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Constructing and Organizing Biogas Markets Amid Fragility and Controversy

Adam Buchhorn

Doctoral School of Organisation
and Management Studies

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The Doctoral School of Organisation and Management Studies (OMS) is an interdisciplinary research environment at Copenhagen Business School for PhD students working on theoretical and empirical themes related to the organisation and management of private, public and voluntary organisations

Preface

Climate change and sustainable development have become central social and political concerns of today's world. Although surrounded by great controversy and uncertainty they are based on the good intentions of improving the environment and creating a more sustainable world. Meanwhile, a great number of companies, private and public research institutes and international conglomerates are seeking to meet these with new solutions for renewable energy production, environmental solutions, biotechnology, and other forms of advanced and complex technology and knowledge. However, in a world based primarily on a market economy the world face the challenge of realizing these good intentions by creating markets for advanced technology that is both new, untried, fragile, and controversial. In short, they have no 'value' beyond a promise to realize good intentions. Without stable and well-performing markets these technologies may well end up in hall of fame as many other revolutions. Hyped and compelling, but generally disappointing. How markets for this particular breed of technology are constructed is the central topic of this research project.

Through the force of argument and academic analysis, I hope this project clearly demonstrate the fragile and controversial nature of markets, the efforts required to create and stabilize them, and why they so often fail to deliver on the good intentions they are conceived with. Today, markets represent a powerful ally but as these pages will illustrate are only rarely effectively organized and assembled to deliver on the good intentions. This inevitably raises difficult questions about the strengths and weaknesses of markets, limitations in our understanding, how they are designed and organized, the inherent conflict between the interest of ordinary citizens and national policy, and finally, to what extent political intervention and control over markets should be allowed.

My ambition is not for my findings and suggestions of my own to constitute finite and exhausted answers to market making. I shall be content if they are plausible in detail and stimulating as a whole, perhaps motivating further research.

As in so many of life's endeavors, performing proper academic research is highly implausible without enlisting a powerful army of supporters.

Above all, I thank my visionary supervisors Professor Peter Karnøe and Associate Professor Maja Horst from the Copenhagen Business School. Your theory-laden talk, combined experiences, ability to speak frank, and visionary mindset helped make the project what it is today. I apologize for the occasional detours, and the pungent reality of manure I exposed you to, but I fear it is the calculated risk of doing proper empirical research. Apparently, livestock manure not only extends itself to relevant and contemporary academic research; it also holds true entertainment value and cause people to laugh.

By simple means the Oticon, Otto Mønsted, and Knud Højgaard foundations, along with the Doctoral School of Organization and Management Studies at CBS helped finance a productive stay at Columbia University in New York, where I had the privilege of working with a diverse group of talented people from academia. To my temporary supervisor David Stark at Columbia, whether spending late nights with PhDs or contemplating life on campus, your approach to extracting our potential is unprecedented, fun, and utterly stimulating.

Above all, I am indebted to the host of people I have interviewed. Bruno Sander Nielsen, Kurt Hjort-Gregersen, Søren Tafdrup, Ulf Henius, Johannes Christensen, Preben Andersen, Alan Lunde and others all helped provide the empirical basis without which *Markets of Good Intentions* could never have been written. I hope you find the results relevant, and that this project provides a new perspective on the ups and downs of biogas in Denmark, while conveying your views and thought with the respect and accuracy as intended.

And finally, to the best partner in life to ever have existed on Earth, in all past and present civilizations, and in the universe - my wife, Julie. No words can encompass the depth and scope of my gratitude for your support and participation in this.

Adam Buchhorn
- Copenhagen, Denmark

1. Markets of Good Intentions – An Introduction

Most of the products or services we consume on a daily basis such as milk, diapers, internet services, etc. are provided to us through markets. They have not only been developed into an entity, but also a commodity that makes it valuable for exchange. And to purchase them is relatively uneventful. A combination of producers, suppliers, distributors, and sellers ensure buyers are provided with a selection of goods and services. Should something go wrong there are warranties, rules and regulation, and even courts of law to handle incidents and settle potential disputes. These markets are in other words, well-organized. In fact, many of markets we encounter are well-organized and able to exchange goods.

Not all markets are like this. The world is also inhabited by entrepreneurs, scientists, grassroots movements, and government agencies with intentions of creating a new innovating product or service to a meet a demand for a cleaner environment, for replacing a fossil fuel economy with renewable energy, or for achieving sustainable production and reducing waste. The world is packed with such 'good intentions' and innovating solutions to realize them. However, in contrast to the markets for milk, diapers, and beer realizing the good intentions of environmental and energy technology by constructing markets is a long road paved with difficulties beyond developing the product itself. Consider these examples:

- After appearing in great numbers in the mid 1990s, the market for electric vehicles (EVs) had almost vanished ten years later. Despite conflicting accounts over who 'killed' the electric car, its limited capacity, range and lack of familiarity with regular cars are often cited as reasons for why it failed to attract a mass audience.
- The Danish company Watech, developed a technology for removing dioxin chemicals from PVC widely used in plastic products as opposed to the costly procedure of storing or incinerating it. But the unit is not commercially

available since the EU refuses to implement regulatory changes that prevent PVC incineration.

- In the early 1980s, the US government provided tax credits to renewable energy production to offset dependence on embargoed oil. When the US Congress voted against an extension of production tax credit for renewable electricity production in the mid 1980s, markets for new wind turbines vanished in the US. Wind power was no longer competitive with conventional forms of energy.
- The Danish government has planned for 50 new so-called biogas plants during 2007-2020 to triple renewable energy production based on manure and other forms of biomass such as industrial waste. At the same time, biogas plants allegedly mitigate climate change, and reduce the pollution of aquatic water ways. So far only one has been constructed because local controversies over potential odor leaks and increased traffic discourage local government from approving construction sites.

Seen from the perspective of this project, these are all examples of markets of good intentions. When various technical, economic, social, and political intentions of developing and implementing various kinds of technology were never realized because markets failed to emerge and stabilize. Some never left the test beds in the laboratory, while others have turned into fully capable technologies after decades of development but encountered other barriers necessary to become a commodity. To deliver on the good intentions, the problem is not only related to technological development, but also related to how innovative goods acquire certain economic properties that transforms it into a valuable commodity allowing it be exchanged and transacted. That is the core function of markets. But just like innovating technology, markets to not automatically appear. These too must be constructed. The question relevant to pursue in this project is how technologies and their markets are created and stabilized to transform underlying good intentions into valuable commodities that can be exchanged with the ease as milk, diapers and beer?

The examples listed above were not randomly identified. I specifically added *biogas plants* to the list. Just as a wind turbine harnesses wind power to produce renewable energy, biogas plants transforms loads of pungent livestock manure and other forms of biomass into a gaseous form of renewable energy known simply as *biogas*. Among its technical, scientific and political supporters it is heralded for its ability to provide clean, renewable energy, reduce agricultural pollution and greenhouse gas emissions, along with numerous socio-economic benefits such as jobs creation and export values. In the early 1980s, it was estimated that 20.000 small biogas plants could supply almost around 18% percent of national energy consumption but only a handful survived the 1980s. In time it developed several new technological purposes in response to environmental problems in agriculture in the 1980s, and more recently as a cost-effective solution to climate change. In the 1990s the government believed biogas would deliver 8 petajoule (PJ) of Danish energy consumption. Today it supplies 4PJ. In 2004, the government called for 40 new plants and 20PJ of energy consumption; a target which was raised to 50 plants in 2007 by 2020 following a decade during which only one plant saw the day of light. In other words, only rarely were the good intentions of biogas realized by markets for biogas plants in Denmark.

But there is one other central reason for choosing biogas for this particular study. In time, biogas plants have developed a talent for 'spilling over' or *overflowing* into its surroundings creating unintended problems for 'innocent' bystanders and sparking controversies over its existence with economic, technical, political, and social aspects. For decades engineers have struggled with low biogas production, if any at all, components failing, and plants leaking the pungent smell of manure to the dismay of the local community. The cost of repairs and maintenance has rendered many plants inoperable and uneconomical. It is argued the problem is not the market, it is the technology. Adding to the challenges of creating a market were controversies over safety and consequences for residential neighborhoods in case leaks from the plants. Recently, it has been argued that the reason why the government intentions of constructing 50 new plants by 2020 cannot be realized is that the plants are not economical. Others claim the opposite and instead problematize the lack of political will and support in the municipalities that makes it difficult to obtain the necessary permits to construct and operation biogas plants. It is argued the problem is not the technology, it is the market. What caught my interest in biogas was this fragile and controversial behavior biogas plants have exhibited in the four decade they have existed in Denmark, consequently making its possible marketization a particular challenging endeavor. Who is right is irrelevant to this study. Instead, the purpose of choosing biogas is not only to examine how markets are constructed for biogas plants, but specifically to address the impact of these overflows and controversies, least of all how they are addressed and mitigated to ensure well-organized markets.

As such, *Markets of Good Intentions* is not just an innovation study, the transformation of manure and a host of other elements into a specific technology known as biogas, but equally a study of the creation and stabilization of markets for biogas plants amid fragility and controversy through which biogas can be exchanged as a commodity. Without a technology that works, and a market that renders it a valuable and tradable economic good, what we end up with are markets of good intentions. Using qualitative data on biogas markets, this research project examines how biogas plants are developed and qualified as an economic good, and markets created to facilitate transactions amid the constant presence of fragility, what I shall define as ‘overflows’ below, along with the controversies that accompany such markets.

The analyses in this project draw on the anthropology of economization, recently published by Koray Caliskan and Michel Callon (2009; 2008). Whether a good becomes economic, whether a market emerges, and whether the good can be exchanged is considered an outcome of an economization process and is not taken for given. Constructing markets, being one prominent form of economization, emerge through a process denoted as *marketization*. For goods to be marketized and for markets to exist the products or services they sell must be framed and organized as worthwhile or valuable, including the pacification of biogas as good, framing of biogas market agencies capable of performing valuations, and the framing of market encounters which makes it possible to complete transactions of biogas plants between different actors. Framing and organizing implies the dual process of identifying and assembling the host human and material actors needed into a frame ‘around’ the market within which interaction between them takes place according to whatever rules and regulation exists. Framing and organizing are broad terms, and refer to a several forms of framing/organizing - from developing and assembling the host of humans and material objects into a good and enlisting key actors, from investors and money to policy-makers and policy, to the process of qualifying it as an economic good and completing transactions. However, framing also implies the possibility of identifying *overflows* and containing them. Overflows can always occur, such as when a product unexpectedly fails, an important investor decides to ‘leave’ the frame, a vital piece of legislation is revoked, or a controversy is sparked over some negative ramification of operating the product. Marketization therefore encompasses the fragile and controversial aspects of technology as well as markets, including how goods are developed and qualified as economic goods, how market actors are qualified to perform valuations, and finally, how market encounters render transactions of biogas plants possible. In this regard, whether overflows and controversies are framed and regulated within the frame allows us to distinguish between well-framed markets, like those for milk, diapers, and beer versus ill-framed markets of good intentions where overflows and controversies make it difficult to marketize specific goods.

It is vital to stress the descriptive rather than normative nature of this study. The purpose is not to argue that marketization is the only answer to the perpetual question of how goods become economic and markets are constructed. The framework is not applied as a recipe to market making, and thereby not a list of answers I can apply and compare to the story of markets for biogas plants. Nor am I a priori assuming that biogas markets are ill-framed markets because of its alleged fragile and controversial characteristics. Instead, these 'fractures' in the frames are entry point through which we can explore the degree of ill-framed versus well-framed before analyzing how individual biogas plants are constructed by completing transactions, if at all possible. I am curious to discover the effects of overflows and controversies on biogas market making and by inference how they are addressed and solved to realize the good intentions of biogas plants.

More accurately, the objective is to study markets for biogas plants in Denmark, known simply as biogas markets, since its appearance in the 1970s, by analyzing the marketization of biogas plants in the past four decades whereby biogas plants are framed as economic goods, and markets are created to render transactions possible. As a central analytical dimension, the project will analyze how overflows and controversies affect the framing and organization of markets and transaction, especially how they are reframed and resolved – if at all? Eventually, this reveals to what degree we can speak of well-framed biogas markets prompting us to discuss the challenges of creating biogas markets in Denmark.

The dissertation is structured around two main analytical chapters, each consisting of several analyses. The first analyzes the marketization of biogas plants since the

1970s when biogas first emerged. This constructs the fundamental understanding of biogas market in Denmark, upon which the next chapter explores how these markets facilitate individual transactions. But to begin with, it is important to briefly describe biogas technology before discussing the theoretical background and methodological considerations in bringing biogas markets to life.

1.1 Biogas Plants

To avoid confusion, when I speak of biogas markets I refer to markets for biogas plants, and not the form of renewable energy these plants produce. Biogas plants were initially conceived as a rudimentary response to the oil crisis of the 1970s to transform a seemingly simple local resource, livestock manure into an equally simple product, energy. The principle in a biogas plant is fairly simple, at least on paper. Biomass material, in this case mainly livestock manure, a mixture of animal urine and feces, produced by cattle and pigs is collected from one or several livestock farms and pumped into a biogas reactor. In the absence of oxygen, technically referred to as anaerobic conditions, this starts a naturally occurring process known as anaerobic digestion. It is sustained by naturally available bacteria which 'eats away' part of the manure producing a gas consisting of methane and carbon dioxide, commonly known as *biogas*. The gas can subsequently be consumed to produce heat and/or electricity for the public energy electricity grid or district heating system. Upon digestion the de-gassed manure is used as fertilizer by crop farmers as is normal procedure (Raven & Hjort-Gregersen, 2007). Processing manure in biogas plants is simply an extra step before it is applied as fertilizer. Initially, only *farm-scale biogas plants* existed. These serviced the needs of a single, perhaps two farmers. In time, however, biogas technology evolved and was transformed into possessing many other valuable qualities, from solving environmental problems from agricultural pollution and turning various forms of industrial and household waste into energy. The 1980s saw a *new centralized biogas plant*, the economies of scale-version which operated from a centralized location used by many, sometimes hundreds of farmers to transform worthless manure into valuable energy. Biogas plants were also promoted as a solution to agricultural pollution, in particular nutrient runoff from manure used as fertilizer. It was discovered that anaerobic digestion rendered crop nutrients more accessible to plants and crops in degassed manure. Meanwhile, this also reduces harmful ammonium emission. The technological development and increased demand for biogas plants resulted in a range of other equipment beyond the reactor. Pre- and post-sanitation units eliminated deceases and dangerous bacteria preventing the spreading and outbreak of deceases among livestock or crops after re-using the manure as fertilizer. Odor retentions systems and air filters are designed to remove the excessively pungent odor of livestock manure. Customized manure trucks deliver manure inside specially designed halls. Advanced computer equipment is used to automate much of the process. In the late 1980s scientists also added other forms of biomass to the reactors, with much higher energy yields than manure, such as household waste, slurry, and industrial waste from meat and dairy factories. A few plants using household waste feature separate systems to remove unwanted non-organic objects..

During the 1990s, it was believed biogas plants alone would not be able to comply with increased environmental regulation on reducing nutrient runoff. Consequently, biogas plants were augmented with so-called separation units which separate considerable amounts of the crop nutrients, phosphor and nitrate from the manure, before it is applied to the fields. Recently, biogas plants have been hoisted to the prestigious array of weapons to combat climate change, directing its capability towards reducing greenhouse gas emissions and producing biofuels. CO2 and the much more potent methane (CH4) are reduced by offsetting the use fossil fuels, and instead harnessing the methane to produce energy. And by using enzymes to extract alcohol from biomass helps create biofuels to replace conventional forms of petrol and diesel based on fossil fuels. At the same time, biogas has consistently been promoted on socio-economic merits such as job creation, industrial 'adventures', and economic growth. As such, it would be incorrect to present biogas plants as a renewable energy technology. Housed in the same good is an environmental technology, waste disposal unit providing a service for other industries, climate change mitigation, etc.

