From Social Acceptance to Socio-Technical Acceptance of Capture, Transport and Storage of CO 2 (CTSC) Technologies

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Abstract

Social Acceptance remains a key factor for the deployment of renewable energy infrastructures projects. However, we notice that in most of the cases, the aim of the social acceptance research is mainly focus on communication about this infrastructure. We think only in focusing on this aspect, these researches miss part of the social dimensions at stake in the acceptance of a technology. According to Sociology and Philosophy of technology's theoretical knowledge, we develop a new framework to take into account social dimensions involved in technologies implementations. In this section we mainly refer to CTSC deployment examples. We expose a critical point of view of previous surveys and then propose a new theoretical and heuristic framework in the implementation of CTSC technologies project.

Introduction

Social acceptance of renewable energy technologies remains a key factor to deploy these technologies on a large scale. However, a review of the literature about social acceptance of these technologies leaves us unconvinced about the definition of this notion. Regarding the research about social acceptance of Carbon, Capture Transport and Storage Technologies (CTSC), we found in each work a different illustrating indicator[1] to highlight what could be social acceptance of theses technologies. All these research works give us a lot of useful information about the social perception of CTSC, but they don't define clearly what social acceptance is. So how manage a key factor of renewable energy technologies deployment without a well scientifically defined concept?
In this chapter, we will try to go beyond previous research about social acceptance of CTSC in intending to apply a new theoretical framework to explore social dimensions involved in the implementation of CTSC technologies. We first analyse few case studies and the previous theoretical frameworks used in these social acceptance researches. Then, based on sociology and philosophy of technical artefact we criticize these approaches in showing their limits. Finally we define a new theoretical framework to reveal forms of acceptance in the implementation of CTSC technologies project.

1. Social acceptance's illustrating indicators: useful tools to communicate about a

[1] Economic acceptances, risk acceptance, trust in involved stakeholder, influence of the information, influence of the information media.

technology

As we noticed in the CSC social acceptance literature a huge number of indicators were used to study how these technologies could be accepted by the populations. However using such methods could leads to question the real aim of a social acceptance survey. Is it the understanding of what social acceptance for CSC technology is? Or to find the best tool to reach it? Therefore we assume that such surveys were often made to persuade people of the necessity of using such technological artefact. In the following words we will refer to CSC Social acceptance survey literature to illustrate our previous assertion, and focus on the several indicators previously used. This short literature review focus on the main survey made about CSC social acceptance but it is not an exhaustive review and other researches deal with this issue.

1.1. Economic indicator

Part of social acceptance literature focus on the acceptance of an electricity bill increase related to the use of renewable energy technology or CSC technology. In this part we will mainly refer to MIT surveys[2] (Reiner et al. 2006) led in several countries (United States, n=1205, United Kingdom, n=1056 Sweden n=742 and Japan n=1006).

These surveys focused on four topics, the understanding of global warming by populations, the knowledge of respondents about CO_2 emissions sources, their perception about renewable energy technologies CSC and nuclear power. And finally researchers focused on the influence of electricity costs information related to the different kind of energy production on perception of CSC.

(Fig. 1)

MIT's researchers conclude that respondents weren't well informed about global warming issues and CO_2 emissions sources. However, respondents strongly support the use of renewable energy to produce electricity. CSC was perceived as better as nuclear power but not really support by the respondents. Lastly, costs information only had few influence on CSC support by the populations.

These researches focused on relevant dimensions about global warming perception and renewable energy equipments' perception by the populations.

These researches focused on relevant dimensions about global warming perception and renewable energy equipments' perception by the populations. Thus they highlight relevant dimensions about people concerns regarding global warming and technology to address it.

However, one of the main assumptions of these researches is to consider costs of electricity as a strong influential factor of populations' perceptions regarding renewable energy or CSC use. According to the previous results social acceptance isn't only related to economic acceptance.

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[2] Reiner, D., Curry, T. E., De Figueiredo, M., & et.al. (2006). An International Comparison of Public Attitude towards Carbon Capture and Storage Technologies. Présenté à 8th International Conference on Greenhouse Gas Control Technologies (GHGHT-8), Trondheim, Norway. Consulté de http://sequestration.mit.edu/pdf/GHGT8_Reiner.pdf

We could criticize these researches because in only focusing on one main factor we suppose they were only looking for the most influential factor to communicate on CSC technology. Therefore, this kind of survey doesn't intend to foster the public debates around the use of this technology.
Issues related to CSC are more complex and doesn't only depend on economic issue. Regarding our assumption this methodology provides interesting information but stay on a superficial comprehension of social perceptions and social issues involved in the implementation of CSC technologies.

1.2. Media, information and communication's influence

Social acceptance surveys related to communication, media and information's influence were made in most of the case by Japanese and Dutch scientists. The general statement about the information's influence on CSC perception is that giving information about CSC technology to population has bad influence on the perception of the technology. We first review survey on media support influence and about CSC representation in Dutch daily news paper. Then we review surveys which address the addition of information in a questionnaire and the persuasiveness of a message issues.

One of the Japanese surveys focused on the influence of information depend on the information source[3] (Itaoka et al. 2009) (newspapers articles, institution report, scientific report, famous scientist point of view, similar experiences descriptions). **(Diagram 2)**
Japanese researchers both use an internet questionnaire (n= 2156 with a 30% response rate) sample was designed in using a stratified random sampling from registrants of a survey company's panel for internet survey and a face to face questionnaire (n=334 with a 37% response rate) sample was designed in using an area sampling method in Tokyo and Sapporo.
In this survey they noticed that newspapers' articles had the worst influence on CSC perception. Researchers assert that type of perception is related to the factual descriptions of CSC experiences and accidents delivered in the newspapers articles.
This survey brought a relevant knowledge about CSC representation through media support. However social acceptance notion couldn't be reduced to one factor. That's why regarding this survey shows the following limits.
The first limit related to Media as a research object could be the purpose of such a research. In fact researches on media are in our view clearly made in order to design a communication plan.
The second limit, is related to the two methodology used to administer the questionnaire. It seems

[3] Itaoka, K., Okuda, Y., Saito, A., & Akai, M. (2009). Influential information and factors for social acceptance of CCS: the 2nd round survey of public opinion in Japan. *Energy Procedia, 1*.

for us difficult to compare internet questionnaire and a face to face questionnaire. In a face to face survey the pollsters guarantee the same administration conditions of the survey for each respondents whereas it's not the case in an internet survey. For instance we could assume that an internet respondent may look for more information before answering questions.

