On the (un)successful Deployment of Renewable Energies: Territorial Context Matters. A conceptual framework and an empirical analysis of biogas projects

Sebastien Bourdin, François Raulin and Clément Josset

Abstract:

Given the goal set by the French government to open 1000 biogas plants by 2020, we feel it is important to investigate the factors linked to the success or failure of anaerobic digestion projects, especially as the inherent challenges mean that there are barely 300 in operation today. We thus developed a conceptual framework to help us examine territorial energy transition projects, which we applied to an empirical analysis of the biogas production process. We conducted a quantitative study (logit model with 91 anaerobic digestion projects) and a qualitative study (49 semi-structured interviews and 455 articles from the regional daily press) to identify and understand the processes through which anaerobic digestion projects reach a successful outcome or, conversely, fail. Our findings indicate that projects may be abandoned or interrupted due to the presence of groups of protestors who are often apprehensive of such schemes and do not trust the project leaders. Lack of anticipation and early dialogue tends to exacerbate the ensuing challenges. Furthermore, social acceptance appears to be correlated with proximity to the biogas plants but not to the size of the digester. Finally, operating and/or investment subsidies appear to have a positive and significant effect on a project's success. In this study, we highlight the need to introduce locally defined policies rather than one-size-fits-all policies in order to develop renewable energy projects in specific regions.

Keywords: biogas, anaerobic digestion, territorial context, energy transition

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1. Introduction

The literature provides valuable information on factors linked to the success or failure of renewable energy projects at local level – especially wind energy projects (Dawley, 2014; Steen & Hansen, 2018) – but there is a severe lack of empirical evidence when it comes to anaerobic digestion projects[1]. Just a few studies have explored the obstacles affecting the development of biogas production plants from the perspective of technical, financial and social factors (Capodaglio, 2016). Most of these studies only deal with the issue of local acceptance, despite the fact that other factors can affect a project's success or failure. Given the increasing number of potential projects in France that do not necessarily succeed[2], we attempt to fill the gap as to why anaerobic digestion projects fail, investigating (i) the role of financial incentives, (ii) social acceptability (project siting and governance) and (iii) the issues linked to geographic location and the size of the digester. We argue that the territorial context and local specificities are key factors in understanding why a project goes ahead or not, and we propose an original conceptual framework in regional science to investigate the issue.

The production of organic effluents and waste in France and the majority of industrialized countries has increased substantially in the last few decades. This production puts politicians in an extremely challenging position as such products and the way they are managed can be a source of pollution for our environment (soil, water and atmospheric pollution) and for mankind, and yet, paradoxically, provides a potential source of renewable energy that can be capitalized on in order to (i) reduce the impact on the environment, (ii) anticipate regulatory changes and (iii) build on its energetic and agronomic, and thus economic, potential. Anaerobic digestion has been developed in several EU countries as a result of the gradual implementation of regulatory requirements concerning the treatment of organic waste and the recent commitments made by the European Union regarding renewable energy (European Commission, 2001, 2006, 2008, 2015 and 2017). This can be partially explained by the fact that anaerobic digestion is considered the best way to recover energy from waste in environmental terms (Chynoweth et al., 2001; European Court of Auditors, 2017). It is a biological process that produces a biogas mainly composed of methane and carbon dioxide from organic effluents and waste (Bishop et al., 2010). Among other options, biogas may be injected directly into the gas network or recovered using cogeneration to produce electricity and heat.

The anaerobic digestion process re-emerged as an energy production solution at the beginning of the 21st century in France. It had developed significantly by the 1970s and 1980s when there were around one hundred facilities. However, the French energy policy, based principally on nuclear energy, rapidly led to its decline, resulting in a barren spell that lasted more than twenty years. The renewed interest in anaerobic digestion stems from the strategy to develop renewable energies as an alternative to fossil fuels with the aim of reducing greenhouse gas emissions. Despite the national political will to revive anaerobic digestion as part of the energy transition process, projects are struggling to materialize or come to fruition. The energy transition act states that by the year 2030, 10% of gas consumption and 40% of electricity in France must come from renewable energies. In order to meet these ambitious goals, 1000 biogas plants are supposed to be open by 2020. However, the new business segment is finding it hard to take off. At the end of 2016, there were just 270 plants in operation, and only 24 injecting clean gas into the network. Consequently, we need to understand why the development of anaerobic digestion appears to be such a challenge in France.

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[1] In the rest of the document we use the term anaerobic digestion or biogas to refer to the methane-producing process which consists of transforming green waste into energy (biogas, heat, electricity).
[2] In 2019, there were 340 on-farm units and 49 centralised plants (also called territorial or multi-partner anaerobic digestion units), while the government's goal for 2020 is to create 1000 biogas plants (source: SINOE database)

Social, geographical and financial factors can all be blamed to some extent. This is partly due to the fact that, like wind energy projects, anaerobic digestion is dependent on social acceptance. Several major social concerns emerge with the setting up of biogas facilities, with nearby populations unhappy about factors such as proximity to housing, the perceived risk of explosions, the smell and the increase in traffic from trucks carrying waste. These concerns are often due to a lack of consultation (Rau et al., 2012; Soland et al., 2013; Kortsch et al., 2015; Bourdin, 2019; Bourdin, 2020). A growing number of local residents have demonstrated their opposition to the setting up of controversial alternative energy projects near their living environment (Dimitropoulos and Kontoleon, 2009; Roberts et al., 2013; Ek and Persson, 2014; Upham et al., 2015 ; Horie and Managi, 2017), claiming that they affect their quality of life (von Möllendorff & Welsch, 2017). Clearly, energy projects provide fertile ground for controversy. Hydraulic structures, wind farms and shale gas extraction have all been subject to sustained local opposition, so much so that developers and decision-makers increasingly acknowledge that the "social aspect" is a major factor, not to mention a risk, when it comes to the success or failure of such projects. In particular, we have seen the development of the NIMBY (not in my back yard) response to wind energy projects over the past few years (Fischel, 2001; Devine-Wright, 2005; Wolsink, 2007; Meyerhoff et al., 2010; Mattmann et al., 2016; Zerrahn, 2017; Klain et al., 2017 and 2018). While there is an extensive body of literature on wind energy issues, there has been very little research on social acceptability with regard to anaerobic digestion and the role of local opposition in the failure of such projects (McCormick and Kåberger, 2007; Adams et al., 2011; Röder, 2016; Schumacher and Schultmann, 2017; Mittal et al., 2018 ; Bourdin, 2019). Moreover, to our knowledge, no studies have examined the extent to which size can influence the local acceptability of projects. However, the question of size is a major parameter to consider in the context of collective biogas projects as it is often a key profitability factor (Van Groenendaal et al., 2010; Rajendran et al., 2013).

