermore, the use of a common set of criteria, accepted by all, for the evaluation of the performance of each project option makes it possible to have objective discussions, thus favouring consensus building and helping to contain opposition.

A preliminary simulation of the stakeholder engagement process may be required to adjust the evaluation framework, to test the ability of the focus groups to handle the evaluation tools and to build confidence. Simulated, actual and operational stakeholder management leads to a higher acceptance of CCS projects.

Finally, the better the preparation of the evaluation framework supporting the engagement strategy, the better the buy-in of the different parties for the project deployment will be.

4.2.2. Design of Focus Groups

A focus group is essentially a group of people assembled according to certain characteristics for a moderated discussion. Focus groups are usually set up for qualitative research. Focus group design depends on the project or research characteristics and objectives, and combines the use of qualitative and quantitative methods.

In this particular case and for illustration purposes, groups are formed according to the section of the CCS chain being considered (Capture, Transport and Storage). A finer segmentation could be adopted for the actual engagement phase, for instance accounting for the main concerns that stakeholders have (e.g. environmental or socio-economic issues). The strategy for group forming generally depends on the results of stakeholder identification and mapping tasks.

Axiom 3

Focus groups are defined according to the stakeholders' geographical location and type of concerns, to create dedicated and peaceful places for exchanging and openly expressing opinions, even though stakeholders may lack information or understanding about the project.

Each focus group is a mix of public actors, economic actors, civil society organizations and local communities.

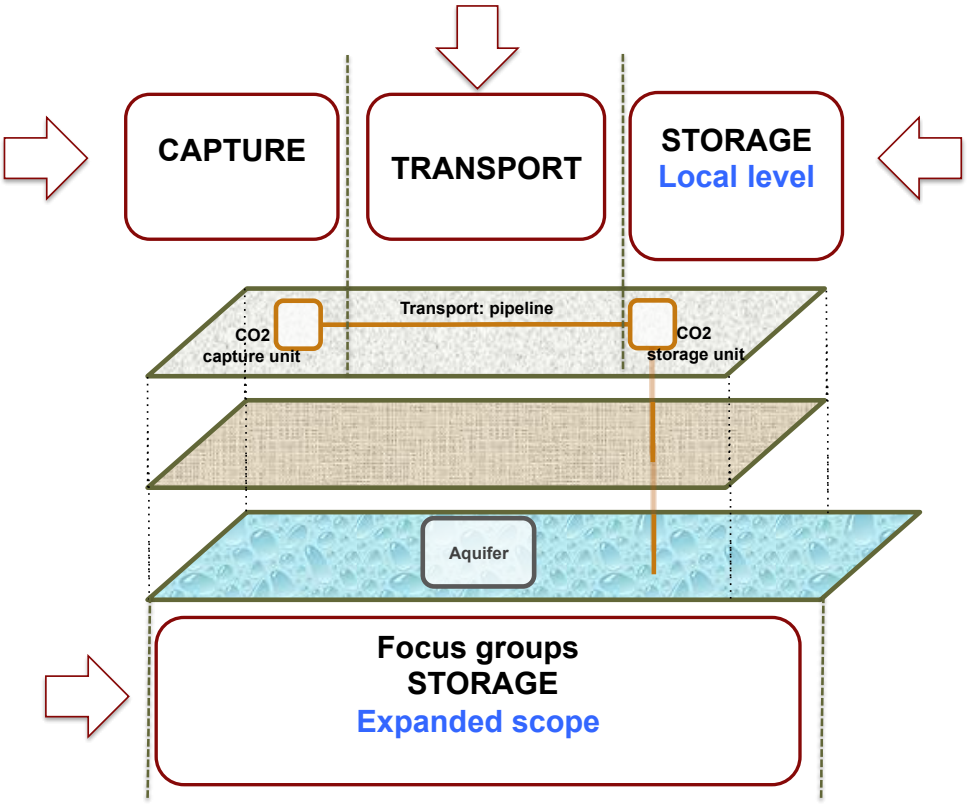


Figure 35: Focus groups organization according to CCS project components

As shown in Figure 35, the storage component is divided into 2 distinct series of focus groups because storage concerns both local issues (the storage surface and subsurface infrastructures) and wider issues due to the aquifer's geographical characteristics.

The composition of focus groups should be kept flexible. Other stakeholders could be integrated into the focus groups as the project progresses, such as those not identified during the prior mapping stage or identified but with hidden beliefs.

The credibility of information sources

At first, basic information about the project and the technology should be provided to all participants, in a form that is adapted to their level of knowledge and understanding. Such information can be delivered through a mixture of formats and styles: formal, informal, technical and simple (Desbarat J. & al., 2010). The choice of sources for these messages is important (Derek Taylor (CCSNetwork.eu, 2012)). When possible, credible sources should be used, for instance documents originating from scientists or NGO's rather than industrial sources. It should also be kept in mind that people tend to consider friends and family as more trustworthy than "official" sources (though probably less accurate) and they tend to believe that information gathered on internet or in social networks such as Facebook is more reliable because more independent than a leaflet pushed under their door (CCSNetwork.eu, 2012).

Communication within focus groups and moderator characteristics

Careful attention must be paid to communication within the focus groups (Chapman A., Quevauvillier P. de Lange W.J., Vervier P., 2010) (Prangnell M., 2013). Each participant should be allowed to express his concerns and opinions, following communication rules R1 and R2. The quality of the communication strongly relies on the quality of the moderator.

For each focus group category, the moderator has to be credible, charismatic and sincere, to set the required level of trust and confidence. He/she needs to be an excellent listener in order to maintain and achieve an effective engagement. Moreover, scientific and technical knowledge is required to

facilitate focus groups activities, as are communication skills to enable the clear presentation of facts and figures and to allow the participants to express their different point of views and to be heard. The moderator must know how to deal with possible conflicting points of view while maintaining a positive working relationship with all parties.

Finally, the focus group moderator must come across as neutral (independent) in order to create an environment that fosters stakeholder commitment. Even if perfect neutrality is difficult to achieve, the stakeholders must feel that they can express themselves freely in order for them to have a positive perception of the engagement strategy.

However, as underlined in the CCS engagement strategy analysis, communication alone cannot guarantee a successful stakeholder engagement process. While good communication provides the essential technical base for a successful project, it must be part of a structured process for the stakeholder engagement to be fully effective.

Dealing with hostile participants

Particular attention must be paid to hostile participants since they can focus the attention of the majority and crystallize conflicts around specific topics. They should not be authorized to monopolize the floor. If their attitude is detrimental to the proper functioning of the group, they should be asked to leave.

During the discussions, their arguments should be brought into the open, even before they publically take position, to show that the project proponent does not deny some of the negative impacts of the project.

The refusal of stakeholders that are opposing the project to participate in focus groups should be acknowledged, and other engagement means should be pursued, for instance on a one-to-one basis. In any case, these stakeholders should be kept informed of the engagement process progress and be welcomed to join, providing they respect the basic principles of a democratic debate.