The third limit is related to the size of the sample. Although these researchers made a face to face questionnaire survey in 2003, the present survey has a quite small and heterogeneous sample if we both consider internet and face to face surveys.

1.3. CSC in Dutch media

Dutch researchers surveyed too the perception of CSC technology in news paper (Van Alphen et al. 2007)[4]. In this survey they both focused on stakeholders' perception of the technology and the presentation of the technology in the daily newspapers. According to the researchers surveying media article could illustrate public opinion about CSC technology. In this review we only refer to the media survey.

The scientists who made that research reviewed 306 newspapers articles related to CSC from 1991 to June 2006 among the daily Dutch national newspapers.

They noticed that CSC technology really appeared in the press in 1999 and the topics often mentioned were energy penalty, costs and CSC as an option to reduce greenhouse gas emissions. From 2005 more and more articles deal with CSC technology issues in the daily national newspapers because of the growing number of CSC projects in Netherlands. These articles emphasized the CO_2 emissions reduction potential of CSC technology and its cost effectiveness compared to other mitigation technologies.

This survey illustrates relevant dimensions regarding CSC representation in newspapers. However these dimensions aren't accurate enough to understand the social acceptance notion which can't be only illustrate through a media survey.

1.4. Addition of information

In this part we first refer to Japanese survey which addresses the influence of additional information on CSC perception[5] (Tokushige et al. 2007) notion. Then we refers to the Dutch (De-Best Waldhober et al.) survey which tackles the same issue.

In this survey Japanese researchers refer to five factors (risk perception, benefit perception, trust and two perception related to human interference with environment) to describe the social

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[4] Klaas van Alphen, Quirine van Voorst tot Voorst, Marko P. Hekkert, & Ruud E.H.M. Smits. (2007). Societal acceptance of carbon capture and storage technologies. *Energy Policy, 35*, 4368–4380.

[5] Tokushige, K., Akimoto,, K., & Tomoda, T. (2007). Public perceptions on the acceptance of geological storage of carbon dioxide and information influencing the acceptance. *international journal of greenhouse gas control, 1*(1).

acceptance notion.

They administer the same questionnaire before and after giving information to a respondents' sample of 276 students.

The researchers concluded that factors they surveyed play a role in the acceptance of CSC. Regarding the influence of information they noticed that natural analogues of CO_2 storage had a positive influence on CSC perception. But information on field demonstration didn't increase public acceptance.

This survey provides relevant information about the influence of information of CSC perception. However, a small sized homogeneous sample didn't enable researchers to come to broad conclusions about these results. But we can't completely agree with such research a purpose which is communication oriented and therefore question the dispassion's demand of the scientists.

Dutch researchers also refer to the influence of information but surveyed it in using another method (De Best Waldhober et al. 2009)[6]. In this questionnaire survey, researchers focused on the perception of people regarding CSC technological options in a broad dimension which are likely to be implemented in Netherlands during the next decades.

In order to survey CSC perception of lay people they decided to use the informed choice questionnaire method with a 995 respondent's sample. In an Informed Choice Questionnaire (ICQ) in each question a balance definition of the question's topic is provided to the respondents. In this survey an expert panel was charged to define CSC technological options then these definitions were translated in a lay language to be understood by respondents.

Dutch researchers would rather use this methodology because they noticed that usual questionnaire surveys without information lead to survey shifting opinions.

The Informed choice questionnaire survey allowed them to notice that the overall opinion of CSC technology's options were positive. They also noticed that there's no negative influencing factor on this overall opinion in this ICQ questionnaire.

This survey shows the significant role played by information. But such survey shows some limitations. First, as noticed by the researchers this survey only refers to CSC options to reduce CO_2 emissions without comparing population perceptions toward other mitigation technological options.

Then, this article won't give us enough information on the survey design especially on the information given to the population.

Finally, didn't completely agree with the purpose of this research. In fact such communication

[6] Best-Waldhober, M. de, Daamen, D., & Faaij, A. (2009). Informed and uninformed public opinions on CO2 capture and storage technologies in the Netherlands. *international journal of greenhouse gas control*, *3*(3), 322 – 332.

oriented researches question the dispassion's demands of scientists.

1.5. Persuasiveness of a message

Another Dutch survey focused on the persuasiveness of a message given to populations (De Vries 2012)[7]. This survey tries to understand how non relevant information (e.g. knowledge export) and non information (e.g. information on internet) could influence the persuasiveness of high relevant information.

The researcher, form a small sample and test two different sets of information. One set was a positively framed CSC information and another set was negatively framed. Researchers administer these two set of information to a small sample of students. They noticed that the addition of non information to a high relevant information create a dilution of the main information and this effect didn't occur when non relevant information were added.

This research brought new knowledge element about messages related to CSC issues. However this research team surveyed a too homogeneous and too small sized sample to come to a broad conclusion about the dilution effect on information.

Then we could notice another limit regarding the definition of the information set because we don't clearly understand according to which analytical framework, researchers define the relevance and the positiveness degree of a piece of information. Finally, as survey reviewed above the scientist position in this survey remain questionable.

We could assume the few survey summarize above which refer to the influence of the information on populations' perception of CSC considered social acceptance mainly as a communication issue. According to this assumption, only a good message have to be find to make CSC technology socially accepted.

Only focusing on economic indicators illustrate a partial view of social acceptance issue. Moreover each project and each context are specific and as we show later a technological project has to deal with modifications to be suitable to its implementation context.

1.6. Trust in stakeholder

This issue about the trust in Stakeholder was mainly surveyed by Nicole Huijts (Huijts 2003, 2007)[8]. However this issue was also taken into account in Claire Gough and Simon Shackley (Gough et al 2001). We first refer here to Nicole Huijts work and then we develop Gough et al

[7] De Vries, G., Tewel, B., Ellemers, N., & Daamen, D. (2012). The dillution effect on the persuasiveness of CCS information. Présenté à IEAGHG Social research network meeting, Noosa Heads, Australia.