Second, the difference in the perception of renewable energy projects according to their siting, from the perspective of both proximity to housing (Roberts et al., 2013; Van Rensburg et al., 2015) and their location in urban or rural areas (Bergmann et al., 2007), have been investigated in the social acceptability literature. However, to date, no specific studies on cases of anaerobic digestion have been published. We feel it is important to examine whether the geographical location of biogas plants plays a role in their acceptance or rejection as the literature is ambiguous on this topic. Taking the example of wind turbines, Van Rensburg et al. (2015) suggest that proximity to housing is unimportant, and yet we might expect people living near these facilities to be reticent about accepting wind turbines in the near vicinity.

Third, given that public funding is very limited, we would also like to examine whether projects that obtain public subsidies have a higher probability of materializing or if, in the end, the money invested to support such projects fails to have the desired effect. So far, the findings from studies that focus on this issue are contradictory (Costello and Finnell, 1998; Rösch and Kaltschmitt, 1999; Kutas et al., 2007; Zglobisz et al., 2010; Adams et al., 2011; Ferreira et al., 2012). To be more specific, between 2011 and 2017, the French government encouraged the development of cogeneration projects with the provision of advantageous feed-in tariffs. Since 2017, it has encouraged project leaders to turn more towards investment in the gas network, so it seems of interest to consider which (if either) type of energy recovery is more likely to see projects come to fruition in the future.

This article contributes to the current multidisciplinary debate on climate change and energy transition from an economic and geographical point of view. Our study examines the deployment of anaerobic digestion in the "Great West" region of France between 2003 and 2018, adopting a mixed method featuring a quantitative approach with a logit model applied to 91 biogas plants and a qualitative approach analysing (i) 49 semi-structured interviews with the stakeholders of 9 successful or failed projects and (ii) 455 articles published in the regional daily press to illustrate and understand the findings obtained from the model.

2. Literature review

We found several reasons in the literature to explain why some projects find it hard to take shape or are later abandoned. These include the acceptability of anaerobic digestion (in terms of the biogas plants' siting, trust and participatory democracy) and the funding of these projects.

2.1. Local hostility towards biogas projects and the siting of plants

Local hostility towards biogas plants is commonly explained in terms of the "NIMBY" effect, which denotes the position of individuals who perceive the energy resulting from biomass as positive for society in general since it is green energy[3], but whose personal cost-benefit analysis leads them to object to the construction of a plant in their immediate vicinity. From an economic point of view, the NIMBY effect presents a social dilemma, i.e. a situation in which the collective interest conflicts with individual interests (Fischel, 2001; Van der Horst, 2007; Thomas, 2017). Moreover, emotions appear to play a crucial role in individual decisions, which are often far from purely rational. As far as the acceptability of wind energy projects is concerned for instance, the extant literature highlights the concept of "attachment to place", which designates an emotional and symbolic bond uniting individuals with the place in which they live (Devine-Wright, 2009 and 2014; Cass and Walker, 2009). From this perspective, the NIMBY concept has frequently been criticized as over simplistic and inappropriate to understand the real motivation of the majority of objectors (Devine-Wright, 2005).

Several studies have tried to go beyond the NIMBY framework, showing that other factors play a crucial role in the acceptability of wind energy projects. Three of them are addressed in more detail below: i.e., distributive justice, procedural justice and trust in the developer.

Distributive justice refers to the subjective individual estimation of the way in which costs and benefits are distributed within a group (Adams, 1965). In this case, benefits may be monetary, such as the profit resulting from the electricity generated and the creation of new jobs in the green energy industry, or non-monetary, including compensatory measures aimed at reducing negative externalities linked to the setting up of biogas plants (Sovacool and Ratan, 2012). They may be related to a depreciation in the value of land and buildings (Vyn, 2019), a change in the landscape (visual pollution), the smell, a perceived risk of potential explosion linked to biogas, or an increase in traffic from trucks carrying raw materials (Soland et al., 2013; Kortsch et al., 2015; Schumacher and Schultmann, 2017; Mittal et al., 2018).

Procedural justice concerns the subjective perception of fairness in the process of setting up biogas plants. It relates to aspects such as choice of site (siting) and the permit procedure, the potential for a participatory approach, the amount of information available, etc. (Zoellner et al., 2008; Kortsch et al., 2015). Perceptions of justice and fairness are inherent to a community's wellbeing. Situations that are viewed as unfair can lead to protest and conflict within a community, especially when decisions seem to favour certain actors at the expense of others. Consequently, if local communities perceive most of the benefits from the energy generated as being monopolized by outside interests, or if they are not involved in the development process, it can foster a feeling of being unfairly treated, resulting in oppositional activism (Upham and Shackley, 2007; McCormick and Kåberger, 2007; Adams et al., 2011; Soland et al., 2013; Capodaglio et al., 2016; Schumacher and Schultmann, 2017). The current literature makes no mention of studies on the link between proximity to housing and the forming of local opposition likely to block anaerobic digestion projects. We therefore attempt to explore this issue since, as far as we know, only one

[3] With positive potential externalities (expansion of the renewable energy capacity and reduction in greenhouse gases from the generation of conventional energy, creation of jobs in the renewable energy industry, decrease in dependence on resource imports, etc.).

study (Bergmann, 2008) to date has examined the difference in acceptability of wind energy projects wih respect to siting, analysing the various perceptions of inhabitants according to the places they live in, whether urban or rural.

Finally, trust in the green energy project developer is essential with regard to social acceptability (Upreti and van der Horst, 2004; Gross, 2007; Goedkoop and Devine-Wright, 2016), especially when residents know little about the technology used, as is the case with anaerobic digestion. Trust enables cooperation and communication to be established, ensuring the project is set up in a way that is adapted to the local situation, generating consensus rather than conflict. Social acceptability is thus a key concern in the anaerobic digestion industry and for populations who feel excluded from local biogas development projects. To date, only the study by Soland et al. (2013) – using the example of Switzerland with a survey of 502 citizens living near 19 biogas plants – has confirmed the importance of trust in such situations, as it emphasizes the fact that social acceptability often increases when the project leader is known. This factor is worth developing through more empirical evidence. Thus, our study looks at the importance of trust as a tool to avoid local opposition to projects. Our method is different from that of Soland et al. (2013) in that we not only focus on what the residents say, but we also examine the reasoning adopted by the various biogas plant project stakeholders.

2.2. The role of public policies in the success of projects

Setting up biogas plants involves relatively high investment, varying between €200,000 and €800,000, depending on the size of the plant (these costs include the site development, the reception and management of substrates, the biogas digester, biogas added value, heat recovery and engineering). Loans or subsidies are consequently required to cover some of the initial costs. Investment subsidies exist in most EU countries (Piterou et al., 2008; van Foreest, 2012) and have been identified as potential incentives for anaerobic digestion development (Costello and Finnell, 1998; Engdahl, 2010). As regards measures aimed at encouraging the development of bioenergy, Kutas et al. (2007) explain that public authorities have also contributed to the funding of experimental demonstrator biogas plants. These measures are crucial to the implementation of the EU energy strategy (European Commission, 2006) for EU countries that aims to reduce carbon emissions by adopting more renewable energies (including biogas). As early as 2004, the European Environment Agency was warning about the need to implement this type of incentive in order to reduce the imbalance in the energy market due to the fact that fossil fuels and nuclear energy were granted large subsidies to support this kind of carbon economy. Adams et al. (2011) explain that the UK introduced this type of measure to reach EU targets. In France, 547 on-farm anaerobic digestion or centralized anaerobic digestion projects received investment support from the National Agency for the Environment between 2007 and 2015, worth 192.3 million euros. In addition, it is not rare for some projects to be co-financed by local authorities (department, region, municipality) or the European Union via the ERDF. However, in a context where public finances are being squeezed, we question whether projects that have obtained public funding have a higher probability of seeing the light of day, or whether, in the end, money invested to support such projects fails to have the desired effect. This issue is all the more important as local authorities spend ever more on their energy bill. However, they could expect a return on investment if the community can extract synergies from being an input supplier for a digester and, simultaneously, a beneficiary of the energy produced (*e.g.* heat for the municipal pool, electricity for public lighting, etc.).