The role of experts

The involvement of experts who are perceived to be independent can help to create a trusting environment. As mentioned above, people not familiar with the project technology usually considered experts as trustworthy sources of information. Furthermore, their answers to the concerns that communities will doubtlessly raise—for instance about the risks of storage operations—will bring weight to the debate.

4.2.3. Definition of project options (or scenarios)

A preliminary list of possible project options is made by the project developer, which may be further extended during discussions in Focus Groups. These options can concern any aspect of a project and different levels of alternatives can be possible for each component (Capture, Transport or Storage):

- If different high-level technical options can be envisioned for each component (as shown in the following figure, (adapted from (SBC Energy Institute, 2012)), the discussion may focus on the advantages and drawbacks of these options. However, in that case, it is likely that the criteria of choice will be techno-economic.

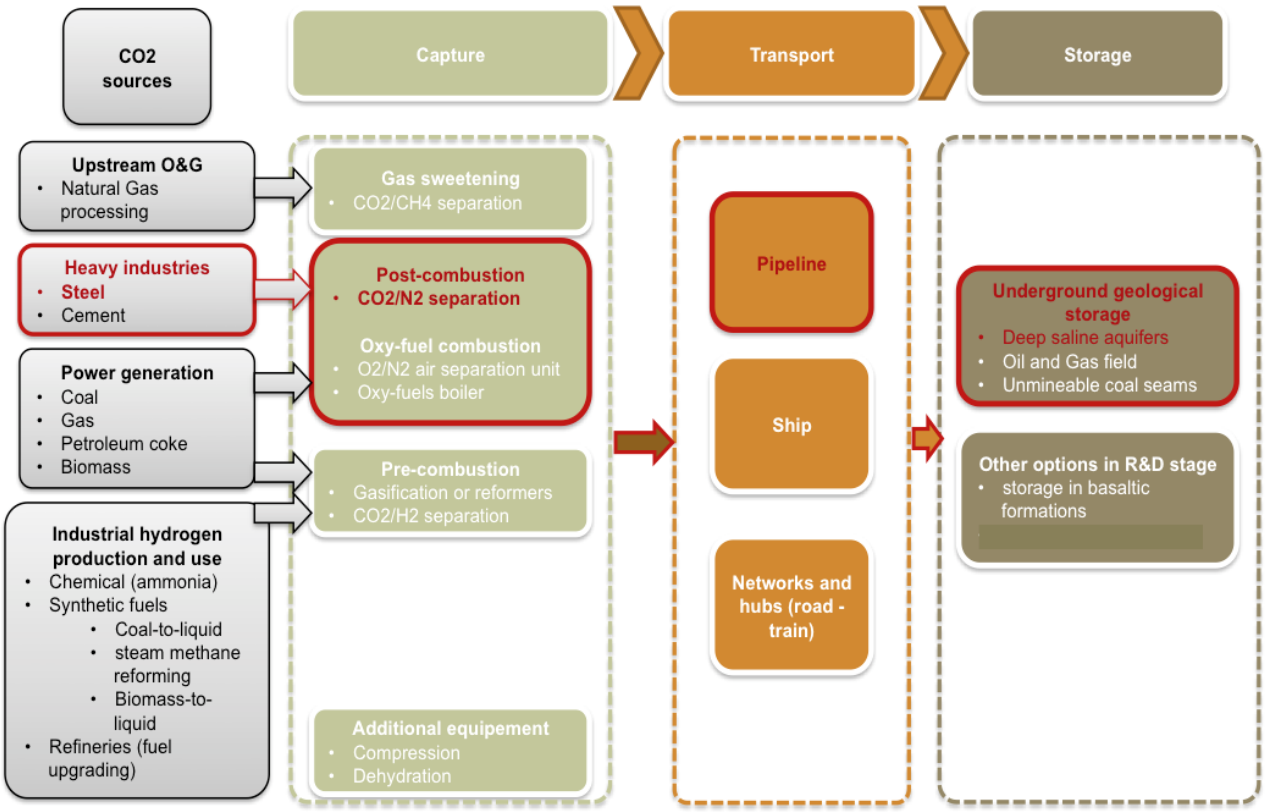


Figure 36: High-level options for Capture, Transport and Storage, for CCS project implementation

- If only one technical option is considered, as in the case of the ULCOS CCS demonstration pilot (highlighted in red in the figure above), discussions may focus on the best way to design and implement it.

Below is a list of possible options for the three components (Capture, Transport and Storage), adapted from (Holloway S. & Al, 2006) to the context of the ULCOS project.

Capture: If technical alternatives exist, it may not be relevant to discuss them in the focus groups because the project developer's strategic choices may not be modifiable. Options for Capture are mainly internal technological choices that are based on techno-economic criteria.

- SC1: Absorption
- SC2: Adsorption
- SC3: Membrane
- SC4: Other option

Transport: Pipeline transportation options could be collectively discussed if length, depth, materials, ecological impacts, safety for communities and so on can be adjusted by the project developer in its technical specifications. Options could be:

- ST1: Pipeline options

  a- Preferred land status for pipeline route: private ownership
  b- Preferred land status for pipeline route: public land
  c- Preferred land status for pipeline route: mix options
  d- Pipeline depth: < 1meter
  e- Pipeline depth: > 1meter
  f- Chemical treatments to control corrosion of pipeline
  g- Supervisory control and data acquisition system
  h- Intermediate compressors on pipeline route

- ST2: Road options
- ST3: Train options

Storage: Storage alternatives are important and must be discussed in the focus groups, particularly regarding their potential socio-economic and environmental issues.

- SS1: Medium depth (1000 meters)
- SS2: Deep storage (more than 1000 meters)
- SS3: Safety barriers to ensure containment of fluids (e.g. prevention of leakage toward the exploited part of aquifer)
- SS4: Multiple injection points
- SS5: Other options

Focus groups inputs

The pre-list of possible options is first amended or completed by experts, before stakeholders are asked to modify or add more options during initial focus group discussions. All options or scenarios should be considered, regardless of their technical feasibility or economic viability.

4.2.4. Design of assessment matrixes

The next step consists of deciding on sets of criteria to evaluate how well project design and implementation options address each of the strategic issues that have been identified.

4.2.4.1. Agreement on strategic project issues

Project-related issues are classified in three main categories, for each component:

- **Techno-economic issues**, corresponding to the technical feasibility and the economic viability of the project. These issues are mainly of concern to the project developer since it has expertise in the technologies to be deployed.
- **Environmental issues,** related to the impact of project operations and implementation (during characterisation, construction, operation and closure phases) on the quality of the ecosystems (biodiversity, hydrology, air, soils, etc.).
- **Socio-economic issues,** related to the impact of project operations and implementation on the living conditions of local populations.

An initial list of strategic issues comes from the materiality analysis, at least for Environmental and Socio-economic issues. This list can be further revisited during the engagement of stakeholders in focus groups. The table below shows the initial list of the most material issues for each category of issues and for the three components (Capture, Transport and Storage). This table is adapted from table 23 in 3.3.1.1.