Among experts, biogas embodies the notion of good intentions. It is presented as a 'win-win' technology with environmental, energy, and a host of socio-economic benefits. But we are getting ahead of ourselves here. The processes, by which these multiple versions of biogas plants were developed, transacted and constructed by biogas markets in Denmark is what this project will examine. How biogas plants evolved from being framed as a renewable by transforming manure into energy, and on to mitigating environmental pollution and combating climate change are the outcomes of complex processes. What is needed is a framework capable of conceptualizing the processes by which biogas plants became valuable for market exchange while acknowledging that technological development and market making can be both a fragile and controversial process.

1.2 Constructing and Organizing Valuable Goods and Economic Markets

The main problem this project sets out to examine is how biogas plants as a good, a product, and a service is attributed with a set of values that allows it to be exchanged in biogas markets, i.e. the construction of a valuable good and economic markets, which also facilitates the transaction that results in the construction of single biogas plant. How does a good end up on the supermarket shelve as a commodity to be transacted? We cannot assume that the good intentions behind biogas plants automatically translate into a market. Nor can we assume the 'supermarket' to exist or to be organized in such a way that it facilitates the transactions whereby goods are exchanged between sellers and buyers. In this section we explore how various theoretical approaches attempt to conceptualize how goods become valuable for market exchange and how these markets are constructed; how underlying good intentions are realized and delivered in markets by facilitating market exchanges. There are undoubtedly numerous starting points for such a review. But above all the notion of *value* is a cornerstone in many theoretical approaches to understand successful innovations. For any product or service to be sold on the marketplace it must provide some form of value economic, personal, rational, or entertainment value to the host of actors involved. In the words of Caliskan and Callon (2009, p. 389), 'If a good is produced it is because it has a value for its producer; if it is distributed it is because it is a source of value for its distributor; and if it is consumed it is because it has a value in its consumer's eyes (…) it is because they are valued that they become goods'. Value therefore encompasses a range of entities and activities required for products to become commodities and markets created, and are not restricted to mere labeling and packaging of the product itself. For a customer to ascertain the value of given produce requires a supermarket, and eventually the ability to purchase the product.

The purpose is to identify a theoretical framework which can be applied to understand how goods become valuable commodities and markets are created. This requires a focus not only on technological development but also on creating economic markets. Biogas plants cannot deliver on the good intentions it is associated with unless able to be transacted in markets. The 60-odd plants currently 'alive' were transacted as gifts from some benevolent force, but the outcome of 60-odd market transactions. What we require is a framework with the analytical capacity and dimensions to account for the process by which products become worthwhile commodities in the first place. I want to argue that a proper framework is not focused on identifying relevant technology and market 'ingredients', such as products, innovations, marketing, organizations, knowledge, capabilities, policy, while black-boxing the process that create and associate them. Rather, a proper framework does the exact opposite by focusing on the processes whereby each of these emerge, and are consequently related to one another and organized to form a durable market. To paraphrase Latour (2005), instead of studying the market as a stabilized entity and inspect its specific ingredients we should scrutinize more thoroughly the exact content of what is 'assembled' under the umbrella of markets. Keep in mind, that we cannot a priori assume a good to be worthwhile for market exchange. To become an economic good, a commodity is not a given but must be studied empirically as the outcome of complex process.

1.2.1 Dosi et al.: Technology and the Economy

Starting from high theoretical ground on the relationship between technology and economy, Dosi et al. attempt to address the general properties and dynamics of technological change and its co-evolutionary perspective with the economic and social context in which it occurs (Dosi, Orsenigo, & Labini, 2005). The purpose is to map various factors that determine and direct the co-evolutionary forces of technological change. Motivated by the historical relationship between technological change, economic performance, and international trade, they map major innovations and discoveries as a function of the uneven distribution of wealth and power in world. Such a perspective should then be fruitful for understanding what defines valuable products and services, and consequently how they become traded as economic goods. The principal argument is that the economic impact of technological innovation depends on a match (or mismatch) between the opportunities and constraints offered by major available technologies, the structures and behaviors of business firms, and finally, the characteristics of broader institutions governing markets in labor, finance, and product.

The first issue to address is patterns of technological search and the production of organizational knowledge as a core ingredient in forming new technological paradigms (e.g. electricity or cyberspace) and the specific technological trajectories (e.g. the internet) that are spawned, before addressing the social and economic 'constraints' to the specific opportunities technologies can provide. Drawing on Nelson and Winter's evolutionary perspective (Nelson & Winter, 1982), who in turn draw on equal parts of Herbert Simon and Joseph Schumpeter, Dosi et al. see technological change and economic activity as an evolutionary process in which business firms compete against one another to deliver products and services in accordance with the ever-changing demands from its economic and social context. Nelson and Winter denote this particular repository as the 'market selection environment' from which business learn of new demand and optimal behaviour. Business firms are considered the most important agent. Their principal activity is to leverage its social pool of knowledge, organizational routines, skills, and discovery opportunities towards constructing organizational knowledge upon which new products and services are innovated. Routines enable firms to solve problems, enhance existing organizational practices, as well as produce and search for new relevant knowledge. Firms continuously search for and extract the 'economic properties' of information from the pool of organizational knowledge to guide technological development and innovation towards appropriation. That involves cognitive categories, codes of interpretation of the information itself, tacit skills, and search and problem solving heuristics (Dosi, Orsenigo, & Labini, 2005, p. 685). In terms of extracting 'technologically useful' knowledge they emphasize the mutually constructive relationship between science and technology. Science produces knowledge used to develop new technologies, and conversely, technology leads to the development of instruments such as the microscope, x-rays, and the computer used to make new scientific discoveries. Dosi et al. note that not all scientific and technological knowledge is appropriated, i.e. other economic and social factors are at play.

And as a cue for describing economic and social factors in technological accumulation, 'in most contemporary economies, one typically observes quite a few institutions, together with a multitude of profit-seeking firms, sharing in different combinations the tasks of scientific explorations and search for would-be technological applications' (p. 687). To fully explain how new technological bases, new search heuristics, dominant designs (term borrowed from Utterback, se more below), and specific products are selected there is good reason to include 'appropriability conditions'. Their point is that various institutions (such as the military), social groups, and individual agents perform ex ante selectors of the avenues of research that are pursued, along with the techno-economic aspects upon which research ought to focus. They ultimately select the new technological paradigms that are explored. One such vital external factor is the economic influences upon technological change. Potential profits, cost of production, patents etc. influence the rates and direction of 'normal' technical change. These also include changes in search/problem-solving heuristics induced by price changes and demand/supply conditions such as supply shocks and bottleneck; the effects of demand patterns upon the allocation of search efforts, i.e. the idea of 'demand-led' innovation and feedback loops between innovation, diffusion, and endogenous generation of new opportunities; and the effects of appropriability conditions such as profit expectations. Other economic factors shaping the selection process also include limitations in firms' organizational routines used to select techniques and paradigms.

Digressing from the evolutionary perspective, Dosi et al. are particularly interested in addressing the social embeddedness, adopted from Granovetter (1985), to explain the process of generating useful knowledge and its economic exploitation in new technologies. National institutions and policies have supported innovation, diffusion and skill accumulation and the notion of market failures (e.g. environmental pollution) bring to mind the role of social pressure groups. Mentioning 'market failures' underscores once more its evolutionary heritage. Much like Nelson and Winter, Dosi et al. explain the role of political and government institutions in rectifying market failures which affects technological development. For instance, environmental policy is instrumental in preventing certain technology considered harmful to the environmental from being implemented. This perspective is originally borrowed from Coase (Coase, 1998). To Dosi et al. there is little doubt about over the social and political role in shaping technologies but they have difficulty in situating their view between traditional technological determinism, whereby new solutions objectively outperform previous ones, and social constructivism (Bijker, Hughes, & Pinch, 1987) whereby everything (even the gravity) is negotiable. While acknowledging the reciprocal relationship between technological, economic, and social factors, their view is more cautious. Citing increased divisions of labor and refined mechanisms of work force control, flexible specialization as examples of degrees of *plasticity of technological knowledge*, Dosi et al. 'maintain that the process of accumulation of technological knowledge entails an inner logic and inner constraints that social and economic drivers can hardly overcome' (Dosi, Orsenigo, & Labini, 2005, p. 692).

To summarize their view, whether a product or service is successful measured by its diffusion, is not only influenced by the production of knowledge, and firms' ability to leverage organizational routines, skills, and capacities to search for and select new ventures. It is equally an outcome of the constantly changing market conditions, as well as institutional and social factors. In fact, they recognize the social-shaping and co-constructing of technology and the complexity and unpredictability in the overall 'algorithm' which determines who survives the shifting tides of evolutionary change. However, beyond this is it unclear how these 'economic and social factors' emerge in the first place, where they come from, how (not why) they influence the diffusion of specific solutions, or how a specific science influence technological development as opposed to others. They are treated as exogenous elements which by means of demand mechanisms help indicate and constrain business firms' future 'appropriability opportunities'. This raises the question of how firms calculate potential profits, or institution and policy emerge to mitigate market failures and influence whether a good secures profits. Soliciting Coase (1998) for an answer to this yields no answer. Even if we accept institutions and markets as pre-existing entities, they still fail to explain the process by which markets or political institutions demand one type of technology over another, thus explaining why a good becomes economic and tradable in the economy. The market and the economy are referred to as a universal container for demand and consumption of firms' products and services. In other words, there are no specific markets for specific products. Despite praising evolutionary economics for 'opening up, together, the "technological black box" and the "organizational black box"' (Dosi, Orsenigo, & Labini, 2005, p. 684) they themselves black-box several overriding aspects crucial to understanding how a good eventually end up on the supermarket shelve. After all, if they believe 'innovation activities are characterized by an intrinsic uncertainty about both technical and commercial success' (p. 691) why not provide answers as how these can be understood and explored empirically?

1.2.2 Tidd et al.: A Management Perspective on Successful Innovations

Dosi et al.'s article was an attempt to provide an overarching perspective on the relationship between technology and the economy but the framework left several crucial questions unanswered. Perhaps, if we explore the management-perspective manifestation of Dosi et al. designed to explain how technological development leads to successful innovations, we find the answers. Take for instance, Joe Tidd, John Bessant, and the late Keith Pavitt's book on *Managing Innovation – Integrating Technological, Market, and Organization Change* (2002). The book tries to provide an integrated understanding of the relationship and dynamics between organizations, innovations and markets towards creating successful innovations. In other words, is should be exactly what this project needs. The starting point for Tidd et al. is the inherent uncertainty in developing new innovations. There are no final recipes for success, but 'despite the uncertain and apparently random nature of the innovation process, it is possible to find an underlying pattern of success (…) Close analysis of many technological innovations over the years reveals (…) the majority of failures are due to some weakness in the way the process is managed'. Tidd et al. argue that 'success in innovation appears to depend upon two key ingredients – technical resources (…) *and* the capabilities in the organization to manage them' (p. 51). In other words, to innovate and market new products and services depends on an ability to leverage organization capabilities towards navigating the uncertain process of the innovation management.

Tidd et al. acknowledges that there is a difference between creating a new technology paradigm/trajectory and creating an innovation and product that is successfully accepted by the market. In other words, it is not assumed that products are automatically accepted and diffused through markets. In fact, that is what separates an invention from innovation. The book is organized around a multi-phase innovation process model, from initial scanning to final implementation in the market before learning and re-innovation processes keeps the evolutionary wheel of the firms' success going. Firstly, the 'environment' is scanned for technological, market, and regulatory signals which are filtered and processed to indicate potentially new innovations. As such, we find the same set of economic and social factors influencing what valuable technologies firms choose to develop, albeit stopping short of denoting it social shaping of technology. Next, firms carry out detailed analyses and assess costs and benefits before agreeing and committing resources. And after the innovation is ready, the product is implemented and marketed. A vital part throughout this sequential phase-view on creating successful innovations is to establish external linkages to a variety of market actors to secure complementary assets and competencies, quiz focus groups for feedback and response on new products, and others through which news of any changed requirements are channeled to the firm. There is strong element of user-driven innovation. Above all, staying in tune with the changing requirements of the market is vital to securing a valuable innovation.

A vital distinction is that not all innovations are the same. Some are radical, others are smaller incremental or modular innovations which results in different managerial challenges with regard to leveraging organizational resources towards creating valuable products. The most difficult forms of innovations to succeed with are radical technological paradigms and complex products. They describe how 'complex products or systems are a special case in marketing because neither the technology nor markets are well defined or understood.' (p. 181). This stands in contrast to more well-known forms of technology. Complex products 'typically consist of a number of components, or subsystems' arguing how 'the benefits to potential users may be difficult to identify and value, and because there are likely to be few direct substitutes available the market may not be able to provide any benchmarks' (p. 182).

For such complex technologies, Tidd et al. believes the technological and market competencies of firms may be a less reliable indicator of 'market adoption rate' hence value, than its position in a network with others. They note a growing tendency, in which new commercialization depends on a range of technological and market characteristics. They focus on assessing market and technology maturity (high vs. low). By inference, this gives rise to four kinds of technology/market situations of which the 'complex' group is one such form of technology. These are characterized by novel technology and market. In this case there is no clearly defined use of a new technology, but over time developers work with lead users to create new applications. Based on these generalizations, they provide a model to forecast the diffusion of innovations, and list a number of characteristics 'which have been found to affect diffusions: relative advantage, compatibility, complexity, trialability, and observability.' (p. 187) Knowledge of these is therefore relevant for firms to possess in estimating the chance of success and enhancing product value.

Above all, the integrated view as presented by Tidd et al. can be considered a direct descendent from the evolutionary economic perspective, focused on developing organizational routines and products by following the cues and signals from the exogenous marketplace. Rather than presenting overarching perspectives the innovation process they present is designed exclusively to commercialize successful innovations, and should therefore be a perfect candidate for studying biogas plants. It is hard to disagree with the preordained list of elements in creating successful innovations. For products to be valuable they must meet customer demands and to do so may involve building external linkages, building a capable organization, and using focus groups and market surveys. However, that is not the problem. The problem is, we learn nothing of the process by which customer demands arise in the first place, thus how the individual value criteria are created and determined, nor how firms themselves acquire the skills and capacities for scanning the environment. Interestingly enough, they differentiate between inventions and innovations, thereby indicating there is a separate process in providing a good with qualities required to be transacted in markets. However, beyond this how goods acquire these economic values are treated as a given. Granted, focus group interviews can reveal a specific customer preference but they fail to answer the central question of how a preference emerges in the first place. What capacities and material tools do customers deploy to arrive at one criterion over another? In short, this process is black-boxed leaving the value as given. Looking beyond the caveats in understanding how values are constructed, the notion of the market as an exogenous element is also inadequate. How do markets emerge and provide the basic capacity for allowing the innovation to be transacted? Are there specific legal, institutional, or regulatory elements which influence whether innovations can be purchased and implemented? If so, where do these come from and how important are they to the functioning of the market?