In addition to such financial incentives, other measures can foster the development of this form of renewable energy and make it attractive, especially through regulations and systems of guaranteed feed-in tariffs, or a partial or total exemption of taxes on the biogas produced (Kutas et al., 2008). These financial measures and support policies, especially in Germany, Finland, Sweden and Portugal, have helped to boost anaerobic digestion (Koplow, 2007; McCormick and Kaberger, 2007; Ferreira et al., 2012). A study in Germany, for instance, showed that such incentive schemes only work if tariffs remain stable over a 15- to

20-year period, and that they are ineffective otherwise (Klein et al., 2008). In Sweden, McCormick and Kaberger (2005 and 2007) showed that the introduction of a carbon tax helped to establish the terms and conditions of a sufficiently competitive bioenergy market.

While the literature provides evidence of the role of financial (investment subsidies, feed-in tariffs) and regulatory incentives to generate the development of anaerobic digestion projects, there is no empirical evidence regarding the role subsidies play in a projects' success, and whether the allocated subsidies create a leverage effect to make the funding of biogas plant projects easier. Our study provides insights into this issue in the French context.

3. A conceptual framework to analyse (un)successful territorial energy transition projects

The conceptual framework we present in this paper is based on two key notions, namely, territorial specificities and social acceptability, as we believe that studying the success and failure of territorial energy transition projects can offer insights into the way firms gain a foothold in an area and the inherent geographical contours. It also implies reconsidering the role of territories in the organisation of energy transition (in terms of spatial planning, territorial governance and taking territorial specificities into account). To this end, it seems useful to develop a better understanding of how relations between individuals and their living environment advance the acceptance or rejection of a project, and which factors in a project's relationship with its chosen territory facilitate a successful energy transition process.

The basic definition of the term 'territory' refers to a portion of space appropriated by a social group to ensure its reproduction and satisfaction of its vital needs. It is the outcome of the interweaving of three, existential (entity and territorial identity), physical (natural and material properties) and organisational (role and properties of social agents) facets, and is also subject to a certain number of natural, historic, economic, financial, social and physical constraints which give it its originality and distinguish it from other territories. That is why we speak about territorial specificities.

'Territory' also reflects the place of collective identity, the feeling of belonging, and territorial practices on the social acceptability of the infrastructure in question. Here, social acceptability is viewed as the agreement of a social group to accept a new development close to their home, and this is largely dependent on the territorial governance processes that come into play. Various studies found in the literature on the social acceptability of technical innovations can provide us with clearer insights into the issues involved. Social representations in general, and of the project in particulier, factor in as intermediary variables, mediating the links between the subject, a specific social group and their spatial context. The social acceptability of a territorial energy transition project thus depends on the social representations of individuals in a given territorial context.

Consequently, the sustainable nature of a territorial energy transition project and the promise of economic development linked to green energy infrastructures do not automatically meet with approval. In similar vein, the renewable nature of a form of energy does not systematically garner the support of local populations and stakeholders insofar as the underlying question not only concerns the innocuous nature of the energy with regard to global warming (fewer polluting emissions, less CO2, etc.), but also the inconvenience and the impact in general. The infrastructure not only pertains to the technology and its repercussions in general, but also to its application in a politically and socially appropriate organised territory. In addition, the territorial integration of renewable energy projects must take the specific features of the siting area into account and the way the issues, challenges and constraints mesh together on various levels.

It thus appears important to identify the factors that affect the success or failure of a territorial green energy project: (i) the nature of the project: each infrastructure has a different impact and generates different reactions. Concomitant with a smaller carbon footprint, renewable energies can nonetheless fuel tension and encounter opposition at local level since they have an impact on the territory and potentially on the wellbeing of individuals. The nature of the project depends on the type of technology used and the size; (ii) the project initiators and their legitimacy, based on the trust capital they may have created in the siting area from prior interactions in the locality; (iii) the decision-making processes and questions relative to the planning of consultation and the territorial governance process; (iv) the project's territorial installation and any potential changes to land use arising from the green energy infrastructure, and the potentially modified relations between actors. Regional integration also refers to the distribution of positive and negative externalities and their fairness; (v) reasons for the emergence of a project such as opportunity-related issues or the imposition of norms and laws independent of the project siting area; (vi) the mobilisation of specific territorial resources, both material (infrastructures, natural resources, land, finance, etc.) and immaterial (skills, local knowhow, stakeholder networks, etc.).

The links between these issues are presented in Figure 1 below. The main working hypothesis thus links the two notions mentioned above: the social acceptability of infrastructures depends on the local population's social representations of the project. These social representations depend on the multidimensional properties of the territory of the populations concerned. The territorial specificities and the nature of the project also determine the outcomes of local renewable energy projects.