[8] Huijts, N. (2003). *Public Perceptions of Carbon Dioxide Storage, the Role of Trust and Affect in Attitude Formation* (master thesis). Department of Technology Management, Eindhoven University of Technology, Eindhoven.
Huijts, N. (2007). Social Acceptance of Carbon Dioxide Storage. *Energy Policy, 35*, 2780-2789.

research.

In choosing the trust in stakeholder indicator, Nicole Huijts focus on more complex dimensions of the Social Acceptance issue. In her survey she addresses the social acceptance of CSC issue in emphasizing on the attitude formations' process and on the trust in stakeholder aspects. Here we more refer to the last aspect.

She administer a questionnaire survey to an inhabitants randomly selected sample (n=103) which are living on a gas field. In this questionnaire survey she focused on the inhabitants' knowledge towards CSC technology. She didn't give them a lot of information about this technology and was more interesting on their trust in the stakeholders involved in this technology's implementation.

She showed that trust in stakeholders depending on people representations about intentions and skills for each stakeholder. Therefore, she concludes that industry representatives were less trusted than NGOs and political representatives because people imagine NGOs and political representatives as better intentioned than industry regarding the implementation of CSC technology. **(Diagram 3)**

This survey provides relevant informations and it was one among few surveys which considered people representation of other stakeholders involved and thus emphasized context dimensions.

Another survey made by Simon Shackley and Claire Gough (Gough et al 2001)[9] tackles trust in stakeholders issue related to CSC implementation. In this survey researchers organised several focus groups meeting with two samples of inhabitants in two different cities and then made a questionnaire survey about CSC perception with a wider sample. During the focus groups survey they essentially focused on risks issues and trust in stakeholders involved in CSC implementation. They noticed that focus groups respondents would like citizens to be associated to the governance process.

This survey illustrates some useful dimensions regarding a potential CSC implementation in the United Kingdom. However, in our view using focus groups methods show limits related to the way of introducing information. We assume that the person who introduces information may influence people's perceptions and lead them to change their views.

1.7. Risk's perception

Risks related to CSC use were mainly tackled in one survey. We will first quickly summarize the survey made by Greg Singleton (Singleton 2007)[10] who focused on risk evaluation methods to

[9] Gough, C., Taylor, I., & Shackley, S. (2001). *Burying carbon under the sea: an initial exploration of public opinions* (working paper No. 10). Manchester: Tydall Center for Climate Change.

[10] Singleton, G., R. (2007). *Geologic Storage of Carbon Dioxide: Risk Analyses and Implication for Public Acceptance* (master thesis). Massachusetts Institute of Technology, Cambridge, MA.

communicate on CSC technology.

He first reviewed several risks evaluation methods and focused on different issues which had to deal with social acceptance and accurately risk acceptance. Then he tried to understand how CSC technology could be perceived among other risks in using different risk evaluation frameworks.

He concludes that for CSC technology realistic risk evaluation methods weren't suitable enough. He noticed that populations in their risk evaluation take into account qualitative dimensions which couldn't be considered in realistic risk's evaluation methods **(Diagram 4).** That's why he recommends keeping the implementation of pilot CSC plants in remote places in order to prove the reliability of these technologies and then convincing people to use it.

Greg Singleton only proposes a relevant theoretical model to assess risk perception related to CO_2 storage in comparing different risks' evaluation methods according to CSC characteristics.

However there's no test in an accurate storage area in his work. More over, risks related to CSC deployment are involved in social acceptance but we assert that the acceptance of a project is more complex than just a risk acceptance.

Regarding CSC social acceptance literature, all the survey reviewed above provides a lot of relevant body of knowledge about CSC perception by population. However we noticed that most of surveys were looking for the best indicators to communicate about CSC in order to persuade people of the necessity to implement the technology. Only some surveys about trust in stakeholders focus on the comprehension of populations perceptions of stakeholders and refer to a local social context.

Another limit of most of these surveys is to ask people their perception about CSC in a general view. However, people could make up their mind if a CSC project is implemented in their neighbourhood as showed in other surveys.

Therefore, in most of the case social acceptance notion remain partially surveyed. Moreover, we could question, especially in survey related to media and communication's influences, the scientific dispassion's demand of the researchers regarding their research object. Consequently these surveys showed a limited knowledge bringing to define the social acceptance notion.

We develop later, another theoretical framework which take in account representation of actors and populations which in play an important role on the project design. **(Diagram 5)**

1.8. Social acceptance as a three-dimensional notion

In this part we will focus on a conceptual definition proposed by Wüstenhagen et al. (Wüstenhagen

et al. 2007)[11] which contributes to define more accurately the social acceptance notion.

Wüstenhagen et al. made a review of literature regarding the social acceptance notion related to renewable energy infrastructures. This set of research work enables them to clarify the definition of social acceptance notion in the specific case of renewable energy infrastructure.

This literature review leads them to the conclusion that the social acceptance notion gathers three interrelated notions (socio-political acceptance, community acceptance, market acceptance). According to them, socio-political acceptance could be considered as the general scale of social acceptance. It takes into account a general support of population stakeholders, and policies to some type of technologies.

With regards to the community acceptance, Wüstenhagen et al. considered the technological projects in a defined place which involved some issues like procedural and distributional justice and trust in stakeholders' issues.

Finally, regarding the market acceptance notion, these researchers focused on the acceptance by the market and the firm of a technological innovation. This notion is related to the diffusion of an innovation notion developed by Rogers (Rogers 1995)[12].

We noticed that this work considering several types of acceptance help us to define our research position and interrelated scales involved in social acceptance of renewable energy's technologies research. But, the use of other indicators to tackle the social acceptance issue doesn't help in giving a clear definition of it. Moreover with regards to the CSC literature review it seems that no general agreement exists on the use of these indicators. That's in our view a limit of this research more over, the interaction between technological artefact and society seem to be put aside on this research too. We will develop the interactions between technological artefact and society and the need to consider it for a social acceptance research in the following paragraphs.