1.2.3 Utterback: Mastering the Dynamics of Innovation

Both Dosi and Tidd refer to the notion of dominant designs, originally coined by Abernathy and Utterback. The dominant design is a measure of successful innovations which had been widely diffused and accepted because it is considered the de-facto standard in the market.
Utterback originally teamed up with Abernathy to create a dynamic model of the patterns in innovation and technology (Abernathy & Utterback, 1978), in which various factors where interacting with one another. Based on the traditional S-curve framework, describing the gradual development of successful innovations from introduction, growth, and maturity, Utterback wrote a book on how to 'master' these dynamic aspects of innovation (Utterback, 1996). Based on accounts of several major technological breakthroughs of the 19th and 20th century Utterback identifies a relationship between innovation and industrial evolution. In his words, the book identifies 'a dynamic relationship among product innovation, the marketplace, and the firms that emerge and compete in industries on the basis of particular innovations (1996, p. 79). He charts the dynamics of innovation through three phases from fluid to the specific phases, where we follow the rate of major innovations in product and process innovation as a function of five components: product (innovation), process, organization, market, and the competitive environment. For instance, the fluid phase is characterized by high levels of target and technical uncertainties (p. 93). Target uncertainty refers to the fact that most early innovations do not enjoy an established market. Instead, markets grow around these innovations. Technical uncertainty exists, which is the outcome of a diffused focus of R&D. Technology is in a state of flux and firms have no clear

idea where to allocate funds. As such new products are frequently introduced or changed (some radical), process technology is rarely used, costs are high, and the organization is organic and highly flexible. Markets are fragmented and competition is increasing.

In the second *transitional* phase products and process innovation grows increasing rigid and the first dominant designs emerge. The dominant design is a specific product class 'that wins the allegiance of the marketplace, the one that competitors and innovators must adhere to if they hope to command significant market following' (p. 24). The dominant design comes about from interplay between market and technology, and several important non-market factors: complementary assets, policy, firm strategy, and communication. In the preceding phase no firm has a 'lock' on the market and 'customers have not yet developed their own sense of the ideal product design or what they want in terms of features or functions' (p. 23). In the final *specific* phase firms focus on developing a high level efficient product while production is standardized and optimized, and competition increases even further.

However, Utterback does not explain how, for the before mentioned components emerge to influence the marketability of products and services, even those benefitting from a dominant design. When he describes how close interaction with users represents 'a case of market learning' through which they learn 'how they are succeeding or failing to satisfy customer requirements, and how design changes might close the gap between product capabilities and user requirements' (p. 29), he does not open the processes whereby these aspects emerge. Preferences seem to suddenly surface in Utterback's, otherwise compelling accounts of the typewriter, personal computer, Edison's incandescent lamps etc. Customer preferences appear throughout the book as guiding the process of development, but are only conceptually included as a given elements rather than the outcome of complex process; processes which would help explain why some products may not become economic goods. Take for instance, Utterback's description of the commercialization of the light bulb: 'An electric system was seen by the owners as an important improvement over open-flame lighting in this application, as the electric lamps would not produce smoke or fumes in the closed, confined spaces of the ship (…) America was taking to the new lighting technology, which was accounted to be cleaner, safer, and more convenient than competing technologies.'

(p. 64). It appears, electric light was considered a valuable product. But Utterback takes the value for given, by not asking the central question of *how* the electric lamp was qualified as a safer and cleaner alternative, let alone how policy and institutions allowed for the widespread electrification of the US? He himself notes how representatives from the traditional gas and kerosene industries tried to sabotage Edison's demonstrations and dissuade policy-makers from promoting electricity. And from Hargadon (2003) we know Edison's inventions sparked controversies over whether it was feasible to construct the extensive national electric grid to power every corner of the house, thus problematizing its possible marketization. It could not be done, some argued, and it would never be economical. Surely, these attempts to dissuade the American consumer from taking the electric leap and the accompanying controversies are vital stories to include? Similarly, the first cases of accidental fires and electric shocks also played a role in implementing new safety standards and regulation influencing the diffusion. However, the process whereby these emerge and are associated to constitute the innovation remain black-boxed which is interesting because Utterback notes that 'no matter how a dominant design is determined, it is doubtful that it can be recognized except in retrospect' (p. 49). On the one hand, he acknowledges that the process is uncertain, the outcome unpredictable, and therefore something we cannot take for granted while on the other hand refraining from opening this black-box. Once more how goods become valuable is a given.

1.2.4 Value as Outcome versus Value as Given

In terms of presenting a theoretical model and perspective capable of accounting for the process whereby goods, products, innovations, services, etc. become economic and possible objects of transaction in markets, it appears the dominant literature on innovation and product commercialization is sketchy at best. Compared to the endeavor of this project the review indicates that although acknowledging the complex setup of markets and even co-constructed nature of technology, they do not explain the process whereby goods become economic goods, how markets emerge, how agencies acquire the capacities to carry out calculations and valuations, let alone how a calculation itself depends on material instruments. In short, as Table 1 below summarizes below there are many aspects of creating a valuable economic good and market that is taken for given, as opposed to be considered an outcome.

Table 1: Comparing Dosi, Tidd, and Utterback - Value as Given vs. Value as Outcome

Source:	Value as Outcome	Values as Given
Dosi et al., 2005	Markets are embedded in social relations and acknowledge the role of social-shaping of technology, including institutional and economic factors.	Markets exist as fixed exogenous entities that shape technology. Fail to how materiality creates value, how institutions emerge, how markets are created, and how transactions are completed.
Tidd, Bessant, Pavitt, 2002	Acknowledge the innovation process is uncertain and success can never be guaranteed, but can be reduced and management through innovation management	Firms learn of values from the market through external linkages. Incapable of explaining the very process by which these come into existence in the first place. Markets exist as exogenous elements. Transactions can be completed once products match customer demands.
Utterback 1996	Acknowledge the innovation process is uncertain and success can never be guaranteed.	Firms conduct market learning through close interaction with customers. Conditions for technological development can only be determined ex post. Markets exist as exogenous elements and

	transactions can be completed.

Note how all three take certain aspects of creating valuable goods and markets for granted while others receive more attention. They all acknowledge the uncertain and unpredictable characteristics of developing new technology, goods, and services, and only by approaching it from a process perspective can firms succeed. Dosi et al. even go as far as seeing the economy as embedded in social relations and accept the economic and social shaping of technology, but stop short of describing how these factors come about and how the economy and markets are created. These simply exist. Likewise, Tidd et al. echo the previous view while not commenting on the social shaping of technology. Perhaps, is it included in the way firms learn of new trends through external linkages and marketing resources, and consequently respond to by innovating new products and services designed to meet those demands. Here we learn a great deal more of the organizational and technological ingredients needed to produce valuable goods to the exogenous market, but much like Dosi the very processes by which firms acquire 'marketing resources', or how the market is created, let alone how goods are transacted in markets is not described. Any further explanation of market dynamics is black-boxed, especially with regard to how values come about. Value is seen treated as a given, rather than an outcome. In a similar attempt, Utterback makes his own attempt at describing the various ingredients and phases by which an incremental or radical innovation becomes a dominant design in time. But like Tidd et al. how the very same values, which a dominant design serves, emerge is unknown.

It is interesting to notice the perpetual black-boxing of quintessential market activities, especially with regard to how goods become valuable and how transactions are made possible in markets, although they simultaneously acknowledge the inherent uncertain and unpredictable nature of creating valuable goods. Utterback specifically mentions how conditions for technological development can only determined ex post, thereby saying "we know there is uncertainty surrounding the conditions for development but we won't look into it". Although, not taking for granted the processes of creating goods that meet the demands from a growing number of disparate actors, they still black-box the process whereby goods become valuable for market exchange, and disparate agencies are configured and thus able to qualify and quantify goods.

What I conclude from this review is that applying these approaches to the study of biogas markets, will produce a picture of biogas markets in accordance with their specific analytical dimensions, but fail to account for the complex processes that produced goods and markets in the first place. It would mainly be a story about *what* was used to develop biogas plants according to a given set of demands from the market, rather than a story of *how* biogas plants and markets were the outcome of processes that sought to develop and transform biogas plants into a valuable economic good that could be exchanged in markets.

What we need is a framework capable of *seeing value purely as an outcome* of complex processes, i.e. no aspect of creating goods valuable for market exchange must be taken treated as a given. Hopefully, the anthropology of economization by Koray Caliskan and Michel Callon will have something to offer in this regard.

1.2.5 Framing The Socio-Technical Assemblage of Markets

Since the late 1990s, Michel Callon from the CSI of the École des Mines in Paris has used the uncertainty that surrounds technological development and their possible *marketization* as the very gateway to suggesting that 'the market is not simply expanding, but rather continuously emerging and reemerging, and that its consolidation requires constant and substantial investments' (Callon, 1998a, p. 244). In his view, what Dosi, Tidd, and Utterback refer to as uncertainty is, in fact a highly useful tool for understanding the dynamics of markets and how they emerge, stabilize, and collapse. Much of Callon's recent work has focused on understanding various components in and aspects of markets (Callon, Millo, & Muniesa, 2007; Callon, 1998b) recently culminating in an effort with Koray Caliskan from the Boğazici University in Istanbul to create their much anticipated *anthropology of economization*. Published in two instalments, one outlining the principles and foundation of the anthropology (Caliskan & Callon, 2009) while the second explores the theory of *marketization* developed to study the establishment of economic markets as one predominant form of economization (Caliskan & Callon, 2008). They draw on much of Callon's previous work including economic sociology and the anthropology of valuation and Koray Caliskan's review of the clash between formalist and substantialist economists.

The anthropology of economization (or of markets) literature takes its point of departure on a similar criticism as the one I presented above. Much of the conventional literature on economics, market making in particular have been more interested in defining certain functions of markets, determining the factors behind different levels of efficiency, and focusing on how a successful transaction is determined according to whether the conditions stipulated in contracts are met. In doing so they have neglected the central issue of understanding the processes by which markets and transactions become possible in the first place. The notion of 'uncertainty' black-boxes the operations markets perform.

To Caliskan and Callon, markets are the temporary outcomes of processes where rules and conventions; technical devices; metrological systems; logistical infrastructures; texts; discourses and narratives (e.g. on the pros and cons of competition); and technical and scientific knowledge (including social sciences and method), along with the competencies and skills embodies in living beings are assembled in socio-technical assemblages or *agencements* (2008, p. 23). Only by this process are economic agents, goods created, rules of the transaction stipulated, actors transformed into buyers, sellers, suppliers, regulators, etc. As a consequence, there are many versions of markets even for the same product.

From the market definition above, it is clear that Caliskan and Callon resort to *Actor-Network Theory* which Callon co-created with Bruno Latour and John Law in the 1980s. Drawing on science and technology studies (STS) studies ANT was designed to avoid essentialists and normative explanations of specific innovations, events, and anything else for that matter. The world is too complex to be categorized as A or B. However, what makes ANT distinct from any other perspective is the material-semiotic perspective, also known as the symmetrical principle whereby human and material actors are treated equally. ANT analysis maps associations between material elements but also between concepts, known as semiotic. A key feature of ANT is therefore its ability to centralize how any organizational practice, such as market making, is bound with materiality. Beyond acknowledging the obvious, that the world cannot be explained in purely social terms and ignore the material aspects, ANT was designed to analyze situations in which it is difficult to separate humans from non-humans; an aspect which others perceive as contextual and taken-for granted in organizations such as markets, or as influential under certain circumstances.

What many other theories tend to black box and conceal, is seen here as gates to underlying stories which must be explored. Uncertainty or luck is not taken for granted or replaced by a multiplier factor. It is an invitation to study markets. Behind the scenes of uncertainty or luck are stories of humans and non-humans relating to one another to form a durable assemblage. Take for instance the often 'heroic' accounts of how Thomas Edison invented electricity. Granted, as humans they played a principal role but their achievements were distributed and afforded only by the host of other actors, ideas and material objects associated with the assemblage. Luck had nothing to do with it. In this sense, the capacity to act are made up not only of human bodies but also of prostheses, tools, equipment, technical devices, algorithms, etc. which not only accompany action and participate in designing, implementing or interpreting it. Entities bounce of each other which influence the ideas and actions by others, in turn creating *co-constructed* and distributed socio-technical assemblages.

Similarly, markets are seen as co-constructed, distributed heterogeneous arrangement or so-called socio-technical *agencements* (I use the terms arrangement and assemblage interchangeably), which in addition to humans include the deployment of rules and conventions, technical devices, metrological systems, texts, discourses and narratives, methods, competencies and skills of living beings. Market ingredients are not identified according to some preordained list. Any human, material entity, arrangement, and infrastructure which through empirical studies of markets turn out to have an effect in market making are granted entry. It thereby enables us to take into account and describe in great detail a great number of entities in markets, whether they are human or material.

Markets are characterized by the following:

1) establishing relations between an almost infinite number of human beings and other living organism as well as material, technical and textual devices. Once assembled in socio-technical assemblages by building relations between a vast array of human and material actors, they

2) organize the conception, production and circulation of goods, as well as the voluntary transfer of the property rights. In doing so,
3) markets delimit and construct a space of confrontation and power struggles, where multiple contradictory definitions and valuations of goods oppose one another until the terms of the transaction are peacefully determined by pricing mechanisms.

For goods to become valuable commodities that are transacted in markets does not only include technological development, or stop when different agencies arrive at positive valuations. It includes the process of making it possible to 'peacefully' facilitate a successful transaction. Within the broader framework of economization they locate a framework called *marketization,* which is the economization process that leads to the establishment of economic markets. Marketization is not concerned with identifying different 'levels' of economic performance or market efficiency. Nor does it assume markets to exist. And instead of assuming products a valuable once they satisfy customer preferences, or that agents automatically are able to calculate and estimate value, marketization raise the more fundamental questions of how value emerge in the first place. Before describing the marketization framework in greater detail, we must first attend to the fundamental dynamics and principles underlying it.

1.2.6 The Perpetual (Re)Framing of Socio-Technical Assemblages

For markets to exists as socio-technical assemblages they must be *framed*. According to Callon, 'Framing is an operation used to define individual agents which are clearly distinct and dissociated from one another. It also allows for the definition of objects, goods and merchandise which are perfectly identifiable and can be separated not only from other goods, but also from the actors involved, for example in their conception, production, circulation or use. It is owing to this framing that the market can exist, that is to say, that distinct agents and distinct goods can be brought into play since all these entities are independent, unrelated and unattached to one another'. (Callon, 1998b, p. 188). As such, framing denotes the process by which a frame is established within which interactions between human and non-human actors take place (Callon, 1998a). I have augmented framing with organizing (or assembling) because it specifically describes the process of associating different human and material actors, as well as coordinating and organizing them in specific ways. To successfully frame a market also means creating associations between specific actors organized to perform a certain activity. The notion of 'framing' does not adequately express this.

The concepts of framing and organizing are easily applied to markets. To frame a market means assembling (or organizing) the plethora of human and material entities, products, producers, suppliers, customers, rules and regulations, political frameworks and institutions, contracts, prices, metrologies, metrics, calculations etc. all of which are related with one another to form a durable frame. The outcome of framing is the socio-technical assemblages of markets. To perform a transaction presupposes a framing of the action without which it would be impossible to reach an agreement, including agreeing on how to calculate and settle on a price. Framing thereby also denotes the process of performing valuations of products, but also include the process of assembling and transforming of human and material entities into the product itself.