Categories of strategic issues	***Strategic issues***	***Description***	***C***	***T***	***S***
Environmental	Local impact	Environmental impact of operations at the storage site			X
		Environmental impact of CO_2 releases from the storage complex			X
		Environmental impact of the CO_2 transportation pipe		X	
		Long-term storage evolution			X
		Contribution to climate change mitigation	X	X	X
	Global impact	Development of an environmentally friendly steel industry	X	X	X
	Environment & tech	Impact of a CO_2 transportation pipe failure on populations		X	
Socio-Economic (Society and Communities)	Health and safety of population	Impact of CO_2 releases on the population's health		X	X
		Impact of a resulting seismic event			X
		Preservation of industrial activity thanks to innovation and modernization	X		
	Local economic development	Job preservation (capture site)	X		
		Job creation (storage site)			X
		Development of local competitiveness and appeal	X	X	X
		Image of Meuse (France's garbage can)			X
	Local social and cultural impact	Improvement of the image of the Lorraine region	X	X	X
		Loss of property value (Meuse)			X
		Preservation of the cultural heritage (Verdun battlefields)			X
		Fair distribution of social costs and benefits		X	X
	Social equilibrium	Demonstration of CO_2 capture technology for the steel industry	X		
Techno-Economic (Industrial sector, company and project)	Project techno-economic feasibility	Demonstration of CO_2 storage feasibility			X
		Project economics and financing	X	X	X
		Research opportunities	X		X
		Reputation (leadership, green, responsible, etc.)	X	X	X
	Project owner company image	Quality of project management	X	X	X
	Quality of operating practices	Workforce health & safety	X	X	X
		Compliance	X	X	X

Table 25: Initial list of material issues for each category and for the three project components (Capture-C, Transport-T, Storage-S)

This suggested list is obviously not exhaustive but instead covers the main concerns raised by stakeholders for the ULCOS project. Indeed, specific issues can arise according to local specificities[35].

4.2.4.2. Agreement on performance criteria

Focus groups must then decide on a set of performance criteria to assess how well a specific option addresses each issue that is considered as strategic. These criteria are not defined from scratch but stem from approved materials derived from the results of the social site characterisation phase, the identification of the issues and the materiality analysis, as well as from the project developer's expertise in dealing with all of the project's technical aspects.

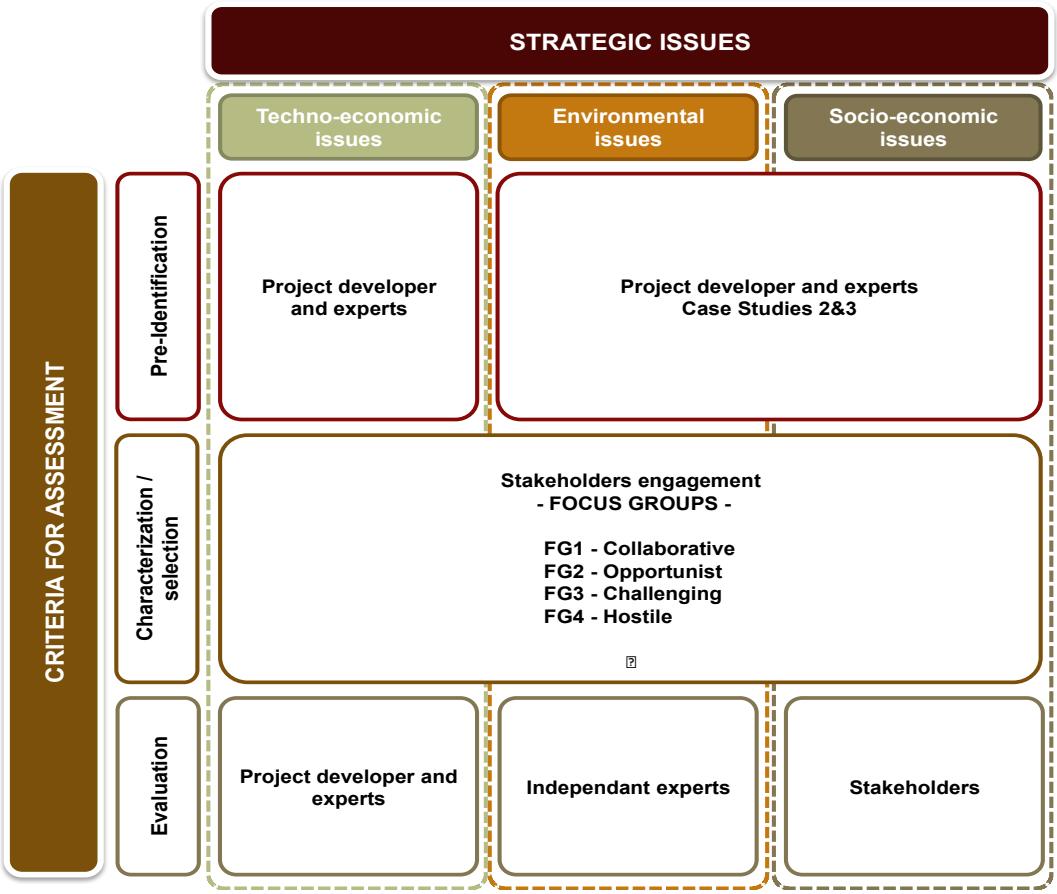


Figure 37: Selection and evaluation of assessment criteria – who does what?

Assessment criteria are discussed and potentially adjusted during focus group discussions, to come up with a set of agreed-upon criteria that will later be used to evaluate all options. The evaluation process will be assigned to different kinds of stakeholders that are considered to be experts in each category.

The assessment matrix basically documents all performance criteria or indicators for each issue. These matrixes are established for each project option. Examples are given in the next section.

[35] For instance for the Lacq project (run in south west of France by Total) the impacts of the project on wine growing activities was one of the discussed issues (Minh Ha-Duong & Al [CIRED/CNRS & APESA], 2010).

4.2.5. Evaluation and Comparison of Options

The option evaluation and comparison process can start once an agreement has been reached on:

- A complete list of project design and implementation options
- A complete list of strategic issues
- Different sets of performance criteria to assess how well a specific project option addresses these various issues.

This process will be iterative and should lead to a formal validation of the evaluation of each option or scenario. This process allows the group(s) to evolve towards a consensus on the optimum conditions for project implementation.

4.2.5.1. Evaluation of CCS project options

As shown in Figure 37, the responsibility for assessing strategic issues is distributed among stakeholders, depending on the category of issues, namely among the 3 main categories and the main actors:

- **Techno-economic issues** are evaluated by the project developer;
- **Environmental issues** are evaluated by the experts;
- **Socio-economic issues** are evaluated by the focus groups.

Each performance criteria is scored from 0 to 10, and the assessment matrix represents the outcome of the performance assessment of each option. An example of an assessment matrix for the storage component is given below, using the following index convention:

Component	Category of strategic issue
SIC for capture	**1** for Techno-economic issues
SIT for transport	**2** for Environmental issues
SIS for storage	**3** for Socio-economic issues.