2. Illustrating cases

In this part we develop few case studies to highlight our theoretical frameworks, to study the acceptance of CSC project. These cases studies refers to interview surveys made in foreign countries in Norway and in Scotland which are already engaged in the implementation of CSC technology and another survey which refer to a CSC project in the Seine Estuary in North west of France.

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[11] Wüstenhagen, Rolf, Wolsink, Martin, & Bürer, Mary., Jean. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, *35*, 2683–2691.

[12] Rogers, E. (1995). *Diffusion of innovations*. New Yortk: Free Press.

Regarding the foreign cases studies the interviews instructions administer to respondents was *"Carbon Capture and Storage technologies are already operated in your territory. Could you tell me how these technologies were implemented and which played your organisation in this implementation? Could you express your point of view according the three following angles?*

- *your actor's point of view towards CSC technologies*
- *main actor's relationships with other actors involved*
- *relations between CSC technologies and others projects against global warming"*

We first have to say that Norway and Scotland hadn't reached the same point of implementation of CSC technologies and different geographical context. Therefore the two cases would be distinguished in the following paragraphs.

2.1. Norway's case

Regarding the Norway situation we first have to explain the context of implementation of CSC technologies. According to people we met, Norway government pass a law to tax CO_2 emissions which from oil and gas production in 1993. Therefore oil and gas company were looking for a technical solution to get rid of the tax. Then decide to implement CSC technologies. At the beginning government gave a strong support to the implementation of CSC technologies comparing that to a "new moon landing".

The contextual dimension enables us to distinguish two actors involved from the beginning of CSC implementation. As interviewed peoples said technology providers, researchers and some environmental NGO indeed were also involved in this implementation process. However, in most of the cases local actors were not really involved in these CSC implementation projects in Norway due to the offshore localisation of oil and gas industry.

All of these contextual dimensions were relevant to explain why CSC succeeds in its implementation process in Norway.

First, as said before the legal context lead oil and gas company to develop CSC. In using this technologies Oil and Gas companies both avoid taxes and make economic benefits with EOR[13] or in capturing CO_2 inside the drilled gas that's enable them to sell it at a better price. Moreover they benefit from the Norwegian government which gave a strong support to CSC deployment.

Then, the offshore location of oil and gas industry which are using CSC technology made also its implementation easier. Indeed as a located remote from populations CSC technologies didn't raise a lot of public concerns. Apart in the Snohvit case where local actors were quite motivated to CSC deployment related to a natural gas plant and made a huge development project around it, local actors don't seem quite involved in CSC project.

[13] Enhanced Oil Recovery

These few elements enable us to understand how CSC technology is used in Norway and which type of actors were involved in the network which operates this technical artefact. To summarize what we noticed above we could first point out that CSC has also a significant economic dimension in its implementation in Norway, which made it attractive for industry. Then CSC has the government support that could make easy its deployment. Finally, in most of the case it's an offshore technology consequently it don't involved a lot of people and actors and don't raise a lot of public concerns.

However NGO which support CSC deployment in Norway don't support the way it has been deployed by Oil and Gas companies. It asserts that these companies were only looking for benefits and that CSC could be an environmental argument to look for new oil and gas resources. Therefore, it could be considered as a misappropriation of CSC technologies. Specifics uses, geographic location, and actors' network involved in CSC technologies could explain the relatively high level of CSC acceptance in Norway. According to theories we referred before, we noticed CSC in Norway succeeded in bringing together most of the actor's involved interests and representations. However each context is specific and CSC technology have to deal with different actor's configuration, and different geographical location which has an influence on the acceptance of the technology.

2.2. United Kingdom's case

Regarding the implementation of CSC in the United Kingdom, the implementation seems to be more difficult. Indeed CSC technology has to deal with a wider actor's configuration than in the Norwegian context. In the United Kingdom, a part of CSC infrastructure have to be implemented onshore and in some of the case lead to the construction of new coal plants. Therefore, these operations brought about the involvement of public and of local stakeholders.

As in Norway, national United Kingdom government has a huge ambition regarding the implementation of CSC. It promises to fund CSC projects but wasn't clear enough at the beginning about what characteristics projects had to fit with. Therefore, a lot of companies applied to this funding opportunity. But government took a lot of time defining which kind of project it was willing to fund. As a consequence, a lot of applicants stopped applying because they were bored of waiting government's funding decision or didn't fit the funding criterion anymore. The funding plan hinders the implementation process of CSC.

Then, we should say that Scotland has a lot of suitable storage reservoirs. However we noticed some tensions between the Scottish state and the United Kingdom state, through interviewing people. The Scottish parliament shows a quite good motivation to develop, renewable energy

technologies and CSC technology. For instance, Scottish government adapted a part of the Scottish laws to fit with the CSC technology implementation. Moreover, scientists and researchers were asked to make a toolkit, in order to help political elected representative to implement CSC. However, the Scottish government doesn't possess any energy competence. Thus it also hinders CSC implementation. According to what our interviewees said, we could notice a gap between the British State and the Scottish State's intentions regarding CSC technology. We assume this gap also hinders the implementation process of CSC technology.

Finally, involving populations acceptance surveys were made either before the implementation of CSC or the construction of a new coal power plant. Scottish interviewees told us that populations were opposed to the construction of new coal power plant because *non solum* it increases CO_2 emissions *sed etiam* CSC technology only applies on few parts of the emissions. However they seem to be more favourable to CSC use, if it removes CO_2 emissions on existing power plant. Regarding the storage issue, most United Kingdom CSC projects plan an offshore storage using for example old oil or gas rigs. By contrast with Norway's case, there weren't a lot of suitable sites to do EOR and consequently no really economic added value.

This second case enables us to understand that a wide network of actors involved leads to a more difficult implementation of CSC. Indeed interests, intentions and definition of the technology for each of them may be different and eventually inconsistent. This case shows that United Kingdom actors involved would not yet succeed in finding agreement to define CSC implementation, according to each particular interest and definition.