Framing market assemblages never stops because at any time markets can overflow, sometimes literally, and consequently cause the socio-technical assemblage of the market to collapse. With the notion of overflows we are able to understand the perpetual re-framing of markets. As Callon argued in his classic study of sea scallops, framing can never be complete or perfect (Callon, 1986); they are temporary outcomes and constant sources of overflowing. Transforming and taming a good can suddenly overflow if a technical component unexpectedly fails causing the framing process to be derailed because a material component 'chose' a different path than anticipated. Likewise, agencies can fail if an important ally leaves the coalition, if a politician looks the other way, or an Excel spreadsheet suddenly suggests its price is too high in effect causing the transaction to stop. What is crucial to understand is, that each of these elements, at the very same time as it is helping to structure and frame the interaction of which it more or less forms the substance, is simultaneously a potential conduit for overflows. Even the slightest alterations to the market setup can cause it collapse. Markets assemblages therefore are not permanent constructs but temporary assemblages in a permanent state of market fluidity. Consequently, I shall address different kinds of overflows. Technical, economical, political, or public overflows each indicate a different type of source although they share the same role: they render markets less effective, sometimes cause them to collapse.

The reason behind overflows is that every actor involved in the frame is governed by its own set of interests, ideas and expectations and therefore exhibit deviating behaviour and actions. Even a technical component has a set of unknown interest, an often unpredictable will of its own. Ideas and concepts are interpreted differently by actors. Here, Latour's original notion of translation comes to mind. Because 'one' is never translated directly into 'one' actors arrive at different understandings and interpretations (Latour, Reassembling the Social - An Introduction to Actor-Network-Theory, 2005; Latour, The Pasteurization of France, 1988). Armed with different resources and capacities for acting, they generate different organizational responses some of which can threaten the market should they decide to leave the frame. It is not always conscious or strategic; it is implicitly governed by the networks of which they are part and parcel. It is important to stress that the effects of overflows can be positive, not always harmful or negative, such as spawning new avenues of thought on technological improvement, new problems for it to solve, or more effective ways of organizing markets.

Overflows are what cause framing to be costly and a rare outcome, if ever. Imagine the leak from a chemical factory or biogas plant into the natural environment and drinking water, leading to its immediate halt in production. Although only representing a fraction of the overall frame within which the interaction takes place, the factory or some component was the conduit for an overflow creating an ill-framed factory. And unless this unfortunate case of overflow is reframed and future incidents avoided the underlying frame its value cannot be restored. However, it is illusory to suppose that one can reframe every possible overflow and stabilize the frame for eternity. As Callon argues, the potential sources of overflow are to be found in precisely those elements that give it its solidity, rather than in any areas left unmentioned. The notion of a fully hermetic frame is a contradiction in terms. The frame is only 'bracketed' from the outside world as its human and material actors are associated to outside members. Moreover, without overflows it would be impossible to produce new knowledge and improve current conditions. Without a leaking chemical plant, no solution could be framed. Here we come to a vital point on overflows. The potential sources of overflow are to be found in precisely those elements that give it its solidity, rather than in any areas left unmentioned (Callon, 1998a).

However, from a marketization perspective Caliskan and Callon stress that for markets to function satisfactorily overflows cannot be completely sidestepped or ignored. Although overflows are bound to occur all the time they must be reframed to restore some degree of market functionality. And to achieve this, they must first be made measurable. Overflows occur all the time without necessarily being identified as an overflow. For overflows to exist these too must be framed and 'brought to life'. For instance, in the 1980s several reports documented widespread pollution of the aquatic and marine environment. Using a complex metrological setup including advanced measuring equipment, computers, metrics, and scientific theories it was concluded that excessive use of manure by the agricultural sector was responsible. The manure had overflowed into the natural environment, but without material 'detectors' and subsequent inscriptions in reports, and scientific journals circulated in the media it may never have been recognized as an overflow to begin with. Similarly, as the ensuing controversy over this overflow escalates other metrologies and documents are mobilized to present counter-claims or further evidence in support of the original contention. As such, to understand framing dynamics we must also dive into the detailed processes and material tools deployed to understand how overflows and controversies emerge and their potential reframing and closure.

But sometimes overflows are not easily solved and reframed and can cause markets to go from stable and 'cold' to 'hot' and contested. They become *controversial*; a distinct kind of overflow or as Caliskan and Callon describe it, controversies 'accompany' markets. Any disagreement over the value of a specific good, hence its market, becomes visible, and debatable. Decades of development of renewable energy technologies has highlighted the role of controversies generated by their commodification and diffusions. Towering wind turbines, smelly biogas plants, expensive electrically powered cars but also nuclear power plants have sparked controversies among the scientific, technical, political and public arenas can cause further disruptions affecting the market. In some fields, controversies represent a distinct academic research discipline on its own (Horst, 2003; Marres, 2007). According to Horst, controversies originate from the theory of science which focused on scientific controversies consisting of a core issue and a limited set of actors and arguments (Engelhardt & Caplan, 1987). As this project will demonstrate, from the perspective of marketization public, social and political controversies often play a decisive role in the reframing of the social-technical assemblage of the market. If disagreement over how to determine and calculate a specific overflow is prolonged the market can remain ‘hot’ indefinitely. Callon is not saying markets are without function at all, only that the socio-technical assemblage is ‘open’ and undergoing change. In other words, there are various degrees of hot and cold and markets may continue to operate while controversies are not fully associated to the goods they transact. Controversies over whether certain forms of renewable energy are economical compared to conventional ones have raged for decades, while markets for wind power have flourished in some parts of the world. As with overflows, to reach closure with controversies requires active processes, from problematization and interessement to enrolment and mobilization (Callon 1984). People, claims, and material entities must be activated in an attempt to frame the good in a particular way, such as when local citizens object to biogas plants out of fear of odour leaks from the plant. The idea is not to apply these in detailed controversy analyses but rather to examine how ‘hot’ periods of controversy over biogas make their potential marketization difficult, for instance how they render biogas plant invaluable among local communities thus difficult to transact and construct.

When overflows strike, actors engage in ongoing framing processes whereby they produce, sometimes competing frames for instance different valuation proposals of the overflow itself. Similarly in markets, controversies can be seen as overflows hence struggles in the constant negotiation over the development of technology and its possible marketization. Controversies often and inadvertently activate a host of other agencies with disparate opinions in the wake of problematizing technology. But despite its negative connotation, they are an inevitable and natural feature of markets just as overflows. While they can disrupt markets and render them completely ineffective, I make no distinction between ‘good’ and ‘bad’ controversies. As with overflows there is a special dynamic with regard to controversies, as Callon originally pointed out (1986). Controversies too must be detected, made visible and debateable before any attempt to reach closure can be made.

1.2.7 Marketization: Framing Goods, Agencies, and Market Encounters

Having outlined the fundamental framing/overflowing dynamics in creating and stabilizing the socio-technical assemblages of markets, we can return to address the particular forms of framing which results in economic markets. Caliskan and Callon have identified several kinds of socio-technical assemblages (2008) for markets to exist: 1) pacifying goods 2) activating agencies capable of performing valuations of goods, and finally, 3) organizing market encounters to allow for goods and agencies to meet one another. Taken together this triple framing constitutes the core economic processes in the *marketization* framework. This is vital distinction from Dosi, Tidd and Utterback. The 'market' is not conceptualized as a single entity but the outcome of framing three different types of frames: goods, agencies, and market encounters.

1.2.7.1 Pacifying Goods

The framing and organizing of markets usually begins with a good or service to sell. If it is developed and produced it is because it has value for its producer. If it is consumed it is because it has value in the consumers' eyes. If it is sought promoted by policy is it because it serves a political agenda, and so on. Things circulate because they are valued and because they are valued that they become goods.

The central idea is that the goods (could also be an immaterial service) that are to be exchanged through market encounters must be *pacified* to enable agencies to form expectations, plan actions, stabilize their preferences, undertake calculations and possibly enter into cooperative or competitive relationships. By ensuring that their qualities evolve predictably, the passivity of goods plays a central role in creating a stable environment which can 'favour organized action'. Actors will exhibit doubt, reluctance, and difficulties in valuating goods when they exhibit different behavior from one day to another. If a good exhibits unstable behaviour, fails, or does not comply with the purpose it was transformed for the marketization is in a constant mode of reframing overflows in turn affecting actors' ability to perform stable valuations of whether it will service their needs. A good with constantly changing features, characteristics, and behaviour makes it difficult for investors and potential buyers to perform valuations and make decisions with regard to its transaction. In other words, for a particular good to end up on a supermarket shelve is the successful outcome of framing process which also renders it an economic good. Any host of human and material actors can be transformed into a good, but to pacified as an economic good requires rules and regulations, legislations, institutions, and procedures to reframe overflows and solve controversies when they emerge.

Analyzing goods also require a view beyond the good itself into the so-called support nets, which Latour revealed in his famous study of the failed Aramis project, a network of automated cars in Paris (Latour, 1996a). Support nets are complementary socio-technical assemblage required for an entity to be transformed into a service activity. Once again, the car is an excellent example. Without roads, bridges, gas stations, signs, and traffic lights driving even a pacified car would be impossible to drive. As such, to pacify a good also implies the concurrent framing of a socio-technical assemblage that makes such a service predictable and stable.

It is owing to these that it is possible to complete transaction, to 'disentangle' it as Caliskan and Callon describe it. For instance, cars are pacified as economic goods and can be exchanged not only because cars after a century of development perform as expected (for the most part), and have access to a support net, but also because when they overflow and require repairs there are insurance policies, body shops, readily available spare parts, etc. without which it would not be possible to purchase it and ensure a peaceful and relatively uneventful reframing of overflows to ensure it continues to favour organized action.

1.2.7.2 Capable and Powerful Market Agencies

However, what a good is, the purpose it serves, its cost, price, and impact is not a priori settled in sales brochures or by producers. Key here is to examine how agents evolve into weak or powerful agencies as a function of their capacity to participate in performing valuations, contributing and competing in defining and calculating the values of a specific good. This enables them to act in markets. Callon has written extensively on this issue. In a 2002 paper, he shows how qualifying and positioning goods are primary activities for market agents (Callon, 2002; Callon & Law, 2005).

The list of market agencies is almost infinite but often includes familiar ones such as firms, consumers, governments, experts, banks, research centres, and local community groups. To perform valuations of goods means agents engage in a process of quantification, involving the calculation of numerical measures, scientific and technological 'facts', and qualification, involving 'softer' measures such as political, social, personal values so that new properties and characteristics are attributed to goods, thus transforming it into something desirable - or not - for itself or for other actors. This capacity to 'qualcufy', as Caliskan and Callon denote it, cannot be taken for granted. It does not automatically take place. Agencies must be qualified and configured in order to create and determine the values of goods. This capacity is not only empowered by its relations to other humans and organizations, but also to its material setup. Superior calculations, Excel spread sheets, and work procedures produce vast differences in capacity to calculate amid ongoing rivalry to control the framing and valuation of goods using, sometimes competing principles and methods of calculation and valuation. We therefore theorize human interaction in relation to an artifactual or material agency. And as such, markets are abound with many forms of agencies in markets, from material, textual, mechanical to human, and natural; what Cooren (2006) calls a plenum of agencies. Once again, the car market serves as a powerful example. Buyers are configured by the host of readily available information from brochures to advanced online calculators, car reviews, historical data on the distinct performance and maintenance records of the specific car, etc. Cars are compared using similar metrics, such as power, acceleration, average fuel consumption, size, weight, and color. Together these configure agencies with the necessary capacity to perform valuations of cars. Stark and Beunza (2009) have identified similar agency characteristics in their study of Wall Street arbitrage dealers. I shall deploy these as part of the theoretical framework in the second analytical chapter on biogas plant transactions.

Unequal abilities by agencies to successfully deploy competencies and tools generate asymmetrical relations and power balances. Agencies with superior qualculating capacities are placed in a powerful situation to dominate the process of valuation of a specific good by which weaker agencies can be excluded from the marketplace, or 'enslaved' by being imposed dominant valuations. Acquiring the material equipment to dominate and possess the power to interact freely, define objectives, calculate interest, and forge new alliances is costly and the outcome is not guaranteed beforehand. Yet, agencies who fail to acquire such equipment risk being excluded by those who do, and may eventually cease to exist. Returning to the car market, the balance of power between a buyer and dealer is equally distributed as they engage each other on relatively equal footing. Today, customers may easily now more about the car than the dealer, due to relatively equal access to a wealth of information afforded by the material assemblage of the Internet. Neither actor has privileged information.

1.2.7.3 Market Encounters

The idea behind market encounters is that for valuation to take place and the market exchange itself to be completed the specific agencies and goods in question have to meet one another. This is comparable to the famous intersection between supply and demand curves. But unlike the theoretical approaches discussed above, Caliskan and Callon do not assume the encounter to automatically take place. Like goods and agencies markets encounters too must be framed and assembled to facilitate certain and desirable circulation and movement of the pacified good in question, while precluding others. Think of Geertz's description of how the specific socio-technical organization of a bazaar encourages customers to follow specific paths to end up at specific shops (Geertz, 1978). Other examples include supermarkets (Cochoy & Grandclément, 2005), online internet shopping sites such as Amazon, or car dealerships. These are all examples of market encounters. They not only bring goods and agencies together to perform valuation. They also facilitate the transaction. Take for instance Fabian Muniesa's study of the Paris Stock Exchange (Muniesa, 2000), which stressed that for the exchange or transaction to function satisfactorily a complex mediation device was required including computers, networks, software, and algorithms which connected brokers with customers. In addition to acknowledging the work and challenges in assembling such a complex social or material setup, the central idea is that market encounters afford and make valuation and transactions possible. Valuation through encounters can be a complex process strongly influenced by how encounters are framed and organized. Caliskan and Callon describe market encounters as *socio-technical mediating algorithms* consisting of a socio-technical assemblage whose activities are entangled and connected to one another. As such, there are many forms of market encounters. Studying market encounters as socio-technical mediating algorithms reveals a long list of humans and material, textual entities and the hard work needed for them to emerge in the first place and, and ultimately, for goods to be transacted. The transaction process itself also takes place in the market encounter. Once again, to purchase a car involves visiting different dealerships to perform valuations o different cars. Each market encounter is framed in a distinct way to the specific make and model. Very expensive high-end luxury cars are put on display in specific ambient light, the buyer is greeted by a slick sales person with a PhD in car engineering, champagne served, specific test drives are organized as opposed to the market encounter used to sell inexpensive cars for the mass-consumption market. To complete the transaction means choosing options, a financial plan (afforded by a financial company), time and place before signing the documents and exchanging money and ownership in the form of keys. In short, how supply meets demand in market encounters is no trivial matter and not all encounters are possible.