Table 26: Index convention for component and issue categorisation

				SCENARIOS				
	PROJECT COMPARTMENT: STORAGE (local level)			SS 1	SS 2	SS 3	SS 4	SS 5
Project Developer	SIT	1	Technico-Economical Strategic Issues					
		SIT*	1.1					
		SIT*	1.2					
		SIT*	1.3					
Experts	SIT	2	Environmental Strategic Issues					
		SIT*	2.1					
		SIT*	2.2					
		SIT*	2.3					
Focus Groups	SIT	3	Socio-Economical Strategic Issues					
		SIT*	3.1					
		SIT*	3.2					
		SIT*	3.3					

Figure 38: Assessment matrix for project options (scenarios) evaluation – the example of the storage component (local level)

Scores are stored in these matrices and are later used to compare the performance of the different options, after some numerical computation.

4.2.5.2. Comparison of the CCS project options

Comparisons are run independently for each section of the project. For each specific project option, the importance of the three main strategic issues (techno-economic, environmental, socio-economic) is assessed on a ternary diagram.

Results are presented graphically, using a representation that makes it possible to identify and compare the evaluated options or scenarios, each of them being represented as a circle placed on a ternary diagram. Two global attributes are used to assess the global performance of each option in addressing the different strategic issues. These two attributes are also displayed graphically. They are:

- The **Equilibrium** attribute**,** represented by the location of the centre of the circle on the ternary diagram.

If the three categories of issues are equally addressed, the centre of the circle is located close to the centre of the triangle. If a circle's centre is close to one of the corners, it means that the corresponding category of issues outweighs the other two categories. This chart makes it possible to evaluate to what extent the various options are balanced with respect to the three main categories of strategic issues.

- The **Global performance** attribute**,** represented by the size of the circle

The size of the circle provides information on the global performance of an option. If two circles are centred on the same spot, the size of the circle specifies which is the best option: a bigger circle indicates a better global performance.

Results are displayed as follows, for performance evaluation purposes and the comparison of options (three scenarios have been considered in this fictitious case, for each section of the project).

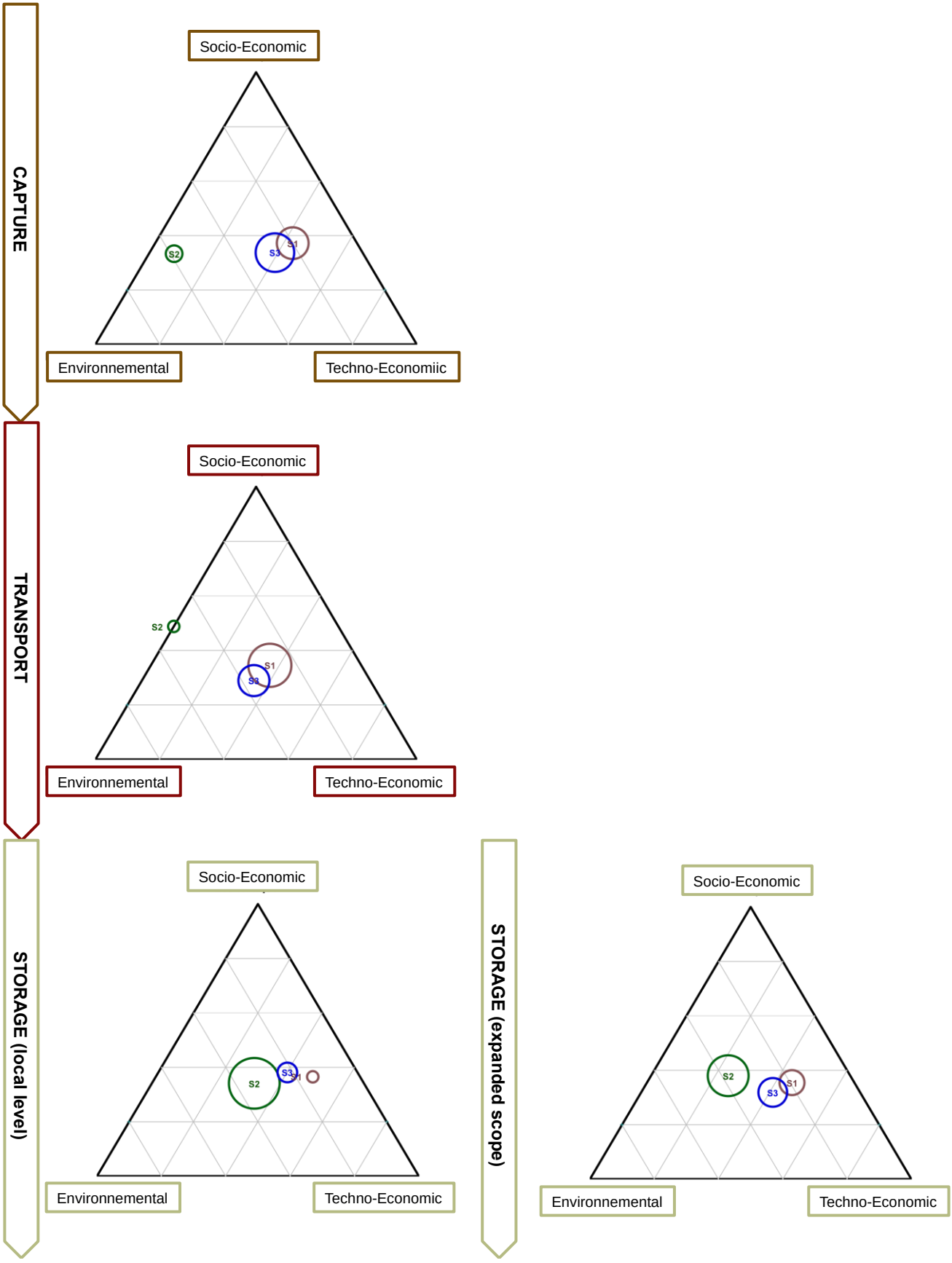


Figure 39: Graphical comparisons of the performance of project options for different CCS project component (circles represent assessed scenarios)

4.2.6. Presentation of the evaluated scenarios

The final step involves organizing a general meeting with the entire stakeholder community to present the evaluation and the comparison of the different project options, and to obtain a common understanding and validation of the results. The graphical display of all the results enables stakeholders to check and compare the performance of their own preferred options with regard to other options.

Final stakeholder acceptance relies on each party's ability to disentangle and elucidate preferences through science-based assessment and comparison, based on jointly established rules.

For each component, this comparison step enables the project developer to adjust and further develop its project implementation strategy, possibly adjusting some of the project options towards a better performance in addressing project issues.

Beyond the simple graphical representation, quantitative indicators can help clarify the comparison of options, providing the project developer and project stakeholders with robust information representing the perceptions and opinions of the whole stakeholder community. These are:

- **Partial evaluation indicators**: for a formal comparison of the performance of an option with respect to different categories of strategic issues;
- **Global performance attribute**: based on the combination of partial performance scores, it provides general information on the ability of an option to address all strategic issues;
- **Equilibrium attribute**: reflects the ability of an option to equally address the different categories of strategic issues;
- **Global ranking**: an overall comparison indicator based on the combination of the global performance score & the global equilibrium score.

4.3. Results – Simulation of the stakeholder engagement process

A simulation of the stakeholder engagement process was carried out to check the adequacy of the methodology for the specific case of the ULCOS project. Other more technical objectives were:

- To amend and detail the prerequisites for comparison (options and criteria)
- To pre-select the most accurate and coherent options for the full deployment of the methodology.