These two examples could illustrate the importance of the local context in regard with the implementation of CSC technology or with the technology design. As showed above, CSC technology deals with two different uses in Norway and in the United Kingdom. In Norway's case, most of the projects use offshore systems which both have an environmental and an economical function. Simultaneously few actors are involved. In the United Kingdom's case, on the contrary, CSC technologies are both located onshore (carbon capture) and offshore (carbon storage) areas. Moreover the economical value is not important as it could be in Norway. And actors involved don't find an agreement on a definition of CSC. These two cases highlight some relevant learning about CSC project implementation. Regarding future CSC implementation, both dimensions have to be taken into account:

- First, the analysis of the context,
- Secondly, strategies and social representations of CSC technology of actors potentially involved.

An accurate study of these two dimensions is required to reveal acceptance conditions of such a

project, in a relevant and predictive way.

2.3. France's case: A qualitative survey on questioning the Seine Estuary stakeholders

The Qualitative Survey on questioning the Seine Estuary stakeholders, conducted in 2009[14], aimed to uncover the perceptions and representations of the stakeholders (i. e.: the local and regional political elected representatives, the professionals in charge and the industrials, the non profit environmental organisation managers), which are necessarily affected by the implementation in the Seine estuary to an experimental site of industrial CO_2 capture.

Questioning these stakeholders could afford to test their knowledge of issues related to this project. The objective of the survey is to reveal differences of opinion according to the position occupied by these actors. This enabled the identification of agreements, differences, uncertainties and questionings in their diversity. It was relevant to compare the expression of the perceptions of these actors to those of the estuary inhabitants interviewed. That's why a thousand people[15] were surveyed, in order to grasp the convergences and the discrepancies between inhabitants and stakeholders.

So, the 19 interviews conducted followed a common interview schedule based on five specific themes:

- The industrial base of the Seine estuary;
- Nuisances and risks of the industrial activity of the estuary;
- The relationship between these nuisances, local risks and global warming;
- The local means to address global warming
    - in particular, the pilot project of capture, transport and storage of CO_2 in a defined site;
    - but also others mitigation technologies;
- The information and communication plan towards the Seine estuary inhabitants about the various measures already taken or to be taken against the effects of global warming.

The local means against global warming on "the CTSC experiment project" was fundamental compared to the overall survey on the social acceptance of a large industrial project. But the four other topics were enlightening for understanding the position of each other on the project.

[14] Etude d'acceptabilité sociale de mise en œuvre d'un site expérimental de CTS CO2 dans l'estuaire de la Seine
Synthèse des entretiens conduits auprès des acteurs en responsabilité
IDEES/CIRTAI université du Havre pour le compte du Havre Développement

[15] Gravé, P., Joly, O. (2010). *Etude d'acceptabilité sociale de la mise en oeuvre d'un site expérimental de captage, transport et stockage (CTS) du CO_2 dans l'estuaire de la seine*. Contrat de recherche ADEME 0874C0042, porté par Le Havre Développement. Synthèse sur : http://www.clubco2.net/servlet/doc?id=74002

2.3.1. Perceptions and representations of local control methods implemented against global warming

We notice that the project of an experimental site of capture, transportation and storage of CO_2 is known by a large majority of managers. Some of them also had a very good technical knowledge of the CSC, even, for some, a high level of information. All the actors agreed on the need to reduce energy consumption. Mobilizing all possible and complementary means to address against CO_2 emissions reaches a consensus. However, discrepancies arose:

- The professional in charge stress the constraints of a more and more demanding legislation but also the imperative of economic profitability;
- The non-profit environmental organisation managers emphasize the weak diversity of used means, particularly the exploration of new energy sources;
- The political elected representatives agree to join the new projects once the scientific credibility and transparency are assured. Elected officials think they are playing a main role as information relays, especially in educating their populations: so being an example is a good way to convince people to engage as eco-citizen.

The perceptions on "the experiment of CTS of CO_2" are different according to the three groups of actors:

- Political elected representatives agree to promote experimentation of capture, transport and storage of CO_2:
  - The responsibility of political elected representatives for the protection of citizens is reaffirmed,
  - Sharing a risk common culture with industrials, based on a trusty cooperation,
  - Experimenting the CTS of CO_2 is an opportunity and a value for the Seine estuary territory, thanks to scientific research and technological innovations, and with the establishment of an industrial chair on CO_2,
  - Such experimentation would create jobs,
  - This experiment would reinforce the will of political elected representatives to protect the environment through greater collaboration with scientific research.

The key differences inside this group of actors are about the cost of the operation, on the "security" aspects, on the fate of CO_2 once captured, including its storage, as well as on the finality of this experiment: promoting the capture of CO_2 could indirectly encouraging industrials to increased their CO_2 production without qualms, precisely because CO_2 will be *in fine* captured.

- Non-profit environmental organisation managers feel that the CSC local experiment project is not a priority. Four types of arguments are given:
  - They deplore the lack of dialogue on the chosen priorities;
  - They question the validity and finality of such experimentation;
  - They regret the lack of openness to other more radical solutions that would lead to effectively reduce CO_2 production, whereas this project, they say, indirectly pushing to produce more CO_2.

- As far as For professional in charge are concerned, there is a agreement to promote experimentation of capture, transport and storage of CO_2, which is justified by:
  - Economic imperatives,
  - Active participation in technological innovation,
  - The image of an eco - productive industry.

However, they question the economic feasibility (investment costs) and even the technical feasibility of the project.

2.3.2. Others mitigation technologies

A consensus arose among stakeholders about the need to produce less CO_2 and also to turn to renewable energy locally:

- the wind,
- the solar power,
- the sea current,
- the burning household and the industrial waste,
- the wood.

Some stakeholders also mentioned the use of controlled nuclear generation as compelling solution for now. Others underlined the use of soft modes of mobility such as public transportation and electric vehicles.

Non profit environmental organisation managers denounce a lack of courage in environmental policy. They criticize politicians' wait and see attitude and fatalism. They develop the theme of man's creative expertise and stress on the development of alternative measures.

Professionals in charge also link economic capacities of human scientific discovery and technological innovation. Firms make efforts using materials in clean energy.

Political elected representatives are turning increasingly to the development of clean energy, and relies on the ability of R & D companies and academic research. For these actors, using various resources is an asset to address global warming. Political elected representatives present their new investments as cleaner and more economical. In practice, pragmatism and idealism are complementary.