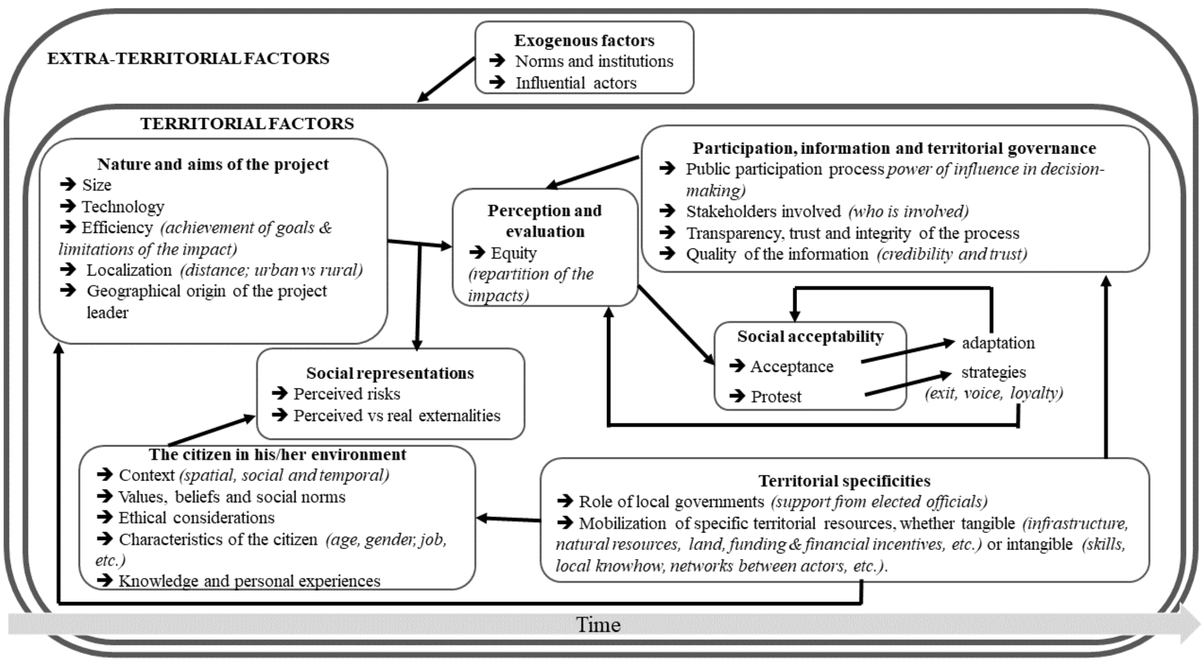


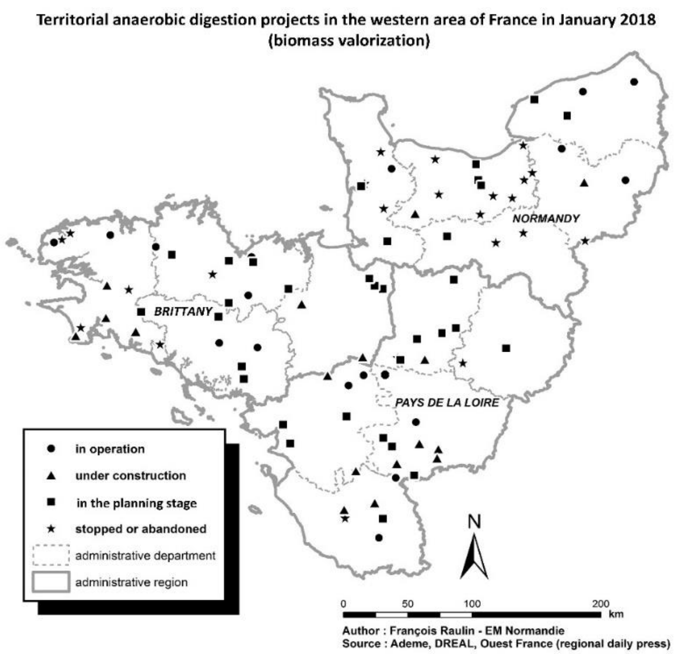
Fig 1. A conceptual framework to analyse (un)successful territorial energy transition projects

The objective attributes of a territorial green energy project are perceived and evaluated through a system of social representations. The behaviours of individuals differ in response to this process, depending on both their personal characteristics and those of their environment: some adapt and remain in place, while others adopt strategies to deal with the project: i.e., exit (departure), voice (manifestation, mobilisation) or loyalty (acceptance). In return, the behaviours have an impact on different elements of the system, especially the territorial dynamics. This process takes place in a specific socio-spatial context at a given moment in time. However, the territory in question fits into a temporal dynamic (past, present, future) and is retroactively linked to other spatial scales that can influence the project (exogenic factors). The territorial specificities play a major role by modifying the nature and aims of the project, but also by influencing the territorial governance and participation processes.

4. Materials and method

4.1. Study area

Our aim is to explain the success of anaerobic digestion projects in the west of France between 2003 and 2018 (see map 1). Our study area stretches across three administrative regions in France, namely Normandy, Brittany and the Pays de la Loire. Between 2004 and 1st July 2018, 91 joint anaerobic digestion projects with partial or exclusive waste biomass recycling had emerged in the "Great West" region of France. Unlike "farm-based" projects where one farm decides to recycle its agricultural waste, joint projects have a territorial dimension involving waste contributors with different profiles (farmer cooperatives, agri-business industry, "*syndicat mixte*" -or joint ventures between various public authorities for waste disposal-, etc.). Our study is based on both qualitative data (semi-structured interviews) and quantitative data. Our dataset covers these 91 projects that have either been launched, are under construction, are still in the planning stage, or are on hold or even abandoned. We compare the findings of the logit model with the findings obtained from our interviews.



Map 1. Territorial anaerobic digestion projects in the western area of France in January 2018

4.2. Quantitative approach: data and model

Our empirical analysis attempts to determine how a predictive dataset X is associated with the probability of success of a biogas plant Y. We used a logistic regression model (Logit) to this end, as follows:

Y = f(X, e), where

Y= the dependent variable as defined above

X= the matrix of variables likely to explain the variation of Y as defined above

e= the logistic distribution error

The estimation of our Logit model is based on the maximum-likelihood method. Let us take P_i as the probability that the Logit associates with the survey unit:

Let us take P_i as the probability that the Logit associates with the biogas plant:

$$P_i = \mathrm{F}(I_i) = \frac{1}{1+e^{Ii}}$$

I = $\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_n X_{in}$

I_i is a vector representing the characteristics of the biogas plant, β_n represents the coefficients of the explanatory variables and X_{in} represents the explanatory variables.

Table 1 provides descriptive statistics for these data. The value of 1 for the binary data in this table indicates that the given variable has occurred and is effective. If this is not the case, the value is zero. Our dependent variable (*FAILURE_PROJECT*) is the presence of an anaerobic digestion project that is on hold or has been abandoned. When this variable is equal to zero, the project has come to fruition. Our explanatory variables reflect the factors that can explain a project's probability of success or failure. We drew upon the extant literature to identify these independent variables (7 in total) and, as we shall see, assumptions about the influence (positive or negative sign expected) these explanatory variables can have on the explained variable are seldom obvious. In fact, they warrant additional empirical analysis. The variables were gathered and systematically compiled for each unit of our study area.

Table 1: Description of the variables

N= 91	Expected sign	Type	Mean	Std dev	Min	Median	Max	Sources
FAILURE_PROJECT		Binomial	0.263	0.443	0	0	1	Collection of field data
AGRI_PROJECT	(-)	Binomial	0.340	0.476	0	0	1	Technical data Collection of field data
TECHNO_GAZ	Uncertain	Binomial	0.516	0.502	0	0	1	Technical data
URBAN_TYPE	Uncertain	Binomial	0.417	0.495	0	0	1	SIG
LOCAL_OPPOSITION	(+)	Binomial	0.351	0.480	0	0	1	Local media Collection of field data
PORTAGE_LOCAL	(-)	Binomial	0.604	0.491	0	0	1	Collection of field data
NO_FUNDING	(+)	Binomial	0.725	0.448	0	0	1	French secure access database
PRICE_GAS	(-)	Quantitative	169	45	145 €/ Mwh	162 €/ Mwh	175 €/ Mwh	French Ministery of Ecology
DISTANCE_DWELLINGS	(-)	Quantitative	307.7	189.02	50	300	900	GIS
SIZE	(-)	Quantitative	40 409	29 580	9 000	33 000	130 000	Technical data