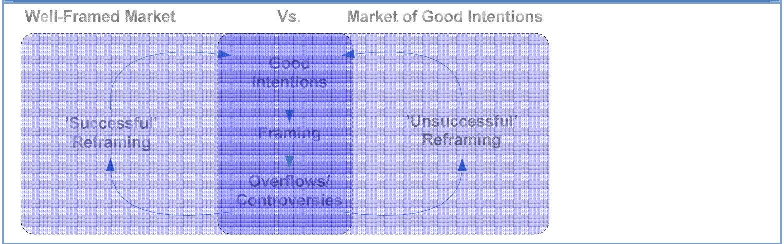
1.2.8 Ill-Framed Markets of Good Intentions versus Well-Framed Biogas Markets

To speak of 'markets' in general terms and simply assume that they exists and render goods valuable and transactions possible as Dosi, Tidd, and Utterback do is incorrect. Whether they sell cars, diapers, or beer their specific markets are all different. Markets should be understood as a perpetual re-framing of socio-technical assemblages amid the inevitable presence of overflows and controversies, some of which are not easily reframed and brought under control again. Not all markets work satisfactorily to this standard. An *ill-framed market* can render even the most benign wonder technology worthless, i.e. if it is not adequately framed and organized to provide goods with economic properties, and to commodify it by configuring agencies with the necessary qualcufying capacities, let alone facilitate their 'meeting' and potential transaction there can be no transaction. Neither has it organized the rules, procedures, metrological systems, along with other human and material actors needed to reframe overflows and reach closures with controversies when they emerge. In short, an ill-framed market is a market of good intentions. Today, we see electrical vehicles and hybrid cars. In the United States hybrid cars, such as the Toyota Prius are relatively successful whereas in Denmark sales are slim to none. The reason is not that the Prius does not work in Denmark, or that Danes prefer gas guzzlers over the high mileage Prius. Rather, it is the outcome of framing well-framed versus ill-framed markets for the Prius. Danes are currently awaiting the outcome of political negotiations on a future automobile tax reform, which are highly controversial. Meanwhile Toyota dealerships will not stock the Prius and spare parts, nor train its personal. Such overflows and controversies make it difficult to pacific the Prius; not the Prius in general, but the Prius in Denmark. And with very few cars in circulation, performing valuations of the potential depreciation and potential value as a used car is surrounded by great uncertainty. The calculations and spreadsheets needed to determine its price cause framing agencies to overflow. And finally, as very few dealerships has it on sale, is able to provide service and maintenance at a reasonable cost, customers have to travel to Sweden where the Prius is more popular. In other words, the market encounter is overflowing. All in all, from the marketization perspective the reason why the Prius fails to proliferate in Denmark are found in the ill-framed state of the market.

Above all, and this is a vital point, a market that performs well is a *well-framed market,* one able to deliver on the good intentions of its key technical, political, scientific, and social agencies. In a well-framed market goods are pacified thus favouring organized action, agencies are capable of performing stable valuations of the good, and market encounters facilitate the peaceful transaction and transfer of ownership from producer to its owner while securing a safe aftermath long time after the transaction itself is concluded. Moreover, a well-framed market is organized in such a way that there are rules, regulation, and procedures in place in the event of overflows or even controversies specifically for the particular good and agencies involves. Think once more of the market that enables the exchange of cars (but obviously not the Prius), milk, beer, or baby diapers between a buyer and a seller. With in markets for conventional cars these are pacified goods in the sense, that cars exhibit relatively stable behaviour along thus reducing uncertainty for buyers. This pacification also includes roads, gas stations, terms and conditions in contracts, rules, warranties, contracts, legislation, and institutional structures, the transfer of property rights between seller and buyer, etc. which makes the car tradable in the first place. When the first cars emerged none of these existed, let alone assembled to form a whole, which made cars initially difficult to trade. Moreover, the pacification has resulted in cars as economic goods in the sense that most people do not consider it a high-risk purchase. After a century of development cars are pacified and favour organized action, the agencies involved – from customers to auto manufacturers – can perform and compare valuations as cars adhere to the same metrics: price, size, color, mileage, acceleration, range, etc. Market encounters in the form of car dealerships are abundant and the process by which to complete a transaction is well-framed and organized. In case of overflows such as breakdowns or accidents, well-framed warranties and insurance stipulate liabilities and responsibilities between owner and supplier while there are pacified spare parts and work shops to re-frame overflows. In case of controversies and legal disputes, there are courts of law to regulate these matters as well. The point is that well-framed markets are also organized address and re-frame potential conduits for overflows, and as I will argue, are therefore organized to deliver on the good intentions. Most of the markets we encounter and use every day are organized as such. But that does not entail, that the process is over. On the contrary – framing never stops as new overflows and controversies can emerge at any point. The question, relevant to this project is of course, to what degree can we speak of well-framed markets in the case of biogas plants, and by that I am in particular interesting in addressing the role of overflows and controversies.

By applying this framework to the story of markets for biogas plants in Denmark, I can examine this central issue. As the principal argument, I want to argue when overflows, as a measure of fragility, and accompanying controversies are not reframed and internalized into the socio-technical assemblages of biogas markets, biogas plants cannot become valuable goods that can be exchanged in markets. In other words, what we end up with are ill-framed biogas markets unable of realizing the underlying intentions. When overflows and controversies are left unchallenged, sidestepped and not re-framed for whatever reason, delivering on the good intentions using well-framed markets is highly unlikely. A market that functions satisfactorily is one that organizes overflows and controversies produced by its very functioning and the framing/overflowing that it entails. As such, there is a strong relationship between the core concepts of this project: good intentions, framing, overflows and controversies, and well-framed versus ill-framed markets better known as a market of good intentions. Figure 1 below depicts the idea.

Figure 1: Well-Framed vs. Markets of Good Intentions - Overflows and Controversies



The dichotomy focuses on the ability by the ways in which markets are framed and organized to handle overflows and controversies, rather than avoiding them. As Callon argued, that is unrealistic. Well-framed markets are organized to successfully reframe overflows and controversies, while markets of good intentions are ill-framed and fail to reframe them. I have used quotations marks to underscore that the purpose of this project is not to establish a normative framework by which to determine different levels of market efficiency thus establishing a benchmark for defining success versus failure. Overflows and controversies cannot be a priori be identified, and neither can 'successful' solutions be framed according to normative rules. In fact, overflows and controversies are not the problem per se. Whether and how markets are framed and organized to reframe and solve these to enable goods to become valuable commodities is the core problem.

This main analytical argument is gradually developed across two analytical chapters, firstly by analyzing to how biogas plants have been (and still are) marketized, and secondly by analyzing how market transactions take place, if at all. This allows us to add an increasing number of detailed accounts and data as we proceed from the general and historic perspective of biogas markets to the highly detailed accounts of day-to-day efforts in framing a single biogas plant for transaction. The second analytical chapter deploys a different theoretical framework to study the framing and organizing of biogas plant transactions. To enhance the reader-friendliness, the description has been removed to the introduction of the second analytical chapter.

1.3 Bringing Biogas Markets to Life: Methodological Considerations

In this section I shall describe the overall methodological considerations and aspects relevant to understanding my research practice thus explaining the connection between research question, theoretical framework described above and the activities I have undertaken to come up with credible answers on the construction of biogas markets. While the chapter is structured as a chronological account of this research, it is vital to stress I view research as an effect or outcome of these three elements rather than a sequential chain of events. All three elements are associated in a socio-technical assemblage of its own along with my informants, archives, transcripts, notebooks, my pen and laptop. I am in other words adhering to the constructionist scientific paradigm. As a social scientist, biogas markets do not exists in the world as 'something' I can uncover and excavate as an 'object' from beneath the soil. I cannot embark on a fact-finding mission. As is implied in the anthropology of economization/marketizaion, markets can only exist by its associations with others be it human or material. And the very processes by which something exists are also involved in the constitution of the very same entities and relations, i.e. it is performative – myself, my theories, and study included. This scientific stance reaches beyond a mere philosophical and methodological discussion as it affects the organization of this project and the dissertation itself. From research question, to choice of theories, methods, analytical designs, to writing up data and the analyses, the perspective of constructionism impacts their shape and form. To begin with, I shall describe these meta-theoretical aspects upon which this entire study is based and should be judged accordingly.

1.3.1 Constructing Meaningful and Relevant Research

Above everything else, the purpose is to conduct meaningful and relevant research which to me entails several aspects. As illustrated above I assume the principal position inherent in the minimal ontology of socio-technical assemblages. In subscribing to the constructionist world view, this also means that nothing automatically comes into existence. For 'anything', physical or otherwise, to exist in the world it must be co-constructed by a host of human and material actors, and meaningful research therefore also depends on the symmetrical principle of treating human and non-humans with equal weight, despite widespread criticism of this approach (Fujimura, 1991). For a market to emerge requires an immense and concerted effort of framing its worth while creating an endless number of relations between human and material actors as part of its own and associated socio-technical assemblages. It is not predefined or 'meant to be', i.e. what a market consists of or what it should be does not unfold according to universal means or ends. As such, the price or socio-economic value of a biogas plant is a negotiation and only temporarily stable until the arrival of new agencies with previously unknown claims of 'this and that', qualculative capacities, resources, and relations to other. A report or Excel spreadsheet may turn out to have an effect in this regard, thus reminding us that material devices are not only illustrative of markets, they are core ingredients in the economic functions performed by markets. As alluded to in the theoretical framework it is vital to broaden the notion of associations to recognize that material aspects perform as well. As Latour (1996b) observed, action is something that is shared and distributed between a wide range of actors - from humans to material actors such as machines, tools, signs, documents, or architectural elements.

In short, 'anything' can only survive if the network it enrolled in is strong enough to support its existence. Unlike Dosi, Tidd, and Utterback the notion of uncertainty is not black-boxed as mere natural conditions for technological change and economic development. Rather, behind these black-boxed realities lies a complex network and interesting stories that must be unraveled and studied empirically. Similarly, generalization such as 'oil and coal is bad', 'local politicians are ignorant', 'biogas is a success', or 'biogas is a failure' are not considered representative of reality. The world is more complex, ambiguous than indicated by such statements. Even ridiculous statements such as 'politicians only serve self-interest' is the expression of a personal opinion based on specific interests and is influenced by belonging to a specific network or assemblage. The market is an outcome and should be treated accordingly, i.e. any study should uproot the underlying processes and mechanisms which create markets rather than take them for granted. The outcome itself is not important as the framing and overflowing processes which created it in the first place. It is not interesting to establish whether we have a market, but rather to understand why it exists, why it does not, could markets have unfolded differently, and how?

I am not studying markets as phenomena, but rather as a process of organizational change. How various human and material entities relate into networks, how they stabilize in time, and how they fall apart, only to be reunited once more at a later point in time. Above all, I want to explore the fragile and unstable nature of human constructs, which is why I use all kinds of overflows, including controversies as entry points into the study of assemblages. They remind that the human world is inherently fragile and its trajectory is uncertain and never set in stone. And thereby prove, that events, overflows, controversies and market properties can appear logic or illogical, natural or unnatural, prudent or imprudent at the same time. It all depends on the assemblages of which it is part and parcel.

To this end, theories are tools of instrumentality and a source of inspiration. As Karl Weick said, ‘to think better is to see better’ (Weick, 2002), i.e. with proper theories one can unlock the ever-changing complexity of the world, reveal new avenues of thought, possibilities, and research endeavors. I have used theories as sources of inspiration in terms of identifying relevant themes, questions to study, and key analytical points on markets. As detailed in the previous section, theory also helped pinpoint that the current body of innovation and economic literature did not provide adequate answers to how goods became economic goods and how markets were created. And as a result, this project opted for Caliskan and Callon’s framework. But we must be careful to adopt theories as conclusions. They are not finite answers to a world of infinite possibilities, and as such the overriding purpose is not to confirm a specific theoretical argument, for instance that markets are socio-technical assemblages. We must keep in mind that theories are models of reality, not descriptions of reality and can never replace data and the empirical ground. Much like Latour did in *Aramis* (1996a), theory and its distinct analytical dimensions (e.g. framing and overflowing mechanisms) are used to produce data that speak for itself. Only with data on the socio-technical assemblages can we unfold the framing and overflowing mechanisms of markets and identify new results towards understanding the marketization of biogas plants in Denmark. In other words, theories are the performative means in producing accounts on biogas markets, not the ends itself.

The role of theories brings me to another criterion I have for conducting meaningful research: relevance. Research should produce knowledge and results which has relevance to others than me and my academic peers. As such, I have pitched various project proposals, data, stories, and results to a host of practitioners outside of academia. Not to receive a 'seal of approval', but to listen and be attentive towards interesting problems while co-constructing new avenues of thought or results that may prove useful beyond it's the confines of academia. However, in inviting others – some very biased personas - conducting what I define as relevant research is by definition political. The outcome is a negotiation, and it has ethical implications. People have asked me 'why biogas? Biogas has limited political relevance compared to wind power.' One even told me that I was providing the weak, indigenous technologies with a voice of its own. I responded that is not my interest. I am not a fan of biogas *per se*. I came across biogas in search of a technology which could represent an exemplary study of the challenges in creating goods valuable of market exchange. As an inevitable result, the voices of others turned it into a battle of affixation, i.e. positioning yourself in the study and establishing relevant and interesting problems and analytical points relating to biogas markets from those that are not. Avoiding accusations of being an errand boy for pro-biogas agencies and navigating between the different versions of peoples' motives and interest became a central task in which the theoretical framework itself helped keep focus on marketization processes.

1.3.2 Constructing Data Through Encounters with People and Objects

Having briefly described the meta-theoretical aspects, this section will explain the practical steps taken to co-construct the data constituting the empirical basis through encounters with people and material objects. I specifically speak of data, in contrast to 'information'. As the main input of an empirical research project, data represent the 'bits and pieces' that can be shaped and organized into a given story based on the distinct theoretical framework and research question. That also means the bits and pieces themselves can undergo change, i.e. they are co-constructed.

In assuming a constructionist position, I have also assumed a distinct epistemological position with regard to creating meaningful and relevant answers. Studying marketization entails all the efforts aimed at describing, analyzing and making intelligible the shaping and dynamics of market sociotechnical *agencements* (Caliskan & Callon, 2009, p. 23). To construct the socio-technical assemblages and associations between humans and material actors I have adopted the fundamental analytical strategy '*follow the actors*', as suggested by Latour (2005) and embodied by several of his studies including *Aramis* (1996a) and *Science in Action* (1987). I have spent the past three years talking to scores of people, collecting dozens of reports, covering thousands of newspaper articles, and press releases to retrace the steps of the life of biogas markets. As a notable distinction from the original anthropological understanding of 'following the actors' I have not followed actors by going native to observe markets in action.

A consequence of subscribing to a constructionist perspective is also a markedly different view on data compared to a positivist and normative view. Rather than data collection, as a process of picking up readily accessible uniform 'pieces' of data easily revealed and identified by theories, I speak of co-construction of data as Harding explains it (Harding, 1998). Much like the shape and configuration of market assemblages is not defined and explained according to universally defined rules and categories, neither is the empirical basis. Data is an outcome of the research 'assemblage' including research design, methodology, theory, analytical design, research questions, not to mention the researcher, his perspective, interests, style of writing, creativity, coding, and translation from Danish into English. Data evolves into an artifact produced at the nexus between the researcher and the explored assemblages. I shall without a doubt have failed to include all the actors, events, and actions required to 'fully' account for how the socio-technical assemblage of a single plant or biogas market emerged. But that is both the drawback as well as power in socio-technical assemblages. On the one hand, it is open to whatever human or material actor emerges from the empirical basis. Unlike Dosi, Tidd, and Utterback there elements are not chosen according to some preordained list of technology or market 'ingredients' or 'factors'. On the other hand, the very same indiscriminate approach makes it a separate task to identify what and who to include in the assemblages. To systematically construct and delimit a specific empirical basis, thus including all relevant actors, I followed the advice of Fabian Muniesa[1] by devising a simple test of whether a given human or material actor had an *effect* in the creation of a socio-technical assemblage, for instance in pacifying biogas as a good. If that was the case, I would retrace other associations to this particular actor until an actor yielded no new data of effect. Especially when retracing actors and associations in the 1970s and 1980s, I reached a dead end if people either could not remember or did not know. On a few occasions, associations came to an abrupt end as many from the 1970s were deceased. In such situations the available data would have to suffice rather than constructing data based on speculations, e.g. why a farmer purchased a specific biogas plant in 1978. Unavailable data is a calculated risk of empirical research.