All actors more or less agree to stress that the economic and social effects will occur, especially if the pattern of conventional energy consumption changes significantly. In others words the question is how better living, even so the industrial base had to be reconstructed. Most of stakeholders think that a collective awakening is needed to address global warming. Education, training, information, and trust in future are the means to reach this objective. But according to them, behaviours, habits and resistance to change die hard. It is a long way becoming an eco-citizen. The green youngsters are enthusiastic to make things happen.

As mentioned before, the global communication concerning both the risks and the nuisances on the one hand, on the other hand the dedicated one to the CTSC project, was also enlightening for understanding the position of each other on the project.

2.3.3. The global communication concerning the risks and the nuisances and the dedicated one to the CTSC project

As for measures to be taken with regards to information and communication with the Seine estuary inhabitants about the global warming mitigation, we observe two levels of representations:

- The first one focuses on the various modes and the vectors of communication on global warming generally,
- The second one especially targets the experiment of the CTSC.

The various non profit environmental organisation managers show a fairly strong distrust, without radically hostile position, of the experimental project. They expected a transparent public debate, but they doubted about the elected officials and business world ability to produce accurate and honest information.

Much of the political elected representatives agree with the need of a public debate. They are willing to relay information, but some of them fear the instrumentation. They demand transparency as to the purposes and experimentation process. Political actors of municipalities nearby the two

industrial clusters of Le Havre and Notre Dame de Gravenchon focus their communication on preventing risks and nuisances devices on the whole agglomeration. Regular small groups meetings are the favorite information mode.

The professionals in charge, especially industrials, feel weakly informed to set up a strong communication strategy, even though they have scientific, economic and financial control of the project experimentation. They emphasize the difficulties in communicating about the experiment project because its actual implementation is uncertain. Overcoming these difficulties of communication needs to spread information, to increase public awareness and to train people, in a transparent and clear definition of finalities. Simultaneously, it is legitimate to inform the public, stakeholders and local partners. Not communicating the issue would be criticized.

The different European case studies developed above refer to unsaid theoretical backgrounds. The following paragraphs expose and criticize them, in order to build a new theoretical framework about CTSC technologies' acceptance.

3. From social acceptance notion to a broader theoretical approach to explore socio-technical acceptance

Yannick Barthe (Barthe 2006)[16] focused on nuclear wastes issue. He used a qualitative survey methodology which enabled to highlight the several dimensions (technical, economical, strategical, environmental etc.). Therefore, this issue led to question the social acceptance notion. According to Barthe, social acceptance appears when a technical choice is locked.

(Diagram 6)

Barthe also said that social acceptance research works leave inside the black box the socio-technical process which leads to technical solution. Designers and decision-makers legitimate this technical choice in defining a communication strategy in order to persuade people. Barthe on the contrary shows the necessity to consider technological innovation acceptance in a broader way. His approach takes into account both technological choice and social perception.

Consistent with him, it could be fruitful to take into account globally the social dimensions, in such a research regarding the acceptance of CTSC technologies. Let's refer to a philosopher who works on technology in order to develop our approach. Andrew Feenberg (Feenberg 2004)[17] studied several technical artefacts and systems. His research fields and his philosophical background led

[16] Barthe, Y. (2006). Le pouvoir de l'indécision, la mise en politique des déchets nucléaires. Paris: Economica.

[17] Feenberg, A. (2004). *Repenser la technique vers une technologie démocratique* (Vol. 1-1). Paris: La Découverte.

him to adapt the concept of concretisation, first theorised by Gilbert Simondon (Simondon 1989)[18]. The *concrétisation* is a way for technical artefacts to manage different functions. Feenberg, in referring to Don Ihde's theory (Ihde 1990)[19], noticed that technological artefacts have social, cultural and symbolic dimensions which depend on a social and cultural context. This observation leads him to think that technological artefacts could contain numerous social, cultural and symbolic functions and gather different social groups around this artefact. We think this concept of *concrétisation* could help us to approach acceptance of Carbon, Capture and Storage, Technologies. It becomes necessary to first understand the socio-cultural context. Then the social representations[20] of various groups of actors involved stress some dimensions to take into account in CTSC project deployment. It causes an eventual feedback on the design of the CTSC project to take into account different actors specific demands.

Regarding the theoretical knowledge described above, we propose a specific theoretical framework to understand populations and stakeholders' representations on a defined area. According to the literature about spatial production (Lefebvre 2000) and "Social reception" of various urban projects (Semmoud 2007), we take into account three dimensions in our framework: the local identities, the territorial development, and social practices related to local territories.

Fig. 7: Forms of socio-technical acceptance in the implementation of CTSC project (P.Gravé, O.Joly & J.Pigeon 2012)

We assume local identities structure territorial development paths and social practices of inhabitants related to local territories. These local identities have a long time influence on the two dimensions mentioned above (diachronic dimension). Simultaneously territorial development and social practices related to local territories follow synchronic dynamics. These two dimensions illustrate stakeholders and inhabitants representations. For instance, studying these dimensions could help us to highlight compromises needed in urban planning projects.

A CTSC project has its own characteristics (social, technical, environmental) and above all its own temporality. However, when such a project is deployed in a territory it has to deal with some specific development scheme and specific inhabitants practices related to local territories. Therefore, we assert that the forms of acceptance of such a technological project lie on three compromises:

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[18] Simondon, G. (1989). Du mode d'existence des objets techniques. Paris: Aubier.

[19] Idhe, D. (1990). *Technology and the Lifeworld.* Bloomington & Indianapolis. Indiana University Press.

[20] These social representations depend themselves on the *habitus* of the groups of actors, i.e. Bourdieu, P., *La distinction : critique sociale du jugement*, Paris, Ed.de minuit, 1996.

- between the inhabitants social practices of local territories and the territorial development schemes;
- Between the CTSC project and the territorial development processes;
- Between the inhabitants social practices of local territories and the CTSC project.