This simulation run took place during a work session that included members from the Global CCS Institute, ArcelorMittal, Acceptables Avenirs, ENEA Consulting and Actys-BEE. Only the storage component was taken into consideration.

4.3.1. Preliminary Steps

The initial steps involved setting up the focus groups and agreeing upon a list of project options, strategic issues and evaluation criteria to assess the performance of the project options in addressing the strategic issues.

4.3.1.1. Focus Groups

Due to the limited number of participants, only one group was constituted and each participant was asked to take the role of a key project stakeholder (project developer, local NGOs, administration representative, local community, etc.).

4.3.1.2. Storage options

An initial list of storage options was further extended during initial group discussions, capitalizing on the participants' expertise and knowledge of the local technical context. The additional options provided by the group are listed in green here below (modifications and additional proposals). Finally, all of the 12 storage options were considered and assessed.

- *SS1: Medium depth (around 1000 m)*
- *SS2: Deeper storage solution (> 1000m)*
- *SS3: Safety barriers to ensure containment of fluids (Prevention of leakage toward the exploited part of aquifer)*
- *SS4: Research and education platform*
- *SS5: Technical monitoring of CO2 losses survey*
- *SS6: Stakeholder participation in the design of the CO2 losses monitoring system*
- *SS7: Long-term operator liability (> 60 years)*
- *SS8: Reversible storage*
- *SS9: Multiple storage complex*
- *SS10: Injection without rock fracturing*
- *SS11: Participation of stakeholders in project management*
- *SS12: Long-term trapping efficiency*

Table 27: List of options selected for the simulation exercise

Storage option performance criteria

An initial list of criteria was proposed, which was again extended during the initial focus group's discussions (additional criteria are in green). Only 3 criteria were finally selected for each category of

issues in order to conduct the evaluation of the options: these criteria are marked with a "*" in the table below.

Categories of strategic issues	***Assessment criteria***
Environmental	* SIS2.1: Environmental quality* a- Water quality b- Biodiversity quality * SIS2.2: Contribution to climate change mitigation* * SIS2.3: Fugitive CO_2 losses - exposure for environment* SIS2.5: Other
Socio-Economic	SIS3.1: Perception of risks exposure * SIS3.2: Impacts on water uses* SIS3.3: Loss of property value * SIS3.4: Impacts on health and safety for population* SIS3.5: Image of Meuse * SIS3.6: Local economic impact* SIS3.7: Conflicts between surface and subsurface soil uses SIS3.8: Allocation of positive and negative effects between different locations SIS3.9: Compensation for negative effects
Techno-Economic	* SIS1.1: Investment costs (additional costs)* a- Site screening and evaluation costs b- Well injection costs c- Injection equipment costs d- Liability protection costs e- Well closure costs SIS1.2: Pore space acquisition SIS1.3: Operation and maintenance costs a- Surface maintenance costs b- Subsurface maintenance costs * SIS1.4: R&D needs* SIS1.5: Workforce health and safety * SIS1.6: Cost-effectiveness (CO_2 prices and economic context) *

Table 28: Table of strategic issues and evaluation criteria

4.3.2. Evaluation of the storage options

Expert evaluators were then selected for the different categories of issues:

- **Techno-economic issues**: evaluated by the project developer (1 person)
- **Environmental issues**: evaluated by experts (1 person)

- **Socio-economic issues**: evaluated by stakeholders (2 persons representing communities)

The evaluation of each option was then performed. Results are given below:

SCENARIOS	Medium depth (around 1000 m)	Deeper storage solution (> 1000m)	Safety barriers to ensure containment of fluids	Research and education plateform	Technical monitoring of CO2 losses survey	Participation of stakeholders to design the monitoring system of the CO2 losses
CRITERIA	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**
investments costs (additional costs)	10	5	3	9	9	8
R&D needs	5	5	7	8	5	6
Cost-effectiveness (CO2 prices and economical context)	10	5	3	10	10	8
Environmental quality	5	10	10	10	10	10
Fugitive CO2 losses exposure for environment	3	8	9	9	8	10
Contribution to mitigation of climate change	5	5	6	3	8	10
Impacts on water uses	7	9	10	9	10	7
Impacts onf Health and security for population	10	10	10	8	9	5
local Economic effects	5	5	6	10	8	6

SCENARIOS	Long term operator Liability (> 60 years)	Reversible storage	Multiple storage complex	Injection without rock fracturing	Participation of stakeholders to the project governance	Long term trapping efficiency
CRITERIA	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**
investments costs (additional costs)	2	1	3	3	2	5
R&D needs	5	7	6	6	5	7
Cost-effectiveness (CO2 prices and economical context)	2	2	4	4	2	5
Environmental quality	10	5	5	9	10	10
Fugitive CO2 losses exposure for environment	10	5	5	10	10	10
Contribution to mitigation of climate change	10	5	5	10	10	10
Impacts on water uses	8	5	5	10	8	9
Impacts onf Health and security for population	10	4	3	8	4	8
local Economic effects	10	5	8	5	5	5

Table: Assessment matrix for the different storage options (scenarios)

After analysis, the scores attributed to each criterion for each storage option provide all the necessary information to compare the different storage options.

4.3.3. Comparison and Discussion

4.3.3.1. Comparison

After numerical treatment, storage options are compared according to two distinct attributes:

1. **Equilibrium: illustrates the propensity to balance the three strategic issues**

2. **Performance: informs on the ability to comply with strategic issues**

For each storage option, the ternary plot presented below shows a synthetic vision of these 2 attributes.

The size of the circle provides information on the global performance of the option and the location of its centre provides information on how well the option addresses the three categories of issues.