While overflows and controversies were central entry points into biogas markets making sure data consistently speaks of markets was an entirely different matter. Identifying data on markets, e.g. framing/overflowing processes from interviews and archival data was vital to the outcome. To carve out data relating specifically to markets (and only markets) as defined by Caliskan and Callon, I consistently used the three market characteristics and the three dominant forms of framing as a system of checks and balances. Beyond these, keeping track of the market in the minimal ontology of socio-technical assemblages depends on the data itself as I have no preordained list of ingredients to resort to. To this end, the marketization framework reveals specific groups of potential candidates such as the material components used to pacify a biogas plants, or reports used by agencies to perform valuations of a specific biogas plant in relations to a specific biogas market.

This raises the vital issue of *credibility* – how can we trust the data constructed is sufficiently robust to shed light on the research question when criteria for credibility are as fluid as the assemblages themselves? Condoning the scientific paradigm of constructionism, one lacks standard scientific criteria for validity and reliability which I can claim to have complied with (Svenningsen, 2004). As there are no universal formulas for what constitutes a market I cannot claim to uphold strong scientific objectivity, simply because it is impossible for the notion to apply. However, the data is not caught out of the blue. To claim credibility I have meticulously kept track of the empirical basis in such a way that it is *localized*, as Svenningsen frames it. I am not analyzing markets in general but the framing and

[1] His advice was dispensed during the doctoral course on Organizing Agents and Institutions in May 2007.

organizing of biogas markets relating to farm-scale and centralized biogas plants in Denmark from 1973-2008, and nothing else. Yet, even within the restricted confines of such a localized setting there is the still issue producing credible and valid 'facts'. In this regard, Latour coined the notion 'powers of association' later applied to understand the process of pasteurization (Latour, 1986). The argument is that power is not possessed by individuals but is constituted by the associations with other human and material actors. When Pasteur first presented the idea of fermentation in 1856, developed in his laboratory by observing the lactic acid, it was easy to reject. He first created fermentation as an actor through the process of inscription, whereby an entity is transformed and materialized through documents, instruments, measurements, and archives. He devised a vocabulary to speak about fermentation, etc. To become a widely accepted fact among the peers of his time, he published it in articles, and presented it among the French scientific community which at first rejected it and disagreed. But in time, a list of *associations* between other human and material actors with other experiments, like-minded researchers, etc. At some point it is weaved into a strong network, or socio-technical assemblage that is has grown robust and is increasingly difficult to undermine and deconstruct. As Latour argues the length and stability of associations 'make for a great deal of what we mean by existence and reality' (Latour, 1999, pp. 161-162). The stronger the assemblage, the greater the credibility. Today lactic acid fermentation is a 'fact', but Latour reminds us that it was not always so. Stopping short of comparing my research results to that of Pasteur, the fundamental argument is the same. To be able to speak truthfully about biogas markets, to convince the reader of the credibility of the data and stories constructed, I too have sought to create data based on multiple associations. While it has not been possible to corroborate and 'confirm' all statements and propositions, where possible I have corroborated statements found in news papers or interviews with others. If a newspaper article refers to a biogas status report, which concludes biogas plants are economical, the status report and its author is consulted to create further associations to the specific 'fact'. That is not to say, that the propositions and arguments of this particular project cannot be problematized and brought into question. No argument is so robust that it is not subject to some degree of problematization. Taken to the extreme, even the laws of gravity are co-constructed arguments and can be re-opened. I shall describe the practical steps I have taken shortly. Ultimately, the story you are about to read is not *the story*, but *a story* constructed as the outcome of deploying a specific theoretical and methodological framework to answer a specific research question in a specific empirical field populated by specific people and material entities by a single researcher with specific interest.

While localizing the research and constructing facts based on multiple associations is necessary to ensure a strong degree of credibility, drawing conclusions beyond biogas markets will undoubtedly raise concerns of applicability. The nature of the constructionist' perspective prevents me from making legitimate generalizations beyond the story of biogas. Consequently, the analytical design is not organized to use biogas markets as a stepping stone to other markets, although the research undoubtedly compels me to discuss the results in relations to technologies and markets with similar characteristics.

Through interviews I collected detailed and rich accounts of the framing and construction of biogas markets. Apart from my first interviews, on referring me to other potential informants they provided me preliminary background information on their potential contribution to the project. I always investigated respondents thoroughly to locate when and how respondents were associated to biogas market making. Resumes and publications found online helped me design the interview around a particular period and socio-technical market assemblage. Scientists and engineers mainly provided data on the pacification on biogas, while government officials and industry experts proved more apt for constructing data on framing agencies.

Gaining access to the network of informants has been a relatively simple process. People have been keen to talk to me, which has been an invaluable part of the outcome. Above all other reasons, I interpret participation as a measure of friendliness and significant interest in conveying their story and views on biogas. For the past three years, I have always been met with involvement, attention and an open invitation to return for additional data. As described in the previous chapter, biogas has to a large extent gone unnoticed by social research let alone being the focal point of a PhD project which integrates a technological *and* market perspective. While I have never had any reason to question their 'good intentions', as a researcher it affects how I interpret the data they produce. As more people were interviewed I noticed the controversy that surrounded biogas. Some voiced their criticism of biogas labeling it a striking example of wasteful government spending, while others dismissed all critical voices arguing biogas was a true success story. What I witnessed were conflicting ways of framing biogas by assembling and organizing different reports and metrics to frame biogas in a specific way. On many occasions two different interviewees mobilized the same report but for a markedly different purpose: success vs. failure. A few also tried to enroll me, by asking whether I agreed. Ruling on the matter, however, is neither the purpose nor consistent with ANT-based research. In fact, as controversies represent a central element in the study of markets as socio-technical assemblages conflicting views are included and used as part of the analysis and understanding how overflows can sometimes spark controversies and affect the economization or marketization of biogas plants. Ultimately, it appears part of their willingness to participate stems from the controversies over biogas and desire on part of some to dominate the storytelling of biogas in Denmark.

In addition to division over biogas among interviewees, I also chose to reduce the amount of information on the project when asking people to participate in an interview. Limiting information upfront was not to restrain the interviewee or ensure the interviewer was more enlightened thus creating an unequal footing and balance between interviewer and interviewee. But revealing the focus on 'markets' may inadvertently have caused them to construct data from a neo-classical supply/demand mechanisms of markets; a perspective that has little in common with that of Caliskan and Callon. The outcome could have been another story, than what this project is about. As such, the purpose of keeping them on a need to know basis was to avoid bias and presumptions. Only rarely did I explain that the purpose of the project was to analyze biogas markets.

What I needed from them was data on the framing of goods, agencies, and markets encounters and therefore actors, associations, overflows, and controversies whereby I could analyze the marketization of biogas. In later interviews, I needed data on specific transactions of biogas plants for the second analytical chapter. Interviews were directed at bringing the socio-technical assemblages to life in their words. At one time or another, every respondent had been part and parcel of the markets I was analyzing; some had devoted their entire life and professional career to biogas. I consistently used simple questions such as 'tell me about how you got involved in working with biogas', 'what were your interests', or simply just 'tell me the story behind the biogas plant'. For the most part, I received very detailed explanations and excellent stories but a few interviewees were in constant need of follow-up questions to keep the trail of actors and associations alive.

By retracing their personal steps they constructed accounts of the biogas market assemblage, even if just a small part. Interviews were also directed towards explaining the role and effects of non-humans, such as reports and the biogas technology itself. By pausing them at certain points in their story, the respondents were alleviated from the chronological dimension and allowed to dig deeper and explain in greater detail what had transpired. This strategy proved especially helpful in understanding the mid-1980s when officials from several government agencies renewed market activity by framing biogas as a solution to agricultural pollution; a process based on the circulation of several key reports. Only on rare cases did respondents automatically highlight the role of materiality. For instance, one interviewee explained how engineers in government research programs circulated charts, showing increasing biogas production in Denmark, to encourage scientists to continue focus on improving biogas yields. For the most part, it was apparent how materiality went unnoticed.

Albeit failing miserably early on, I gradually learned part of the discipline of conducting interviews from a constructionist perspective. Following an advice from my supervisor, I kept an interview journal detailing my experiences before and after the interview to measure my progress and learning from the many mistakes. The journal was a tremendous help, especially in enhancing questions following interviews that had failed to produce relevant data. At the same time it documented defining moments and revelations which for better and worse impacted the project design, in particular with regard to the research question, premises and my preconception about biogas which often turned out to be misconceived.

The primary data of the empirical basis is made up by 14 interviews, each lasting anywhere between 1-3 hours. They include scientists and engineers from different government agencies, research institutes, and the five succeeding biogas research programs instituted and funded by the state between the late 1970s and late 1990s. I have also interviewed government officials, biogas industry representatives, farmers, and other individuals who on behalf of a group of farmers have tried to build biogas plants in Denmark. My first interview was with a senior researcher, Kurt Hjort-Gregersen who co-authored an article on the 'successes and failures' of biogas development in Denmark, thus providing me the first historical lesson and perspective on biogas (Raven & Hjort-Gregersen, 2007). He appeared to have significant knowledge on biogas in Denmark. By 'following the actors' in his stories on biogas I quickly identified a list of other relevant people to interview; 'relevant' in the sense that they were deemed able to reveal a host of other human and material actors and associations on goods, agencies, and market encounters. Interviews also revealed several people of interest, whom I have not had the pleasure of interviewing due to time constraints. Almost every interview was consequently recorded and transcribed.

The first couple of interviews were only preliminary and designed to outline directions I found relevant to pursue, i.e. how my research could contribute with new knowledge and improved understanding of the 'ups and downs' of biogas plant diffusion in Denmark. As previously stated, to conduct relevant research I also meant producing knowledge interesting to others than my academic peers. With almost everybody, I noticed an acute sense of frustration and 'we are not there yet with biogas'. It was obvious that biogas was developed to fulfill good intentions – energy, environment, climate change, jobs, export, etc. Following the first interviews, I decided to tap into this 'frustration' and see it as potential for contributing with 'something new', although not yet knowing exactly what that was.

Before explaining the distinct data analysis steps I took as part of writing up the stories on biogas markets, the empirical basis also consisted of secondary data crucial to the outcome. Interviewees often provided me with handouts of artifacts, such as reports and documents on biogas but only represented a small amount of the data collected from artifacts. In addition to the large amount of documents revealed in interviews such as biogas status reports and calculations, newspaper articles form a vital part of the empirical basis as they chronicles events and provide a host of other data. To this end I used online media search engines such as i*nformedia.dk,* by which is it possible to search across every major state and local news paper, trade journal, and tabloid published in Denmark. For some, articles date back to the 1970s.

Articles from the 1970s and 80s were not always electronically available in full length or available at all. I therefore made copies of the original articles from the archives of the individual media companies. For instance, the weekly trade journal, Ingeniøren, allowed me to browse archives going back to the 1950s. Here I found full size replicas of articles on the first biogas plants constructed and energy policy in the 1970s and early 1980s. Newspaper articles proved very useful both in regard to chronicling the development of socio-technical assemblages, such as the construction of new plants, energy policy, etc. but also on overflows and controversies. In fact, I later noticed how journalists' inclination to uncover the fragile and controversial nature of biogas markets served my particular research endeavor.

Whether searching online or browsing through the archives, to maximize the amount of data on biogas I used broad search criteria such as 'biogas' which returned thousands of hits. Around one third were redundant, as several media will publish the same report from large news agencies, such as Reuters, AP, and Ritzau's Bureau. This left me with around 2000 articles, all of which I saved and categorized according to the specific time (1973-2009) it was published. No article was rejected as I was still unsure of the distinct analytical dimensions and thereby what to look for in the data other than 'biogas'.

A brief note on the available literature on biogas markets. Data on biogas can be roughly divided into two groups. The largest group of artifacts constitutes the plethora of status reports on the technical, economic, and environmental performance of biogas plants published by the host of research groups and government agencies since the late 1970s. These have formed an integral part of the empirical basis, as explained above. According to my research, there is not a single book around on biogas plants in Denmark, let alone one that covers the historical development and diffusion of biogas in Denmark. I have come across a few articles (Raven & Hjort-Gregersen, 2007), individual chapters with historical accounts on biogas development in Denmark (Beuse, et al., 2000) and masters' theses by Danish and Dutch university students who had included some degree of historical data as useful background knowledge. These were kept for the data analysis, as I shall return to in the next section.

1.3.3 Constructing The Biogas 'Technography' and Dissertation

Heavily inspired by Latour's *Aramis*, the chronological study of the automatic cable car system in Paris, for my first attempt to write the story of biogas markets I chose to maintain a chronological order starting in 1973 when the first biogas plant was constructed. The combined career of biogas spans almost four decades and continues to this day. Hoping to extract a pattern while organizing my data, I started writing the biography of biogas plants, or 'technography' in a first attempt to engage my data. With 'technography' I sought to devise a technological counterpart for a biography detailing the actions and characteristics of a specific person.

Using Callon's original papers on framing/overflowing and controversies (1986) to structure the technography and bring the biogas technology to life, I started the arduous work of transcribing and coding the data while writing up the stories. These chapters were organized to describe what had occurred in a chronological order. Whether digesting interviews transcripts, newspaper articles, the few books with historical accounts on biogas, or reports from government research programs I was looking for the framing and assembling of assemblages. Inspired not just by the anthropology on economization but also by dozens of actor-network theory-based analysis (Czarniawska & Hernes, 2005; Czarniawska, 2002; Holm & Nielsen, 2007) I compiled a limited list of reasonably simple codes, albeit describing a complex reality, which included human actors, non-human (material) actors, associations, interest, capacities/capabilities, and least of all the dynamics of overflows and controversies (e.g. hot and cold). As the framing/overflowing literature inherits the symmetrical principle from ANT whereby human and material actors are treated on par, I also differentiated between human or material actors. But as Latour's *Aramis* study taught us, assemblages are the outcomes of creating associations between multiple human and material actors at which point it becomes virtually impossible to distinguish between what is human and what is material. The ability by a given agency to act is distributed across humans and a material setup, such as calculators or metrics. However, by letting data speak for itself it is possible. If, for instance, an interviewee explains how a biogas plant overflowed because the manure resisted attempts to be transformed into biogas, the source of the overflow is classified as material. Conversely, if another interviewee accounts for a same event, but attributes the overflow to a scientist's failure to react, the overflow is classified as human.

This also included returning to the 2000 news paper articles, I had initially downloaded. Using the same set of codes I looked for actors, relations, overflows, controversies, and the effects of associating them into assemblages. News paper reports were often found to contain data on a specific biogas plant, event, policy or persons. Interviewees rarely bothered to deliver the basic details on a specific plant such as year of construction, price, capacity, etc. Articles were also instrumental in identifying new interviewees or new questions to ask existing interviewees. Combining news reports with interviews was very important to the data construction process. Where the former were excellent in reporting the arrival of new agencies, technologies as well as overflows and controversies, the latter enabled in-depth 'think' descriptions of assemblages and uncover the framing and relation-building process by which these agencies and overflows occurred in the first place. In other words, articles often plotted actors, associations and events whereas interviews went behind the scenes to expound the story of how actors emerged and became associated. In reading existing accounts from articles or interview transcripts you run the risk of inheriting and simply reproducing the them, and thereby also interests, classifications, capacities, etc. It is important to keep in mind that who is acting on behalf of who is not predefined or as accurate as accounted for by the respondent. There is always more to the story, than what meets the eye. Especially with regard to secondary data, news stories and reports on biogas follow their own logic and serve a purpose different from that of my project. However, by using multiple sources of data method triangulation afforded the possibility of corroborating data, for instance by asking an interviewee to explain a specific event which I had carefully studied from news reports. On the rare occasions that I came across contradictions between primary and secondary data I used the account provided by the primary source.