The first type of variable concerns the social aspect of project governance and acceptability. First, the *AGRI_PROJECT* variable equals 1 if the plant only recycles agricultural waste. Only farmers supply the raw materials for such projects. The fact that they know each other well and generally trust each other (Goedkoop and Devine-Wright, 2016) lets us assume that this type of project is likely to be more successful than a project led by industrialists who might join forces with farmers and local authorities with different ways of working (Torre and Wallet, 2014), making the project more difficult to achieve. Another variable, *LOCAL_PORTAGE*, equals 1 if all the project stakeholders are located within a 50km radius of the biogas plant. The actors' spatial proximity must be beneficial to the project, notably by reducing transport costs and enabling the stakeholders to meet up more often and facilitate the project's governance (Filippi and Torre, 2003; Torre and Wallet, 2014). The *LOCAL_OPPOSITION* variable equals 1 if the residents, inhabitants or environmental activists have organized opposition to the anaerobic digestion project. To collect this data, we conducted an exhaustive survey of the associations that challenged a biogas scheme linked to a project under study, with the help of regional daily newspapers and the list of associations held by the prefecture. The probability of a biogas plant being accepted is lower if a group of protestors rallies against it (Adams et al., 2011; Soland et al., 2013; Capodaglio et al., 2016; Schumacher and Schultmann, 2017). Finally, some authors (Van Groenendaal et al, 2010; Rajendran et al, 2013) have indicated that the project's size is a key factor in the profitability of digesters. However, it appears that projects which are too large are likely to generate more negative outcomes for local residents and affect their quality of life (von Möllendorff & Welsch, 2017), and may therefore result in reduced social acceptance. To our knowledge, however, no studies have investigated this crucial aspect. Moreover, as Capodaglio (2016) points out, financial incentives may depend on the project's size and consequently influence the project leader's choice in this regard. The *SIZE* variable is measured according to the tonnage of the digester (Napierian logarithm).

The second type of variable concerns the question of acceptability viewed from the geographical perspective of siting. Firstly, the *URBAN_TYPE* variable equals 1 if the biogas plant is located in an urban environment[4], otherwise its value is 0. It is assumed that people living in rural areas are more likely to accept anaerobic digestion projects since they can boost a region by creating local jobs, especially given that rural areas often struggle with unemployment. However, unlike urban areas where digesters can be located on industrial wasteland, the impact on the landscape is greater in the countryside, and this can have an adverse impact on the acceptance of biogas plant installations (Bergmann et al., 2007). Secondly, the *DWELLINGS_DISTANCE* variable represents the distance in metres (Napierian logarithm) between the first house and the biogas plant. We developed a geographical information system (GIS) to calculate this distance. It is assumed that this variable has a positive impact on the creation of biogas plants (Roberts et al., 2013; Van Rensburg et al., 2015) since the further the first houses are from the plant, the less risk there is of them being subjected to the associated costs (smell, increase in traffic, etc.).

The last type of variable concerns financial issues. First of all, we introduced a variable concerning changing biogas market conditions because during the period of the study, it has significantly change and we can reasonably think that it influences the success or failure of a project. We introduced a dummy variable on the change in the purchase price of electricity from biogas over the period (PRICE_GAS). Concerning the others variables, on the one hand, we have the *GAS_TECHNO* variable, which equals 1 if the plant injects the biomethane it produces directly into the natural gas network. It is assumed that projects recycling the gas will be more profitable than traditional anaerobic digestion plants, since biomethane has multiple uses, especially as fuel for certain kinds of vehicles. Furthermore, the French government wants to have 10% of its overall gas sources produced from green gas by the year 2030, and is therefore likely to introduce incentive mechanisms (monetary and non-monetary) for the development of this technology in order to support project leaders. On the other hand, there is the additional cost of cleaning the biogas and connecting it to the natural gas network, which may pose a threat to the project's sustainability. Moreover, as the technology is recent (the first biogas plant with direct injection was commissioned in France in 2013), the actors do not yet have the hindsight needed and may hesitate with regard to this type of project. In

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[4] According to INSEE (French National Institute for Statistics): "an urban unit is a district or group of districts with an uninterrupted built-up area (no more than 200m between two buildings where there are at least 200 inhabitants)"

addition, the *NO_FINANCING* variable equals 1 if the project has not received any operating and/or investment subsidies. The probability of a project being launched increases when subsidies are granted (Costello and Finnell, 1998; Engdahl, 2010). It is therefore assumed that a project which receives no financial aid through public policies has more chance of failing.

4.3. Qualitative approach

Our qualitative approach is based on two sets of data: one concerns the transcription of semi-directive interviews, the other the collection of press articles. A total of 49 interviews were conducted with biogas actors in the Great-West region of France between July 2016 and February 2018. The semi-structured interviews had two aims, namely, to separate issues into themes and to delve deeper into certain aspects using follow-up questions set out in an interview guide. The questions relate to several different topics, such as the levers and obstacles encountered during the project's development, the project's territorial governance and clustering strategies within a joint project (Table 2). Although most of the questions remained the same, we created a guide with specific questions for each type of actor interviewed (farmer, local politician, regional point of contact, company, association, resident) in order to specifically target their role within the project. Additional questions were included for project leaders (farmers, local politicians and company directors) on the project's emergence and the levers and obstacles encountered. The questions concerned identity (name, gender, age) and career path (professional situation, training, qualifications, etc.) to give us a better understanding of the respondents' profiles. These interviews were then recorded and re-transcribed in their entirety in order to make the analysis easier. The interviews were face-to-face and ranged in length from 30 minutes to 2 hours and 15 minutes.

The stakeholders targeted to take part in the survey were first contacted by phone or by email. The vast majority of those who answered agreed to take part. As far as the residents were concerned, we made door-to-door enquiries near the projects or the biogas plants selected for our analysis. These interviews were conducted in various places (office, meeting room, residents' dining room, project leaders' dining room, farmers' dining room, etc.). The length of the interviews varied considerably, ranging from 30 minutes for some residents to more than two hours for a project leader. The interviews were recorded using a voice recorder placed on the table between the interviewer and the interviewee.

A study sample of nine fields (i.e. around 10% of all the projects) was selected in order to conduct the interviews with project stakeholders (map 2). In total, fourteen territorial interlocutors (Chamber of Agriculture, ADEME, etc.), eleven residents near collective anaerobic digestion projects, six association presidents (pro and anti- anaerobic digestion schemes), eight companies (project leader and stakeholder), seven elected representatives (mayor, president of a community of municipalities and a politician) and seven farmers (project leader and stakeholders) were interviewed. We studied the following ventures in detail: five projects in Normandy (Coutances Agricultural High School, in the planning stage during our study and managed by a school; Capik in Fresnoy-Folny, in operation since 2011 and managed by an energy industrialist, a grain cooperative and EDF (the French Electricity Distribution Company); Biogaz de Gaillon, in operation since 2013 and managed by a local authority together with an environmental industrialist; Percy Biogaz in Percy-en-Normandie, currently on hold and managed by a farmers cooperative; Agrigaz Vire in Vire-Normandie, in the planning stage during our study and managed by a farmers co-operative), three projects in the Pays de la Loire area (Agrimaine in Charchigné, under construction during the study and managed by a farmers cooperative; Oudon Biogaz in Livré-la-Touche, in the planning stage during the study and managed by a farmers cooperative; Methamaine in Meslay du Maine, in the planning stage during the study and managed by a local authority) and one project in Brittany (Geotexia in Le Mené, in operation since 2009 and managed by a farmers cooperative, an energy industrialist and the *Caisse des Dépôts et Consignations* (French consignment and deposit office)).