Moreover, on the long view, the implementation of such a project also involves a feedback on the local identities which have to be recomposed. This framework also takes into account temporality (diachronic and synchronic dimensions), as shown in the following figure:

Fig. 8: Forms of socio-technical acceptance diachronic approach in the implementation of CTSC project (P.Gravé, O.Joly & J.Pigeon 2012)

The diachronic dimension refers to local identities which are built on a long range time. The territorial development and CTSC project have their own temporality, based on projects temporality. Social practises can be revealed in a synchronic perspective, i.e. at a given time. The three compromises both follows a synchronic and diachronic logic.

Conclusion

As noticed in this chapter the social acceptance notion know some limits. This notion is often surveyed in focusing on one illustrating factors which could be used to convince populations to accept a technology. These illustrating factors certainly provide relevant information regarding the perception of CTSC technologies. As mentioned previously, most of surveys were looking for the best indicators, which are mainly (geographically) "non-scalar indicators" referring to the generic technology of CSC to communicate about it, in order to persuade people of the necessity to implement the technology. Only some surveys about trust in stakeholders focus on the comprehension of the inhabitants perceptions of stakeholders and refer to a social context linked to issues of proximity. By way of opening towards spatial approaches, Alain Nadai and Olivier Labussière (Nadaï 2010) assert that "*technology is changing the socio-spatial context in which it is inserted and (...) cannot presage the conditions of territorial acceptance*". When “proximity planning”, seen as a set of located territorial development processes, become indicative rather than prescriptive for future developers, they are putting themselves collectively and locally negotiated in position to reinterpret the principles of wind farms construction. It plays a crucial role in building social acceptance because "*it is an essential link between a generic technology driven by national policy and a technology that takes territorialised exploration of social and spatial configurations*"(Nadaï 2010). However, as we showed here, only focusing on illustrating factors does not enable researchers to understand deeply populations and actors’ representations which

could highlight what could be the acceptance of CTSC technologies.

Moreover, as illustrated by the case studies described above, we noticed the importance of the local context to understand what could be the CTSC projects acceptance. These case studies showed that CTSC technologies are implemented in taking into account social representations of the actors involved and territorial development processes.

Consequently we develop a theoretical framework which enables the consideration of these dimensions in a research focused on social representations and acceptance of CSC projects. To develop this framework we refer to philosophy and sociology of technology, and also to urban planning operations reception literature. In our theoretical framework, we decided to survey four main dimensions (the local identities, the territorial development processes, the inhabitants social practices related to local territories and the CTSC projects dimensions). This framework also takes into account temporality (diachronic and synchronic dimensions). As we showed the territorial development processes and the social practices of inhabitants were determined by local identities on a long range. Simultaneously, territorial development processes and social practices related to local territories also deal with synchronic dynamics. Then CTSC projects as well have their own temporality. Therefore, we assert the socio-technical acceptance form of such a project lie on three compromises:

- between the inhabitants social practices of local territories and the territorial development schemes;
- between the CTSC project and the territorial development scheme;
- the inhabitants social practices related to local territories and the CTSC project.

Moreover, on the long range, the implementation of such a project also involves the feedback on the local identities which have to be recomposed.

In short, this new framework is based on both systemic and interactionist conception, only able to take into account the complexity of the processes involved. Furthermore, the integration of different temporalities involved in this model warrants emergentist approach, whose heuristic value will reveal the socio-technical acceptability of technologies CTSC.