The eventual outcome was a 250 page document entitled 'Biogas – A Technography', detailing the entire life of biogas from its conception in 1973 ending in 2009 along with my data gathering. In opting for a chronological approach, I divided the technography into three main phases by comparing the input from three different interviewees on how best to divide the life of biogas. Irrespective of one another, they arrived at the same result. The first phase from the early 1970s to mid-1980s was the *pioneering* phase focused on pacifying biogas technology. The second phase was the stable phase during which biogas plants saw a continuous expansion with 2-3 new plants constructed annually. The period from around 1998 to this day was denoted *dismantlement* during which only a few plants were constructed despite intentions of otherwise.

Following every subsequent interview, newspaper article, and other artifact that emerged the technography was continuously updated on the framing of goods, agencies, and market encounters representing the overall marketization of biogas plants. Having tracked the perpetual framing/overflowing activities, controversies and resulting socio-technical assemblages I had constructed a story (not *the* story) retracing the four decade historical journey on biogas plants in Denmark. But at this point it had no direction or purpose, let alone academic framework beyond the framing/overflowing perspective. Next, was to outline specific analyses designed with distinctive theme, and analytical points I could eventually turn into a dissertation.

1.3.4 Constructing 'Markets of Good Intentions'

The technography showed that the 'frustration', I had initially identified, came from four decades of attempt to realize the alleged benefits of biogas plant technology: transforming the useless and harmful waste by-product of livestock manure into a valuable source of renewable energy, which at the same time reduced agricultural pollution, mitigated climate change, created new industries, and could possibly evolve into a significant export commodity for Denmark. Among everybody I interviewed, biogas was framed as a win-win technology, but for various reasons the underlying frame continuously overflowed. The senior experts I interviewed argued that a combination of technical failures, the government production grant and problems with obtaining environmental and building permits from local authorities were primary concerns. But these overflows indicated that to understand the troublesome journey of biogas was not only a matter of technological development. It also involved policy and the processes by which plants could be transacted and constructed regardless of its technical and economic performance. None of the existing government biogas reports I had initially studied directly entertained the idea, that perhaps the troublesome journey of biogas plants could be explained by analyzing markets for biogas plants. Perhaps they were not adequately framed and organized to transform biogas plants into economic goods that could be exchanged in markets that too had to be framed and organized. Perhaps, it simply was not possible to construct biogas plants because the market did not work? Similarly to Dosi, Tidd, and Utterback it appeared they too were making the assumption that markets exist.

I had recently come across the recently published economization/marketization framework, in which Caliskan and Callon applies the original framing/overflowing specifically to the study of markets. Rather than speaking of framing in general terms, it was now applied to goods, agencies, and market encounters as three distinctive frames forming the core of markets. Meanwhile, the marketization perspective provided me with the leverage to construct that 'something' relevant I could contribute with in this dissertation, eventually called *Markets of Good Intentions*. To argue that overflows and controversies played a central role in realizing the good intentions of biogas plants. Knowing specifically what to look for in my data, I operationalized the three forms of framing outlined in the marketization framework – goods, agencies, and market encounters. I used the same set of codes as before, but as the list of relevant human and non-human actors is virtually unlimited, the marketization framework helped group the range of relevant human and material actors into goods, agencies, and market encounters. Similarly, defining what specifically to interview and search for within each type of framing, turning to Caliskan and Callon also proved helpful. For instance, in operationalizing market encounters they use online stores like amazon.com, an auction house, and supermarkets to exemplify them as socio-technical mediating algorithm. Using well-known and easily comprehensible types of market encounters to comprehend and model the ubiquitous, ambivalent, and complex markets encounters, found in biogas markets proved very helpful. To complete a biogas plant transaction in biogas market encounter is far more complex, time-consuming and unambiguous than to complete the transaction for beer in the supermarket. As such, the 'supermarket' was a metaphor that helped organize the data and analysis of biogas plant 'supermarket'. Similarly for goods, I used Latour's study of the failed automatic car service Aramis because it is a detailed study of the complexity in pacifying goods with particular attention to overflows and the support net needed. Framing agencies was more difficult to operationalize because Caliskan and Callon describe multiple dimensions to framing agencies.

Apart from listing identifying agencies from whether they participate in creating and determining the values of biogas, there are several minor yet important analytical dimensions to understanding the shapes and forms they assume: their associations to one another, multiple valuations of biogas, qualculative capabilities, and thereby the ability to dominate valuations and exclude others from partaking. The perpetual (re)framing not only meant keeping track of a number of agencies, but also shifts in each of these dimensions. To this Cooren's (Cooren, 2006) notion of a plenum of agencies helped tremendously by considered the biogas market as a playing field of different agencies with material tools, grouped in different teams. Biogas markets have consistently been represented by a pro-biogas agency seeking to promote biogas plants in Denmark, but has been represented by various grass roots movements, scientific and political actors in time.

The purpose of the first analytical chapter became to analyze the marketization of biogas plants and to understand the role of overflows and controversies. I based the analytical design on the marketization framework creating three main analytical tracks, one for each kind of framing (good, agency, and market encounter) across the lifespan of biogas markets which I had divided into the three main periods mentioned above. I had come to respect the chronological progress of the technography through which I could track the continuous emergence, stabilization, and collapse of market assemblages. From interviews, it appeared that the present life of biogas was difficult to convey without making reference to past assemblages, i.e. to understand the socio-technical assemblages of the 1990s biogas markets required an understanding of what had taken place in the 1980s and 1970s. At the same time, the marketization framework created three different analyses, one for goods, agencies, and market encounters each with a separate analytical point. As opposed to applying them as three main analytical tracks with equal emphasis across all three periods, I assigned one analytical track to each of the three corresponding periods. Consequently, the first period analyzes the pacification of biogas plants as a good, the second studies the framing of qualculative biogas market agencies, and the third examines the framing of biogas market encounters. Determining which track to assign to each period was based on whether the data on a period was considered sufficient for the analysis. Instead, the notions of framing and specifically the role of overflows and controversies are overarching analytical themes across all three periods.

By drawing up associations between the host of human and material devices, while keeping track of overflows and controversies, I was able to draw up frames of the three underlying socio-technical assemblages in marketization – the good, agencies, and market encounters in accordance with the marketization framework. As the number of entities in the frame quickly cultivated into very complex frames, groups of actors were sometimes pooled into smaller groups such as a pro-biogas agency and anti-biogas agency along with its material setup. The outcome was three sets of frames and underlying socio-technical assemblages evolving over time from 1973 to 2008, one for each of the three periods.

Next to the frames, I kept an inventory of overflows and controversies. Once overflows occurred the individual actor that overflowed (for instance when manure resisted attempts to be transformed into biogas or when a politician redrew support for biogas), the effect of the overflow such as low biogas production, poor economic performance, or local protests, and time was noted. Similarly, time and main dispute for controversies over biogas were noted. To keep track of their dynamics I devised a small system. When overflows were reframed I marked them as such. Similarly, controversies were either ‘hot’ (open) or ‘cold’ (solved). But I never deleted them as they were by definition only in a temporal state. More importantly, I also kept track of how overflows and controversies, for instance how agricultural pollution became widely accepted following the publication of several reports identifying Danish agriculture as the source in the mid-1980s. Overflows and controversies may occur all the time, but only those that are detected and expressed become visible.

Together, the first analytical chapter consists of three analyses – goods, agencies, and market encounters – which in combination with one another represents the marketization analysis of biogas plants in Denmark from 1973-2009. The idea is to construct a fundamental understanding for how well-framed and organized biogas markets are, upon which I could continue with a detailed analysis of how individual transactions of biogas plants are framed and organized amid overflows and controversies.

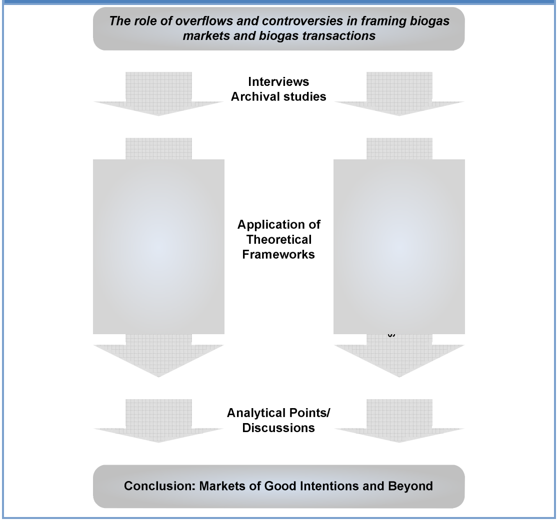
In January 2009, I moved to New York as a visiting scholar at the Department of Sociology at Columbia University under the auspices of David Stark to continue the analysis of biogas markets. At this stage I had formed a generic understanding of biogas markets, and why capitalizing on the good intentions through markets were difficult but had yet to fully understand the challenges in completing a single market exchange.

What had surprised me the most in the first analysis was the immense difficulty with which biogas plants were transacted. Moving away from the general marketization perspective, I decided to create a theoretical framework to study the core economic activity of framing and organizing the transaction. The second analytical chapter, '*Framing Transactions: Devices, Principles, and Resistance*' evolved into a detailed study of the role of overflows and controversies in completing two biogas plant transactions. By retracing the socio-technical assemblages of specific transaction, I would be able to describe the work required to bring these plants to live in Denmark. Well-framed and ill-framed markets are not two different modes, but represent two extremes. In between we find various degrees of well-framed or ill-framed. In other words, even relatively ill-framed markets can still facilitate transactions. They are not impossible. But through multiple stimulating sessions with Stark and other talented faculty members at Columbia University in and around campus, I realized my data was insufficient to this end and further data construction was necessary. Upon my return to Denmark six months later, I contacted people who had played a central role in constructing new biogas plants in Denmark. Through these new detailed accounts it became possible to elucidate aspects of markets making when the good is inherently fragile and controversial. For good measure, I have relocated the detailed methodological aspects concerning this analysis to the introduction of the second analytical chapter on page 164.

1.3.5 Analytical Design

Combined and individually, these two analyses expound several core aspects of market and technology dynamics that are relevant to understand why biogas markets in Denmark have at times struggled to realize the good intentions.

Figure 2: Markets of Good Intentions - Analytical Design



The first uses the overarching marketization framework, with its three forms framing – goods, agencies, and market encounters - to analyze biogas markets from 1973-2008. The overall purpose is to understand how biogas market are framed and organized, by using the data and theoretical framework to extract several individual analytical points which as a whole allow us to formulate a general response to the research question. Having sketched a new understanding, the second chapter – *Framing Transactions: Devices, Principles, and Resistance* - augments with a much more detailed analysis of how individual biogas plant transactions are framed and organized. Adhering to the same analytical dimensions, the chapter introduces a distinct theoretical framework for analyzing the activities performed by so-called biogas frame-makers that is the key agencies in charge of the transaction. Amid fragility and controversy the purpose is to show several distinct features of the activities and tools they deploy towards framing and organizing a single transaction. We begin with the general and overarching perspective of framing biogas markets in Denmark based on data from 1973-2008, before diving into the detailed aspects of framing transactions using data from two recent transactions of biogas plants.

Each of the two analytical chapters deploys a separate empirical basis and unique theoretical framework although adhering the general framing/overflowing perspectives. The first chapter uses the marketization framework, as previously described. The other theoretical framework has been removed to the introduction of the second analytical chapter. As a result of the considerations presented in this chapter, each period has been determined to be best suited for a particular kind of analysis towards demonstrating a particular analytical point. In combination the three analyses can be extended and compared to bringing home three overarching analytical points on the framing of biogas markets. These also prompt several interesting discussions on some of the challenges in framing biogas markets.

Together, I hope this PhD project demonstrates the fragile and controversial nature of biogas markets. Overflows and controversies lie at the heart of markets to the extent, that they cannot be sidestepped or ignored. They are central in conceptualizing biogas markets, and thereby inescapable to consider in answering how markets are constructed and maintained. Otherwise we end up with markets of good intentions; markets which are unable to capitalize on the technical, financial, social, and political intentions by governments, scientists, industries and others.

2 Framing and Organizing Biogas Markets

By analyzing the marketization of biogas plants in Denmark from 1973-2008 the purpose of this chapter is to examine the marketization process whereby biogas plants are framed as economic goods, and markets are created to render transactions possible. To what extent can we speak of well-framed markets as opposed to ill-framed markets of good intentions in the case of biogas plants? What is the role of overflows and controversies on biogas market making, and how are they addressed – if at all?

This first of two analytical installments of this project is divided into four sections. Each of the first three is devoted to analyzing particular aspects of framing and organizing biogas markets based on one of three periods. The first section analyzes the *pacification of biogas plants* as principal ingredient in market making. The argument is that without a pacified good exhibiting a stable behavior and performance there can be no organized action, i.e. those involved cannot make plans and carry out action. In the second section we analyze the perpetual and material aspects of *framing biogas market agencies* capable of performing valuations of biogas plants with particular focus on the various forms agencies assume. Here, the argument is that agency properties are never stable and fixed. And thirdly, to bring goods and agencies together I shall analyze the central role of *framing market encounters* in facilitating transactions of biogas plants. As will be argued, their multitude, complexity, idiosyncratic configuration along with the presence of overflows and controversies can render transactions lengthy and impossible. The fourth and final section uses all three analyses to reflect on the fragile and controversial nature of biogas markets and discuss the implications for marketizing biogas towards creating well-framed biogas markets.

Combined and individually, these results will demonstrate that the combined work and effort needed to frame and organize markets to deliver on good intentions amid fragility and controversy. The notion of well-framed markets versus ill-framed markets of good intentions as a measure the perpetual role of overflows and controversies, will provide new vital answers to the troublesome journey of biogas plants in Denmark.

2.1 Pacifying Biogas Plants Favours Organized Action

In this first section I want to analyze the pacification of biogas plant technology. I want to demonstrate that only stable performance in goods is conducive for organized action, and only thereby can markets stabilize. A pacified good exhibits stable characteristics and performance which allows agencies to perform valuations and make plans. For producers to decide whether to develop biogas plants, for customers to reach a decision on whether to purchase a plant, or for politicians to institute public support, depends on its potential disentanglement. By *stable*, I refer to the well-framed sense of the word, i.e. when goods do not suddenly change characteristics and behaviour to the effect that those involved cannot plan actions, make informed decisions, and depend on existing valuations of the good. Consequently, I want to demonstrate that when pacification does fail according to whatever good intentions the plant is designed to deliver on, any fundamental re-framing and re-pacification of technology renders previous stability and effort lost. In other words, stability plays a key role in affording further stability. As a recurring question, I shall address the role of overflows and accompanying controversies over biogas plants in its pacification and consequent marketability. To this end, we will track the first three attempts to pacify biogas plants during the 1970s and 1980s (there are many more in the 1990s and 2000s) using Caliskan and Callon's notion of pacifying goods. We shall focus on the difficulties in transforming worthless manure into valuable biogas, securing a predictable and stable biogas production, and introduce an extended view on support nets and legislative elements all relevant for goods to be pacified and disentangled from its seller. The story is constructed from interviews with key informants from this specific period, along with a broad range of archival data, new paper articles, reports etc. We begin in the 1970s when the first biogas plants were constructed in Denmark following in the wake of the 1973 oil-crisis.

2.1.1 Pacifying Attempt #1: The Farm-scale Biogas Plant

In a response to the oil crisis following the outbreak of the Yom Kippur war in the Middle East a wave of technological development in renewable energy was started, primarily in the West which was heavily affected by the ensuing oil embargo. Governments subsidized research and development focused on transforming domestic energy supplies from wind and solar to geothermal and various forms of biomass material into energy. Although mainly driven by concerns for energy, awareness of the relationship between fossil fuels and air pollution and public health problems also helped draw attention to renewable energy. Among them, some of which saw light for the first time, emerged a solution in the rural districts of Denmark simply known as *biogas*.