Table 2: Interview guide (example for oe "farmer" project leader)

Themes	Sub-themes	Follow-up question
Did you encounter any difficulties with your project? Conversely, what made it easy?	Levers	-Financial, Economic, Environmental issues -Setting up the project (financial/fiscal/technical/legal/politica measures)
	Obstacles	-Legal or regulatory, financial, economic, environmental difficulties -Reluctance from inhabitants
	Possible improvement	-How to encourage the emergence of new biogas plants
Why did you choose to join forces to set up this biogas plant project?	Project management	-Origin of the project -Organizational issues -Communication with the local population
	Interests	-Reasons for a collective project rather than an individual one
	Proximity	-Stakeholders involved in the project and their provenance -Geographical scope of the project
	Limits	-Distance in the collaboration and ecological issues of the supply chain
	Conflict	-Presence of conflicts, origins, issues -Causes and effects of such tension?
Do you think that biogas models are sustainable from an economic and financial point of view?	Budgetary aspects	-Annual turnover -Type of share ownership -Redistribution of income
	Financial aspects	-Method of financing -Difficulties to finance the project
	Profitability, sustainability	-Profitability and expectations -Sustainability of the business -Outlooks for development -Future investments
Conclusion	If you were to do it again	If you had to develop a biogas plant again, what would you do differently? Why?

In addition to the corpus of interviews, we collected a number of press articles for analysis. The regional daily press is a useful research medium to understand how an object captures the media's attention and how it is treated (Darly and Torre, 2013). It also helps to detail the perceptions of different actors on a topic (Carducci et al., 2011; Torre et al., 2014). However, press articles (especially the written press) have certain specific features. They are polyphonic in nature (journalists transcribe the words they hear or read) and can be divided into three categories: (i) the reported event, (ii) the commented event and (iii) the induced event. Consequently, studying articles in the regional daily press requires taking certain factors into account by distinguishing, for instance, between words in quotation marks (theoretically reported spoken words) and those without quotation marks (journalistic writing that may adopt a freer tone).

We selected the daily newspaper *Ouest France* to conduct our analysis as, first, it is distributed in three administrative regions of north-western France (Brittany, Normandy and Pays-de-la-Loire) and its distribution area covers our study area and, second, it is a mainstream paper and so has a high probability of relaying biogas project news at local level. In addition, it is widely read, with fifty local editions and a daily circulation of about 700,000 copies[5], providing a wide-ranging source of information. Using the Factiva electronic database[6], we first selected articles with the keyword "aerobic digestion" and/or "biogas"

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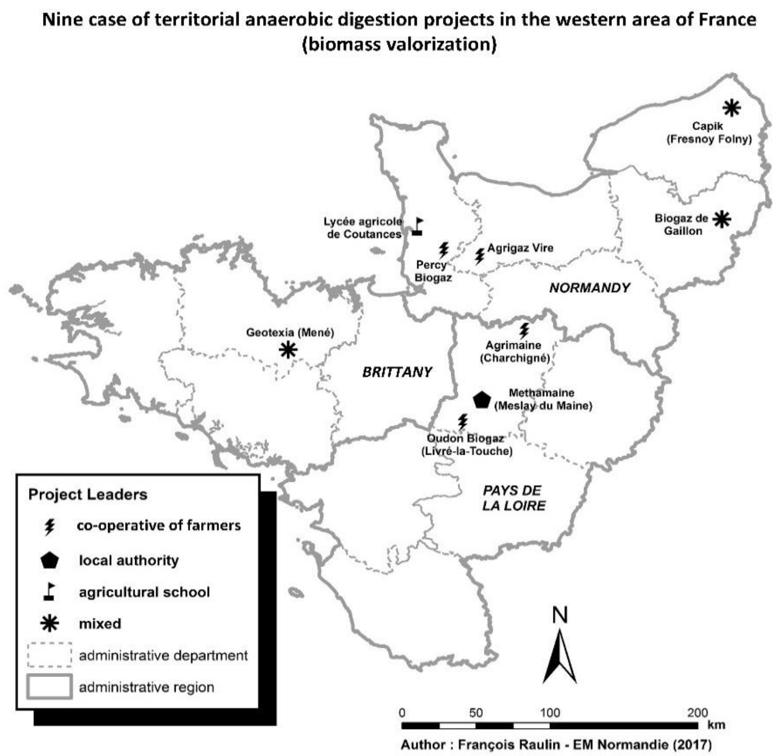
[5] *Ouest France* ranked first in the French regional daily press in terms of readership in 2016 and has been first for several years according to figures provided by the National Press Agency.

[6] A professional information tool that aggregates different content such as newspapers, magazines, photos, etc.

in the title. We then retained articles that dealt only with local aerobic digestion projects, focusing exclusively on the actors' discourse. However, this method is not exhaustive since articles dealing with aerobic digestion may have titles that do not include either of the two keywords. 455 items were collected between October 2003 and July 2016.



Map 2. Nine territorial digestion projects in the western region of France

Regarding the processing of qualitative data, the re-transcribed interviews and press articles collected were manually analysed for their themed content in order to define and understand the drivers and obstacles to the rollout of the biogas projects. According to Miles et al. (1994), themed coding can reduce large quantities of data to a small number of analytical units, helping the researchers to re-focus the analysis as the data are being gathered. In line with these authors' recommendations, we therefore drew up a preliminary list of codes (e.g.: on the organisational and socio-economic obstacles and success factors inherent in biogas development), keeping in mind that these would inevitably change and evolve over the course of the field experience. This involved identifying and grouping similar expressions and sentences within the corpus to help the researcher analyse the qualitative data collected. Thus, a reference dictionary of themes was created from the beginning of the interview stage. This helped us to group themes, dimensions and verbatim, categorised to some extent in order to reduce and summarise the information available from the data gathered. The analysis of qualitative content consists of carrying out a pre-analysis (floating reading, identification of clues, division into significant units), then exploitation (categorisation, counting) and finally, interpretation. The data were analysed using standard methods of qualitative thematic analysis. We thus built up a dictionary of themes in three stages. The first stage enabled us to identify the main themes and to identify recurring ideas and the use of metaphors and analogies. The second stage consisted of drawing up theoretical linkages following a second reading. The third stage allowed us to analyse the data collected in the field. To this end, we first sorted the data using key words from the interviews and press articles collected and classified by field (a micro level process focusing on an analysis of each biogas project and its development over time), and we included personal observations and particularly striking or illustrative sentences from the interviewees. During the discourse analysis, we identified more general project-related aspects (a more macro level process aimed at understanding and identifying the obstacles and levers to project development). Finally, we conducted cross-tabulations in which the comments of project stakeholders were categorized into variables, and aerobic digestion projects whose wording disclosed these variables were identified in order to define classes. It should be noted that the corpus was read and coded by the principal researcher and validated by the other two researchers to ensure that the data analysis was robust and accurate.