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Illustrations

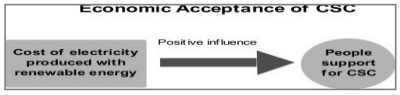

Fig. 1: Economic Acceptance of CSC projects

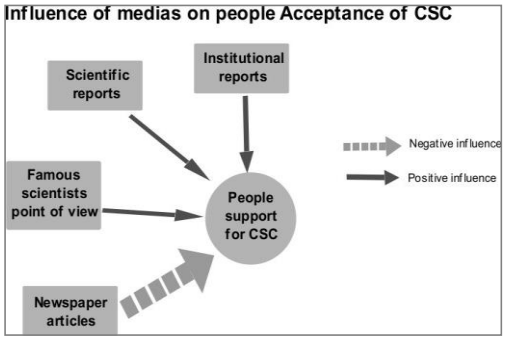

Fig. 2: Influence of Medias on social acceptance

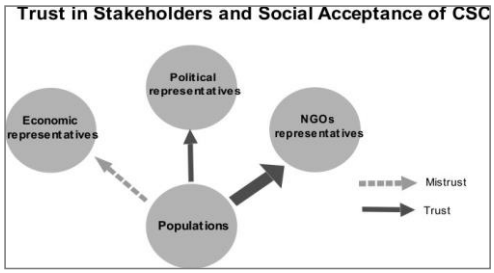

Fig. 3: Trust in stakeholders and social acceptance of CSC

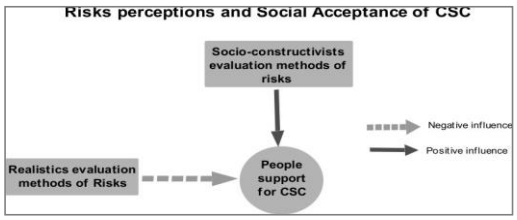

Fig. 4: Risks perceptions and social acceptance of CSC

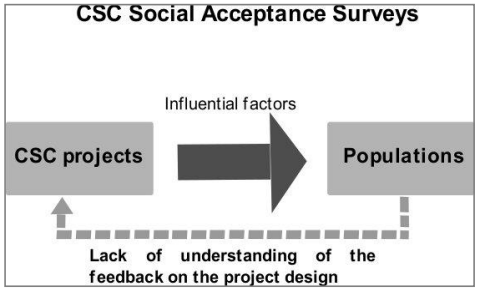

Fig. 5: CSC social acceptance surveys process

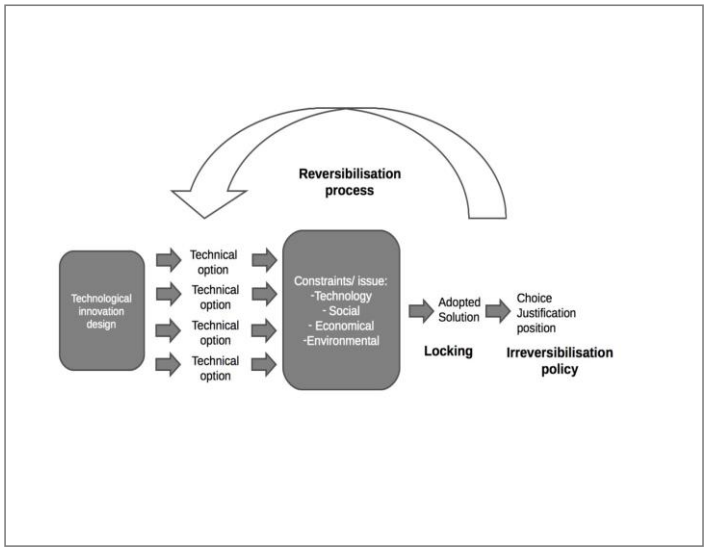

Fig. 6: (Jonas Pigeon 2011) referring to: Barthe, Y (2006), Le pouvoir d'indécision : la mise en politique des déchets nucléaires, Paris, Economica.

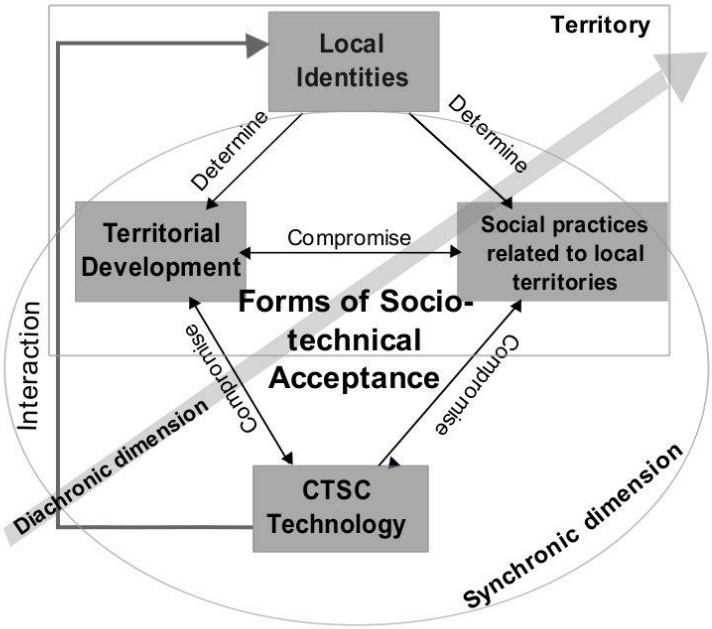

Fig. 7: Forms of socio-technical acceptance in the implementation of CTSC project (P.Gravé, O.Joly & J.Pigeon 2012)

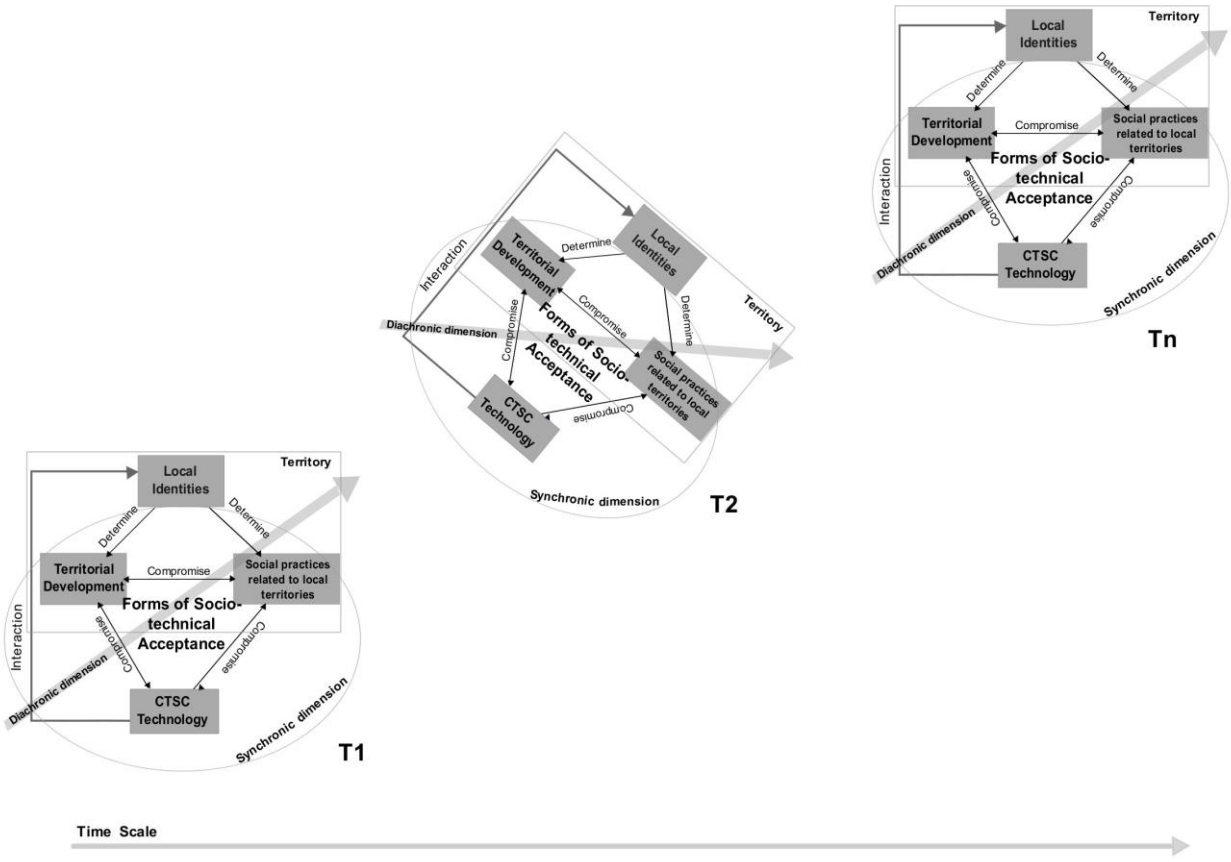

Fig. 8: Forms of socio-technical acceptance diachronic approach in the implementation of CTSC project (P.Gravé, O.Joly & J.Pigeon 2012)