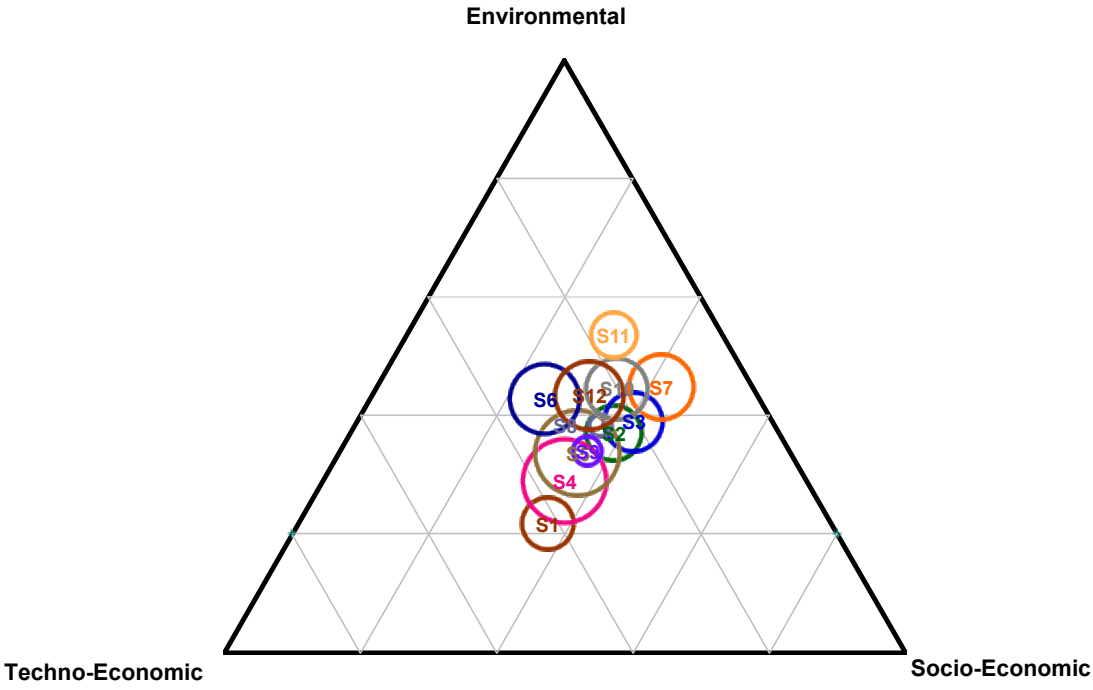


Figure 40: Comparison of the storage options

4.3.3.2. Interpretation

The objective of the interpretation phase is to pre-select the options that best address the three categories of issues, and are thus likely to satisfy both the project developer and external project stakeholder criteria.

First-level interpretation

Given the relative positioning of the circles representing the different options, some appear inadequate due to a lack of equilibrium and/or global performance.

Storage options	lack of performance	lack of equilibrium
SS1: Medium depth (around 1000 m)	x	x
SS2: Deeper storage solution (> 1000m)		
SS3: Safety barriers to ensure fluid containment (prevention of leakage toward the exploited part of aquifer)		
SS4: Research and education platform		
SS5: Technical monitoring of CO2 losses survey		
SS6: Stakeholder participation in the design of the CO2 losses monitoring system		
SS7: Long term operator liability (> 60 years)		x
SS8: Reversible storage	x	
SS9: Multiple storage complex	x	
SS10: Injection without rock fracturing		x
SS11: Stakeholder participation in project governance	x	x
SS12: Long term trapping efficiency		

Table 29: Analysis of the quality of the different storage options in terms of Performance and Equilibrium

Options marked in red do not require further attention and the process can focus on the remaining options. For these options, interpretation can be refined with a more in-depth look at the performance indicators.

Advanced interpretation

A quantitative analysis of options with the best equilibrium/performance levels provides additional information to better adjust the methodology.

The analysis is performed by classifying options by performance and equilibrium.

Storage options	performance rank	equilibrium rank	global rank
SS5: Technical monitoring of CO2 losses survey	1	1	1
SS4: Research and education platform	2	2	2
SS6: Stakeholder participation in the design of the CO2 losses monitoring system	3	4	3
SS12: Long term trapping efficiency	4	5	4
SS2: Deeper storage solution (> 1000m)	6	3	5
SS3: Safety barriers to ensure fluid containment (prevention of leakage toward the exploited part of aquifer)	5	6	6

Table 30: Analysis of the global quality of the different storage options

This sample provides an operational overview of the options that are most likely to match the basic requirements to satisfy both the project developer and the external project stakeholders.

4.3.3.3. Discussion

As previously underlined, the coherence of the evaluation framework (scenario list and assessment criteria) is a preliminary condition to run a successful engagement strategy. On this basis, stakeholders can consider the most appropriate options to discuss, which increases the likelihood of successful outcomes from the engagement strategy process.

In essence, using this methodology, the pre-selected sample of options is consistent with the techno-economic, environmental and socio-economic realities of the situation.

The project developer can thus take into consideration the different best-scored options to adjust the final project implementation specifications.

From the options selected through the simulation process, some options are shown to be relevant and should be further considered, although all option combinations may not be possible because of technical incompatibilities or inconsistencies. In our case, the options to be considered because they lead to favourable conditions are:

- SS2: Deeper storage solution (> 1000m)
- SS3: Safety barriers to ensure containment of fluids (Prevention of leakage toward the exploited part of aquifer)
- SS4: Research and education platform
- SS5: Technical monitoring of CO_2 losses survey
- SS6: Stakeholder participation in the design of the CO_2 losses monitoring system
- SS12: Long-term trapping efficiency

Most of these options appear to be independent and complementary, although some level of compromise is inevitable.

If the project is intended to be a demonstration case with active stakeholder engagement, the options SS3, SS4, SS5 and SS6 should definitely be considered. If the project is intended to be a showcase for global warming mitigation, combinations of SS2, SS12 or SS5 should be preferred.

Regardless of the combination considered, the pre-selection phase ensures that the selected options are the most appropriate ones to deal with stakeholders concerns and engagement throughout the process.

Final observations on the simulation of the stakeholder engagement strategy

A few limitations should be kept in mind regarding the representativeness of a simulation exercise with a limited number of selected participants:

- Because the simulation process required that people play an “expert” role, the scores do not reflect what could have been obtained with “real” experts. The simulation was run to test the feasibility of the methodology for stakeholder engagement rather than to deliver correct results, as would be the case if the methodology were run in real conditions.
- The simulation process focused on the storage component only. In real conditions, the methodology should be run for each project component (i.e. also for capture and transport).

4.4. Lessons learned and recommendations

Identification of best options

The project developer acquires several options, allowing it to use the results based on its own priorities. Regardless of its choice, the project developer must comply with the stakeholder engagement strategy outputs to reinforce social acceptance.

This methodology is used to conduct the project's stakeholder engagement strategy, generating possible technical routes[36] for the full deployment of the CCS project by supporting its design and encouraging buy-in within a wide stakeholder community.

Given the project developer's priorities, technical routes were broken down into the following interests:

- Best options route
- Best overall performance route
- Best equilibrium route
- Best techno-economic route
- Best environmental route
- Best socio-economic route

Recommendations to strengthen social acceptance for an effective project implementation

Stakeholder engagement strategy outputs should help the project developer design its final CCS project specifications.

Social acceptance explicitly relies on stakeholder preferences, which are elicited through the engagement strategy.

Feedback from this simulation test could be considered as a cornerstone for the consistency of the methodology framework. Through this fourth process step, the project developer is able to run an effective stakeholder engagement strategy, which enhances social acceptance for a CCS project. Thus, it should facilitate the designing of technical specifications for a CCS project.

The hypothesis is that a collaborative process of identifying, evaluating and discussing options with stakeholders can lead to a consensus on a unified proposal for a CCS project, by giving all stakeholders the possibility to visualize in a synthetic way the consequences of the options they propose for the project. This hypothesis has been extensively tested and validated through other projects in different application domains that have more environmental and socio-economic issues (agricultural practices and water quality, hydromophological restoration programs, etc.).

The project developer obtains a roadmap for the acceptance of its project, allowing it to choose among options:

- With high scores: in this case, the project developer will have to act to fill the gap between its own expectations and the stakeholders' expectations
- With low or moderate equilibrium rank: the project developer will know precisely which stakeholders will be dissatisfied and the reasons for their dissatisfaction.