5. Findings

5.1. Lack of anticipation, feelings of injustice and fears concerning aerobic digestion

Table 3 shows the results of our Logit model. We organized the section on the analysis of the findings in such a way as to compare the model's output and the content of the semi-structured interviews.

Table 3. Logit model

	Coeff.	Std. err.	z	p. value
AGRI_PROJECT	0.251**	0.017	0,426	0,0254
TECHNO_GAZ	-0.079**	0.020	-1,446	0,0299
URBAN_TYPE	0.0845**	0.179	1,026	0,0129
LOCAL_OPPOSITION	0.182***	0.172	2,235	0,004
PORTAGE_LOCAL	-0.110	0.018	−2,875	0,1483
GAS_PRICE	-0.002	0.045	-2,489	0,1658
NO_FUNDING	-0.235***	0.164	-2,487	0,0021
DISTANCE_DWELLINGS	-0.108**	0.015	−0,735	0,0186
SIZE	-0.002***	0.016	-1,829	0,0001
No. of observations	91	Criteria of Schwarz		176,697
Log PseudoLikelihood	-57.421	Hannan-Quinn		142,9655
AIC	98.654			

Lack of understanding and trust leads to rejection of the project

Despite the development of anaerobic digestion and the large number of reports appearing in the mainstream media, its principles remain relatively unknown and projects were perceived as creating uncertainty. The study of the interviews and the press articles helped us to underscore the socio-spatial representations that citizens make of territorial anaerobic digestion projects. Given the lack of understanding of this type of alternative energy and the externalities it can generate, the issue of fear was frequently mentioned, as were the negative impacts.

Our qualitative corpus clearly shows that lack of anticipation and early dialogue contributes to a lack of trust and heightened fears, despite the fact that the project leader felt he had given enough information about the project. In effect, in our cross-tabulation of the interviews and press articles, we often came across issues pertaining to the rules of participation of the public. The concerns raised reflect the reactions of third parties that epitomize their need to understand and be reassured rather than their objections to such schemes. Their responses are nonetheless often seen as a rejection of the project by the project leaders.

Other, more radical forms of disagreement may give rise to far stronger opposition, with associations being created to oppose the projects (expression of procedural justice). Residents' resistance often reflects the defence of a living environment that supports a "lifelong project". Our model (Table 3) shows a very significant likelihood that a project will fail if a group of protestors is created.

Problems of communication and lack of information reinforce opposition

Our interviews show that project leaders faced with local opposition are generally surprised when conflict arises and by the scale of such conflict. This surprise effect helps to explain their lack of anticipation, which is all the more evident when there is no public inquiry as they believe they are less exposed to a risk of opposition and even think they can ignore local opposition entirely. Moreover, in the cases we studied, the third parties were only contacted once the opposition had emerged (whereas project leaders with no opposition had initiated dialogue beforehand), and their approach was more of an attempt to persuade the opponents (crisis communication) than a real desire to discuss the matter. In the case of the Percy-en-Normandie project (in the Manche region), the project leader was very apprehensive of local residents learning about the project's existence for fear they would oppose it. According to interviews with citizens living near a biogas plant where opposition had been strong, we noted that when there is a lack of transparency surrounding a project, there is cause for concern, and almost all the objecting residents said words to the effect that: "when it's not clear, there's something fishy going on". The residents who felt affected by the project wanted at least some dialogue and, if possible, prior consultation so they could put their point of view across, including before the project is submitted for administrative approval. Indeed, a lack of public consultation when a project is considered as industrial and potentially dangerous is widely perceived as unacceptable and unfair by local residents. It makes them want to air their grievances in public so their voices may be heard. These findings confirm the work of Hirschman (1970) on conflict situations with the logic of voice, reiterated and developed in other studies on environmental conflict (Torre and Zuindeau, 2009; Bouba-Olga et al., 2009; Torre and Wallet, 2014). Our findings are in line with the work of Soland et al. (2013) who show that lack of information and participatory democracy frequently leads to local hostility. Finally, in some projects that were well on their way to success, the situation was reversed when local elected officials who initially supported the project, seeing the opposition grow, decided to no longer support it and to no longer help the promoter with participatory governance. In some cases, this has gone even further with the project being buried following the rallying of support for local opposition associations, a clear illustration of the NIMEY phenomenon (Not In My Electoral Yard).

Size doesn't matter

In the wind energy sector, Manwell et al (2009) reported that acceptability declines as wind projects grow larger. However, our findings indicate that the likelihood of failure is not linked to the size of a project (Table 3). In other words, contrary to our initial assumption, size is not a factor in a project's success or failure. This is supported by several studies on projects involving large digesters but without any local opposition, as in the case of Gaillon, where the unit is located in an industrial area about 500 meters from the first houses. The strategic choice of location appears to play a key role in the emergence or otherwise of conflict. Thus, the mayor of Gaillon explained in his interview that the site was selected on an industrial estate in the midst of other industrial firms in order to go unnoticed by the local residents. In the regional daily press, the president of the town's golf club said that it was only when it was in operation that he discovered a big unit had been installed as he sometimes smelled the odours.

5.2. Project location and the territorial context in which it is implemented matter

Proximity to dwellings is important

The likelihood of a project failing appears to increase with proximity to housing (Table 3). This seems to endorse the postulate of the importance of siting choice for a biogas plant. Indeed, our interviews confirm that siting is the starting point for conflict and tension as well as who will have to bear the cost of a project once it has been defined on a map, when those concerned will be able to estimate such costs and maximize their profits. This type of NIMBYism based on the issue of siting generally focuses on 3 aspects: the impact on the value of buildings, personal safety, and the amenities in the surrounding environment. Interviews with residents reveal that it is not the principle of the anaerobic digestion project that is controversial (production of gas using digestible waste), but rather its impact (bad smells, risk of pollution or explosion).

The characteristics of the project leader and territorial specificities play an important role

The territorial context is a major factor in the onset of conflict between users that can involve residents and local politicians. The issue also depends on the quality of local relations as a whole and, more specifically, on the behaviour of the project leaders and how they are accepted locally. In this regard, the results of our model together with our analysis of the interviews are very enlightening. First, the model shows that when support is merely local, it is not a significant factor, in other words, the probability that a project will fail or be completed is not influenced by where the project leader comes from. In addition, projects that are led solely by farmers seem to show more likelihood of failure with a positive and significant sign (Table 3). Our interview analysis indicates that "red tape" is widely abhorred by farmers leading projects, as they are less comfortable with administrative procedures than biogas industrialists when it comes to paperwork. Some of the newspaper articles deal specifically with this issue to highlight the administrative difficulties for project leaders. Another factor mentioned in several of the interviews can explain this: farmers are less likely to adopt a consultation approach than professional biogas industrialists who are more used to organizing this type of practice. A final assumption that farmers will have better relations with rural inhabitants may be challenged by the arrival of new inhabitants who do not know them and therefore do not trust them in the same way. This idea is credible since our model shows that the probability of a project being abandoned/put on hold is greater in urban areas as city dwellers appear less willing to see a biogas plant set up near their homes. Consequently, more and more urban dwellers choose to live in the suburbs and even the countryside, leading to the urban sprawl phenomenon (Bae et al., 2017). For these rural newcomers, any parameter likely to create the feeling of a sizeable change to their living environment (e.g., the opening of a biogas plant) will have a significant negative impact. This is the NIMBY effect, potentially leading to residents grouping together to oppose such projects.

5.3. Financial incentives needed to support emerging projects

Public funding improves the probability of success

Finally, we attempted to assess the role of public policies in the success of projects. First of all, we showed that the price of the market is no significant. Since 2019, the French Government has decided to change significantly this price of purchase, so we can expect that, in the future, it will affect the business model of the biogas units. Looking to develop a model, we tested two variables in connection with these policies. The first concerns the financial aid that public authorities may allocate for such projects. The probability of a project failing appears to be linked to a lack of funding (investment and/or operating subsidies). This corroborates the work by Engdahl (2010) on the need to provide aid for emerging projects. Analysis of the regional daily press clearly shows this, both in the speeches of elected politicians who publicly point to their financial support as essential, and in project leaders' comments to journalists on the need for public assistance. The second variable concerns the type of recycling process involved. Injection-type biogas recycling appears to have a negative effect on failure, in other words, it should be preferred to cogeneration to increase the chances of a project's success. This was confirmed in our qualitative corpus in which project leaders explained that the profitability factors for plants with cogeneration and electricity production were unsatisfactory. They consequently often refocused their project on direct injection of methane, made possible by the nearby presence of firms (especially agri-business firms) that require gas all year round.

Support from public authorities is a determining factor

We went beyond the two variables included in our model to ask the project leaders more general questions about the role that political decision-makers and public policies played in supporting their project. For both farmers and industrialist project leaders, the evidence shows that while the process is longer when politicians are associated with it, they nonetheless enable more actors to get involved and more meetings to be organized, changing the project's dimension. As has been shown before (Bourdin, 2020), politicians place such projects within a wider territorial strategy. If we take the example of the Vire project, an environment cluster was created after the politicians noted that the biogas scheme was making good progress and the Chamber of Agriculture supported it. Having an influential leader – in this case, a farmer as the driving force – is not enough to drive action if it is not supported by a regional dynamic.

6. Conclusion and policy recommendations: local fairness and territory matter

The identification and discussion of the main factors that affect the success or failure of territorial renewable energy projects add new contributions to this topic that include not only aspects concerning social acceptability, but also other factors linked to territorial specificities as mentioned in the conceptual framework. We showed that the projects are contingent on the territorial context. The mixed methodology adopted allows us to cross reference the analyses and to take a synoptic approach to a complex issue. The logit model could be extended to include a georeferenced survey of local residents in the data, which would give a more detailed socio-spatial representation of the aspects linked to local residents and their environment.

We showed that lack of anticipation and early dialogue impinge on a project's success. Trust plays a particularly important role. As a result, consultation is an essential pre-condition to the success of any project. In addition, we showed that the characteristics of the project leader are also important. In this respect, a project managed solely by farmers seems to have less chance of succeeding. Furthermore, social acceptance appears to be correlated with the proximity of the biogas plant to local housing. The likelihood of failure increases if a biogas plant is too close to houses, as it often leads to groups of protesters being formed, further minimizing the project's chances of coming to fruition. Our study indicates that operating and/or investment subsidies have a positive impact on the chances of the project being successful.

Another key finding from our analysis is that the size of the project is not a determining factor. This is very important as it shows it is possible to build large projects without necessarily being doomed to failure or subject to local opposition. In this respect, as mentioned above, the way the project is presented to the population is more significant.

Negative externalities linked to the production of biomass energy are mainly local, and affect the direct individual wellbeing of the inhabitants, but they are also reversible. These externalities can be minimized through education, consultation and choosing a 'safe' location. Even if dialogue with the inhabitants does not necessarily imply a joint decision, involving local citizens in the project design stage can help to develop trust and prevent a feeling of injustice. Explaining how the project will be rolled out and its likely impact is important in boosting acceptance. Whatever the situation, ignoring citizens' concerns regarding the visual impact, the impact of noise and/or smell and potential risks – whether sanitary or industrial – is not the solution, and is often a source of increased tension.

Our study indicates that conflict linked to anaerobic digestion projects is based on specific fears held by residents. These fears are related to the newness of anaerobic digestion and the fact that it creates uncertainty, especially when the projects rely on non-agricultural inputs or on creating a site from nothing. Such concerns lead citizens to pose questions and express opinions about the projects since these issues are likely to have an impact on their living environment. They may be led by groups of residents who are against the project or local environmental protection associations. Risk of the onset of conflict can be mitigated by providing the residents with early targeted information prior to the project's introduction to encourage dialogue rather than during a public meeting. Project leaders must be prepared for these discussions and be ready with answers to the fears expressed. They therefore need the necessary tools for their project to be accepted by the local population, such as a guide to good practices with ways to inform residents and details of the different chronological stages of presenting targeted information.

Following the law on energy transition for green growth enacted in France in 2015, anaerobic digestion is destined to develop rapidly and to spread across France in the coming years. Consequently, training adapted to aerobic digestion project leadership needs to be envisaged in view of the numerous joint projects to come, designed to promote social acceptability and financial profitability which individuals who are novices in the construction and management of joint projects may otherwise lack.

Moreover, the distribution of externalities and the legal situation must also be well thought through. Generally speaking, objections to biogas plants can be lessened by the fair distribution of the benefits renewable energy facilities can offer. This "local fairness" can take many forms: a reduction in local taxes linked to an increase in the municipal authorities' tax revenues, a reduction in the cost of electricity for local residents, damages for home owners living near a facility, partial or total ownership of a project by citizens or community groups who distribute the benefits, and tightening the law to prevent such green facilities from being set up too close to housing. At the same time, the financial benefits should not be used to mitigate the potential (sanitary and land-related) risks generated by biogas plants. These issues need to be discussed irrespective of the financial benefits.

Finally, our conceptual framework is designed to be applied to other territorial energy transition contexts, especially those likely to involve rollout issues such as aerobic digestion or wind energy projects (on land or at sea). It could also be applied to land management projects such as the construction or extension of an airport, landfill centres or high-speed train lines. Reflections on the methodology protocols to be adopted and the nature of the data should also be taken into consideration to add an operating framework to the conceptual framework developed in the present paper.

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