[36] A "route" refers to the sequence of the technical choices made by the project developer for each project component.

5. Conclusion

We have seen that the social acceptance of a project is the result of a process through which stakeholders together define the conditions that are needed to seamlessly integrate the project into a unique natural and human environment, at a given time. At the stakeholder level, acceptance is the result of a judgement process involving the evaluation of different design or implementation options (including the status quo) and a decision as to whether the acceptable conditions are met or not. If this is not the case, stakeholders may initiate behaviours, sometimes alone but often through interest groups, to shift these conditions towards more acceptable ones.

The term "project stakeholders" lacks clarity and homogeneity. Indeed, it includes people or organisations that are either actively involved in the project, have interests that may be positively or negatively affected by the performance or completion of the project, or, finally, may exert influence over the project, its deliverables or its team members. Because of these different kinds of relationships with the project, stakeholders must be carefully identified and their positioning with respect to the project carefully evaluated before any negotiation is engaged concerning the conditions or the options.

This report details a comprehensive methodological approach to move towards social acceptance. It includes two main phases: (1) social site characterisation and (2) stakeholder engagement. The objective of the social site characterisation phase is to characterise the project environment (or project context), identify and map the project stakeholders, and list the most material issues that matter to the project developer and the external stakeholders. It is followed by the stakeholder engagement phase, during which the conditions of acceptability are negotiated. This takes place during group meetings in which project design and implementation options are proposed, discussed and evaluated using a multi-criteria evaluation tool.

This methodology was tested for a real CCS project: the ULCOS project. However, since the project has been put on hold, the stakeholder engagement phase was not fully rolled out. Instead, it was simulated with a small group of experts, each playing the role of a key project stakeholder.

With respect to the social site characterisation and the stakeholder engagement phases, the key conclusions of this study are:

Project context analysis

This initial step makes it possible to develop a deep understanding of the main regional challenges, in particular those that are likely to influence the stakeholders' perceptions of the project. It also enables a preliminary identification of project stakeholders (people and organizations that may be impacted by project activities, local actors who may prove to be influential). Furthermore, comprehensive information on the local context helps the project developer show concern about the area in which it plans to operate, and account for local specificities when deciding on project options (at the design stage or during the operation phase).

Stakeholder identification and mapping

A comprehensive characterisation of the stakeholder base complements the project context analysis. The objective is to qualitatively and quantitatively evaluate the relationship that each stakeholder has with the project. The proposed 3-dimensional mapping technique, which is based on key concepts and theories of social psychology, has proven to be very effective in achieving this goal through the evaluation of stakeholder profiles, which can be interpreted as behavioural intentions towards the project. The identification of project issues or project-related stakeholders' concerns concludes this second step.

Materiality analysis of project issues

All stakeholders' concerns or issues cannot be dealt with and, hence, the focus should be on the most significant ones for efficiency purposes. The technique called "materiality analysis" should be used to this end. It makes it possible to identify "what counts and for whom", i.e. the main topics of

concern for the most important project stakeholders, including the project developer. This last step concludes the Social Site Characterisation phase.

Stakeholder engagement

Real stakeholder engagement is required to obtain support for the project or, at minimum, to avoid blockage. Indeed, it is assumed that the exercise of authority or persuasive communication are no longer appropriate in our societies, where stakeholders are increasingly asking to be involved in important decision-making processes, especially when these decisions have an impact on their environment, interests, safety or welfare. Therefore, a stakeholder engagement strategy must be established to properly deal with the issue of social acceptance. It is deemed necessary to propose some level of co-construction of the project design and implementation conditions, which requires group discussions and some kind of negotiation process. The format of this engagement phase must be carefully defined: the modes of engagement, the participation of independent experts, the information vehicles, etc. for maximum efficacy in creating the optimum conditions for an open debate.

As stated above, it was only possible to simulate the stakeholder engagement phase in a small group. Despite this, the deployment of the methodology, even in a limited context, brought some insights about its pertinence and efficacy. A collaborative process of identifying, evaluating and discussing options with stakeholders clearly helps reach a consensus on a unified proposal for a CCS project, by giving all stakeholders the possibility of visualizing in a concise way the consequences of the options they propose for the project. More specifically, the stakeholder engagement process simulation points out the following strengths of the methodology:

- The flexibility of the process that can be adapted to any socio-cultural, economic, political, environmental and technical environment, since the stakeholders have first agreed on a set of evaluation criteria relevant to the project.
- The ability to deal with the various project activities separately, mobilizing stakeholders according to their expertise and main concerns. This avoids the dilution of the energies involved.
- The opening of the evaluation process to ensure an effective involvement of stakeholders.
- The objectivity of the evaluation by mobilizing appropriate and accepted expertise, in order to develop a peaceful dialogue between stakeholders with different interests and sensitivities.
- The possibility of finding balanced solutions that meet the project's technical and economic constraints but that also satisfactorily address the environmental issues and the concerns of stakeholders.

Final stakeholder acceptance relies on the ability of all parties to disentangle and elucidate preferences through science-based assessment and comparison, based on jointly defined rules.

The work on stakeholder engagement should now focus on the capture and transport sections of the project, and the methodology should be fully deployed on a real CCS project for validation. The use of information technology would also help to automate the process and make it available to a larger number of projects.

This work has also left a few research questions, mainly about the definition of an optimum strategy for stakeholder engagement: How should focus groups be organized to achieve the best results? What are the best ways of conveying information about the project (sources, vehicles) to prepare for efficient and open debates? How to deal with hostile stakeholders? How to address stakeholders not willing to be engaged? Beyond expertise in communication, it seems that two fields of research can be called upon to contribute: the theory of engagement and the theory of commitment. That will be the subject of future work.

6. Annex

Table 3: Top 100 companies according to turnover
(Source: verfi.com and ENEA Consulting analysis)

Company Name	Code	City	Turnover
SOCIETE MECANIQUE AUTOMOBILE DE L'EST	57300	TREMERY	3 322 244 144 €
SOCIETE VEHICULES AUTOMOBILES BATILLY	54980	BATILLY	1 423 758 139 €
SAINT GOBAIN PAM	54000	NANCY	801 934 256 €
CONTINENTAL FRANCE	57200	SARREGUEMINES	684 281 558 €
CPE ENERGIES	54000	NANCY	634 106 053 €
ARCELORMITTAL CONSTRUCTION FRANCE	55800	CONTRISSON	462 479 462 €
ARCELORMITTAL GANDRANGE	57175	GANDRANGE	436 367 736 €
EMC2	55100	BRAS SUR MEUSE	420 686 993 €
ESKA	57130	JOUY AUX ARCHES	391 208 089 €
ALLIANCE REGIONALE EST APPRO	54000	NANCY	342 694 868 €
ARCELORMITTAL PROFIL	57970	YUTZ	338 183 624 €
POMPES GRUNDFOS	57740	LONGEVILLE LES SAINT AVOLD	321 842 170 €
FM FRANCE	57370	PHALSBOURG	291 129 239 €
COLAS EST	54000	NANCY	285 531 396 €
THYSSENKRUPP PRESTA FRANCE SAS	57190	FLORANGE	274 438 628 €
SCREG EST	54000	NANCY	272 846 326 €
MAXIMO	55840	THIERVILLE SUR MEUSE	260 744 236 €
COOPERATIVE AGRICOLE LORRAINE	54520	LAXOU	256 398 744 €
TATA STEEL FRANCE RAIL SA	57700	HAYANGE	255 013 646 €
LORRAINE CEREALES APPROVISIONNEMENT	57580	LEMUD	254 372 123 €
DEMATHIEU & BARD	57950	MONTIGNY LES METZ	239 844 128 €
PERTUY CONSTRUCTION	54320	MAXEVILLE	236 808 367 €
DELIPAPIER	54390	FROUARD	228 883 482 €

REHAU SA	57340	MORHANGE	226 500 531 €
TRW SYSTEMES DE FREINAGE	57320	BOUZONVILLE	210 621 134 €
UEM	57000	METZ	208 760 528 €
PROSIMO	57970	YUTZ	182 750 937 €
LORRAINE TUBES	54720	LEXY	181 355 069 €
VIESSMANN FRANCE	57380	FAULQUEMONT	181 137 805 €
FERCO	57445	REDING	177 070 391 €
BAILLY	57970	YUTZ	167 990 463 €
FRANCE TRANSFO	57280	MAIZIERES LES METZ	162 390 017 €
MEPHISTO SA	57400	SARREBOURG	160 365 427 €
INEOS CHAMPLOR SAS	55100	VERDUN	157 552 524 €
RECYLUX FRANCE	57000	METZ	157 481 985 €
PIERBURG PUMP TECHNOLOGY FRANCE SARL	57970	BASSE HAM	156 521 017 €
DLSI	57600	OETING	155 937 994 €
EIFFAGE TRAVAUX PUBLICS EST	54320	MAXEVILLE	153 428 480 €
JOHNSON CONTROLS SARREGUEMINES SAS	57200	SARREGUEMINES	150 759 322 €
EUROSTAMP	54920	VILLERS LA MONTAGNE	149 732 094 €
EUROVIA LORRAINE	57140	WOIPPY	144 032 614 €
ONYX EST	57230	BITCHE	130 242 042 €
COOPER STANDARD AUTOMOTIVE FRANCE	57150	CREUTZWALD	129 823 165 €
FIVES NORDON	54000	NANCY	122 857 350 €
UNION LAITIERE DE LA MEUSE	55100	BRAS SUR MEUSE	119 986 705 €
CROWN BEVCAN FRANCE SAS	54670	CUSTINES	116 659 785 €
SOC ACIERS D'ARMATURES POUR LE BETON	54230	NEUVES MAISONS	114 946 107 €
SOLORMAG SA	57100	THIONVILLE	114 506 949 €
VIESSMANN FAULQUEMONT	57380	FAULQUEMONT	107 015 596 €
CHAUSSEA SAS	54910	VALLEROY	106 318 148 €
NOVACARB	54410	LANEUVEVILLE DEVANT NANCY	105 384 966 €
ICF NORD-EST SA D'HLM	57000	METZ	104 648 777 €

BATIGERE NORD EST	54000	NANCY	103 840 636 €
REHAU INDUSTRIE SARL	57340	MORHANGE	103 469 974 €
SOCIETE DU JOURNAL L'EST REPUBLICAIN	54180	HOUDEMONT	103 446 597 €
FACTUM FINANCE	54520	LAXOU	102 500 358 €
OBLINGER	57400	BUHL LORRAINE	101 976 379 €
BATIGERE SAREL SA D'HLM	57000	METZ	99 467 125 €
BACCARAT	54120	BACCARAT	97 822 000 €
FROUDIS	54390	FROUARD	96 941 322 €
USINES CLAAS FRANCE SAS	57140	WOIPPY	96 587 468 €
BRASSERIE CHAMPIGNEULLES	54250	CHAMPIGNEULLES	95 536 742 €
SARREDIS	57400	SARREBOURG	93 102 950 €
4MURS	57155	MARLY	91 428 908 €
LACTO SERUM FRANCE	55100	VERDUN	91 164 214 €
BEHR FRANCE HAMBACH	57910	HAMBACH	90 727 251 €
SPIE BATIGNOLLES EST	54300	LUNEVILLE	89 807 725 €
APERAM STAINLESS SCE SOLUTION TUBE EUR	55170	ANCERVILLE	88 726 483 €
PHARMAGEST INTERACTIVE	54600	VILLERS LES NANCY	85 117 542 €
CLARION EUROPE S.A.S.	54670	CUSTINES	83 035 695 €
LEACH INTERNATIONAL EUROPE SA	57430	SARRALBE	82 453 093 €
EIFFAGE CONSTRUCTION LORRAINE	54320	MAXEVILLE	81 897 290 €
LONGLAVILLE PERFORMANCE FIBERS SAS	54810	LONGLAVILLE	81 488 179 €
LE REPUBLICAIN LORRAIN	57140	WOIPPY	80 016 893 €
METZDIS	57280	HAUCONCOURT	77 759 179 €
FONCIERE DES REGIONS	57000	METZ	77 715 684 €
SAS SAINTE BARBE	57800	FREYMING MERLEBACH	77 695 000 €
CROIXDIS	57150	CREUTZWALD	76 302 801 €
AKERS FRANCE	57100	THIONVILLE	75 777 328 €
CABLERIES LAPP SARL	57600	OETING	75 522 462 €
FIMUREX PLANCHERS	57140	WOIPPY	75 037 039 €
FIFAM	57290	FAMECK	73 941 199 €

COMPAGNIE ITALIENNE DE PRODUITS FRAIS	57000	METZ	73 817 268 €
SICAMO	57580	LEMUD	73 523 345 €
SA HABITATION A LOYER MODERE LOGIEST	57000	METZ	73 213 694 €
INTERPANE GLASS FRANCE	57455	SEINGBOUSE	73 174 048 €
JOHNSON CONTROLS CREUTZWALD SAS	57150	CREUTZWALD	72 376 234 €
VANDIS	54500	VANDOEUVRE LES NANCY	72 004 257 €
FICOMIRRORS FRANCE SAS	57260	DIEUZE	70 763 910 €
VERDUN DISTRIBUTION	55100	VERDUN	69 862 234 €
COOPERATIVE LORRAINE D'ELEVAGE	57420	COIN LES CUVRY	66 213 601 €
ETABLISSEMENTS GUERMONT WEBER	57050	METZ	65 892 768 €
F.V.M. TECHNOLOGIES	54920	VILLERS LA MONTAGNE	65 533 119 €
NOVASEP PROCESS	54340	POMPEY	63 319 363 €
SEMIN	57920	KEDANGE SUR CANNER	63 084 362 €
SOGEA EST B T P	54700	LESMENILS	62 008 304 €
PRONORD-EST	57100	THIONVILLE	61 939 077 €
POLYGONE TOMBLAINE	54510	TOMBLAINE	61 426 284 €
TPA	57160	SCY CHAZELLES	60 957 066 €
KS KOLBENSCHMIDT FRANCE	57970	BASSE HAM	60 488 016 €

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