The first plants to produce biogas in Denmark were constructed in the rural areas dominated by endless crop and livestock farmers, small villages and the unfortunate whiff of livestock manure. Among farmers it was well-known that apart from containing nutrients essential to any crop, the abundance of livestock manure also contained the ingredients necessary to produce this flammable gas of methane and carbon dioxide particles. Experiments with biogas based on livestock manure go back to the 1950s, and was a common source of energy in the rural parts of China and the Netherlands (Beuse, et al., 2000). In the wake of the 1973 oil crisis, the challenge for certain farmers was to transform worthless manure into a valuable form of energy by framing a biogas plant in which a stable anaerobic digestion could take place. It had never been successfully done before in Denmark but in late 1973 the first biogas plant came online in Denmark. The farmer, Anders Lassen was the first in Denmark known to have constructed a small biogas plant on the village of Voel near Silkeborg on the Jutland peninsula. Exactly how he came across the idea is unknown, but his goal was to produce enough biogas to power his house and farm, and store excess gas inside a large glass bell for winter, and possibly even power his car. Servicing a single farm it became known as the *farm-*

scale plant. The challenge consisted of building a biogas reactor large enough to house the production of biogas using manure gathered from Lassen's livestock. Key components were glass fiber, a relatively novel product used to produce wings for wind turbines, along with a gas turbine to power an electric generator. Armed with limited knowledge, DKK 3000 in personal funds, and these material means, Lassen enlisted the local blacksmith to construct it. In 1974, another farmer Hans Aage Jespersen followed in Lassen's footsteps and built a similar biogas plant in the small village of Nørre Aaby. He also enlisted the support of two local blacksmiths. Why or how he came up with the idea is also unknown, but Jespersen shared Lassen's idealistic and pioneering approach (Beuse, et al., 2000). In addition to meeting personal energy needs, Jespersen was allegedly also interested in demonstrating basic digestion principles and contributing with new knowledge to the scientific community, whose interest in biogas was also increasing. In an alliance with farmers the scientific community began exploring the potential in various forms of biomass in addition to livestock manure. This way seaweed, household waste, mustard, grass and straw found their way into the reactor. Grassroots movements also became interested in biogas, as part of an overall activation of local efforts within alternative energy, driven by ideological and political agendas. People from the Danish Folk High Schools, local communities and local energy advisors worked together to pool what limited knowledge and insight they had in a common goal, albeit serving idiosyncratic interests, to experiment with renewable energy.

It was not surprising to find farmers behind biogas plants. During the nineteenth century farmers constructed dairy factories to process their farm products formed as co-ops to distribute the costs among a large group of farmers thus benefitting from economies of scale. During the twentieth century they used a similar approach to drive the electrification of Denmark. Using a similar organizational approach, to distribute costs they established power and utility companies organized in co-ops all over Denmark (Jensen, 2003). Energy was therefore nothing new to farmers. Independence and self-reliance was an essential motivating factor in these endeavours. Likewise, framing biogas plants not only served a strict economic and practical purpose, biogas could also secure 'independence' from expensive foreign oil. Along with a host of other small agencies – blacksmiths, NGOs, high school teachers, local energy advisors, scientists, etc – pooled limited knowledge and resources in transforming manure into valuable biogas.

There was just one problem. None of the plants worked for more than a few hours, much less an entire day. In most cases the plants failed all together. It could take weeks of careful work to stabilize biogas production, and even the slightest alteration could bring a plant to a grinding halt in matter of minutes. In many cases production stopped on its own without any human involvement. As a result, the transformation far from lived up to the good intentions. Unstable production resulted in low biogas yields (the amount of gas produced from a fixed quantity of manure) making the entire investment uneconomical to the dismay of farmers who had taken the financial plunge. No one had anticipated this natural process to be this unstable. Neither farmers nor blacksmiths, or scientific experts in microbiology had any credible or documented answers as to what exactly caused production to stop, let alone any solution. At the same time, reactors would *literally* overflow with livestock manure, when the fittings used to hold the reactor together caved in under the immense pressure from the manure and gas. Pumps and pipes used to circulate the manure also proved incapable. Deteriorating the situation, every plant experienced a unique set of problems unrelated to other plants although inheriting the same design and blueprint. The midwives of biogas had encountered a problem of Callonian proportions, when living organisms (such as genes, stem cells, and GMOs) enter the assemblages. These have lives of their own and are at times highly unpredictable. When this overflowing actor forms the core of a larger technical configuration it renders the entire frame unstable and overflowing. The technical and manure overflows had formed an alliance of resistance, almost 'resisting' their effort to pacify it. The material agency – manure and technology – was biting back which meant the transformation of manure into biogas became increasing difficult. They realized that biogas production was far more complex than initially anticipated. What was anaerobic digestion, really? Lacking knowledge on their properties and performance overflows remained as such and the plants refused to work. Constructing and reframing the number of overflows with each new plant became an experimental trial-error process, and it was only through their mutual interaction in the assemblage new knowledge and solutions to the unexpected overflows in each plant were produced. Rendering the operation stable and predictable was extremely difficult and the biogas plant responded to every attempt of reframing the overflows by creating more overflows.

By now the biogas industry had evolved into suppliers of farm-scale plants offering a full array of services from initial design to construction, and maintenance. Spearheaded by Danish engineering conglomerate Carl Bro Group the industry had gradually developed the basic competencies needed to construct plants but lacked the capacity to research how to control and re-frame these overflows thus bringing the pacification process back on track. To succeed, they not only required additional knowledge of certain basic principles in anaerobic digestion and manure. An idiosyncratic and complex network of microorganisms and construction materials was needed to accommodate the individual problems with each plant; a task which required scientific resources beyond their capacity.

2.1.2 Pacifying Attempt #2: Advanced Farm-scale Biogas Plants

In 1976 a researcher, Johannes Christensen had published a report under the Ministry of Agriculture (Christensen J. , Håndtering af affald fra husdyrholdet, 1976) in which he indicated that the nation's vast amounts of livestock manure posed a potentially large source of energy. Interested in activating the government even further, Carl Bro also published a report echoing Christensen's idea of using biogas as an alternative source of energy in the domestic energy system (Groen, 1981). As a company they were interested in capitalizing on what they believed was a growing market for farm-scale plants but lacked the scientific resources to adequately reframe the technical overflows (Christensen J. , 2007). Due to Denmark's relatively large production of livestock both reports argued biogas could become a significant source of renewable energy. However, both also envisioned technical challenges and with farmers in over their heads in manure, debt, and technical challenges beyond their competencies they called for the government to assume a principal role in developing biogas with government sponsorships and organization.

At this stage, a new important agency in the market for farm-scale biogas plants was mobilized. The government's reaction to the oil shortage in October 1973 focused on short-term damage control. The public was immediately encouraged to conserve energy, prices on energy were increased, and the remaining oil was reserved for industrial production. The energy crisis not only upset the energy system and the economy, but also the political system which had no prior experience with energy crises management and response. The relation between oil crisis, economic recession, and renewable energy, including biogas meant it became highly politicized early on. Up until October 1973, energy was considered cheap and unlimited and the political notion of national energy policy was unknown. In Denmark energy policy was in 1973 the official responsibility of the Ministry of Education but the government had no official energy policy at the time. An Energy Committee was established to advice the government on how to formulate new strategies and policy while energy policy was transferred to the domain of the Ministry of Trade (MoT) because of its primary importance to Danish industry and business sectors. In May 1976, the government presented the nation's first official energy plan. The main objective was to reduce Danish dependence on imported oil by re-organizing the energy system towards a multi-stringed system based more on coal, which was cheap and readily available throughout the world, and less on oil from the Middle East. Nuclear energy and natural gas from Danish deposits in the North Sea, still inaccessible in 1976[2], were also part of the long-term vision. Ambitious reduction targets for national energy consumption through conservation were also established and to implement the plan, the Danish Energy Authority (DEA) was established the same year (Energistyrelsen, 2006-2008).

The prospect of nuclear power, more coal, and no prospect of renewable energy was ill-received by some. Alternative energy plans were published (Jensen, 2003)emphasizing combined heat and power plants (CHP), which were more efficient than traditional power plants and renewable energy. A green alliance emerged in Parliament represented by the left-wing parties which formed an alliance with environmental organizations such as the OOA (Organization to Inform on Atomic Energy), OVE (Organization for Renewable Energy) and Nordic Folkecenter for Renewable Energy (FC) who were opponents of nuclear energy due to the potential security and environmental hazards. Fossil fuels were framed as a temporary solution until renewable energy was sufficiently pacified and economical to become the backbone of the domestic energy system. Although

[2] Oil shipments arrived in 1975, natural gas in 1984

renewable energy contribution was considered marginal, the technology experimental, and up against the 'clean potential' of nuclear power (Beuse, et al., 2000) biogas was now enlisted in a political alliance.

In the spring of 1978 the minister of trade Ivar Nørgaard launched a more comprehensive five year government research program providing the DEA with a mandate to research alternative forms of energy. With the arrival of the Christensen and Carl Bro reports biogas was framed as a political tool to reduce dependence on foreign oil. DTU professor Ulf Meyer Henius had contacts in the biogas industry, who thought of the idea of using the reports as a basis for applying for funds from the DEA to research and pacify farm-scale biogas plants. Many were left unemployed in the wake first attempt to pacify farm-scale plants. Henius circulated the reports in the DEA along with an application for funds which was accepted (Henius, 2008). Consequently, the Ministry of Trade formed the Cooperation for Technological Development of Biogas Plants, known as *STUB*[3] in April 1978. Under the auspices of the DEA, it was mandated 'to organize the development and demonstration of biogas plants, combine early experiences, and mobilize knowledge from various sources to ensure biogas can evolve into a significant source of energy' (Energistyrelsen, 1981). In other words, to attempt once more to pacify biogas plant by transforming manure into a valuable source of domestic energy. In understanding how pacification, crucial for markets to emerge, the creation of STUB clearly demonstrates we cannot ignore the host of political and legislative elements without which funds and people were not activated and organized to reframe biogas plants. And as we shall see while STUB was the first politically instituted agency to be solely activated in the framing and pacification of biogas plants, it would not be the last.

Having assembled many experts and authorities on biogas in Denmark, STUB set about repairing the ensuing 'technical disaster' among the biogas plants, as Henius described it during an interview. Acknowledging that the primary challenge was technical, it was staffed by engineers - including Henius, Christensen, Carl Bro, representatives from various government branches, public research agencies, along with a few agricultural specialists. Farmers were not represented as knowledge of their individual plants did not fit the advanced engineering regime of STUB. STUB

[3] In Danish: Samarbejdsgruppen for Teknologisk Udvikling af Biogas - STUB

was not a grassroots project and it was not believed members of grassroots organizations and farmers were able to bring any value to STUB. They found the existing plants ‘low tech’, ‘homemade’, and above all technical failures promoted at the hands of people whose expertise was farming and physical education, not biogas (Henius, 2008). However, the target group was farmers. Many had lost interest in biogas, and fearing any further discredit of biogas technology it was agreed that although primarily faced with technical issues, economic feasibility hence biogas yields should also be improved, while researching the basic principles of anaerobic digestion, the effects of manure, and environmental aspects. From a framing and pacification perspective their approach was to realize the good intentions of biogas by pacifying an advanced and high-tech version of the existing farm-scale plant. From previous overflows they identified number of elements – technical, economic etc – as crucial to succeed. To succeed in transforming manure into biogas by framing a stable biogas plant they found it necessary to restart with transforming biogas into a product fit for wide-scale application in Denmark. Three new biogas demonstration plants were announced, each based on a different experimental production layout in 1978-79. By framing and pacifying three different technical configurations STUB was convinced they could find an optimal one. To attract farmers as primary investors and owners of the plants STUB offered to co-fund the cost of construction. They felt harnessing their interest would provide better results, if farmers assumed part of the risk rather than the government handing them the plant as a gift. Johannes Christensen explains:

“We needed to carefully select the farmers to increase the odds of success. We were primarily interested in farmers who were really interested and motivated. Someone with an inner drive for the project. Of course, we gave priority to those with sufficient financial backing since the state only provided 40 percent of the required investment. The farmer had to put up the rest of the money.” (Christensen J. , 2007)

Christensen’s statement clearly indicates that the purpose was to help pacify a product that could be disentanglement from STUB thus allowing farmers to assume ownership. As Caliskan and Callon notes, what separates a market as opposed to a gift regime is the notion of disentaglement. This is a fundamental characteristic. As a gift the good is never fully detached from the buyer because nothing is returned in exchange for the gift. However, in a market it is important the good is fully disentangled from its source of origin and ownership transferred from producer to buyer, usually in exchange of money. However, disentanglement is only possible if the product is pacified, exhibits stable and predictable characteristics and performance which consequently favors organized action such as drawing up plans and deciding whether to construct a plant. Rendering such organized actors by means pacification was the aim of STUB. Succeeding in this endeavor, however, was an entirely different matter.

STUB wanted to 'return to basics' and start from scratch with the pacification. More than a hundred farmers signed up (Ingeniøren, 1983a) but only a handful was selected through rigorous interviews designed to select the best candidates. STUB was well aware of existence of overflows and the possibility of new ones which is why a dedicated group of farmers were considered crucial for a successful pacification outcome. They could not afford them to overflow as well. Only four existing plants were included as part of STUB's monitoring activities to record technical and economical performance. In doing so, they rendered the technical configurations existing plants obsolete. STUB's framing of past development as 'homemade' and decision to only include the most recent and advanced existing plants, sparked a small controversy over STUB among grassroots movements and farmers whose plants were excluded. STUB argued they were only interested in the newest plants featuring the latest technology, and that older plants regardless of performance did not fit the high-tech scientific and engineering goals of developing 'advanced' farm-scale biogas plants (Henius, 2008). Disgruntled farmers were, however powerless to produce an alternative to STUB. Instead, through interviews STUB gave priority to farmers with sufficient financial backing but also whether they were properly motivated and patient as success was deemed to require a concerted and time-consuming effort. Other criteria were also looked at, for instance whether a farmer had technical insight and experience.

Between 1978 and 1981, the biogas market saw the arrival of 21 new farm-scale plants, seven with STUB involvement - four more than originally planned for. Chairman Henius explained that by staffing STUB with scientists and other highly educated people with relevant PhDs and insight, it had become possible to match the magnitude if the pacification work needed to construct new plants based on various layouts and reframing overflows as they occurred; something farmers and grassroots organizations had been incapable of doing (Henius, 2008). He also explained how STUB's ability to identify and keep track of overflows was the result of framing a material setup. Measurement equipment and other material devices were installed with the demonstration plants to collect, analyze, and document progress with each plant and related research activities. This comprehensive metrological system empowered them to track the transformation of manure into energy and gradually transform an increasing amount of human and material actors into a stable and predictable assemblage. By keeping track of overflows they could indicate possible solutions or patterns in plant behavior, for instance if biogas production suddenly stopped; something farmers and grassroots movements had not been capable of. For scientists and engineers, quantitative measurement was a basic heuristic. All operational data from the plants was collected each month when a STUB engineer toured the plants. With a tradition for quantitative analysis and reporting resulted in an unprecedented production of data, analysis, documents, along with officieal status and evaluation reports. Most of them were made public to keep the government and other key agencies in the demonstration projects informed. Results were reported back to participating farmers and were published in the 'Biogas Nyt' magazine established by STUB (now 'BioPress') making results available to other farmers who had purchased farm-scale plants outside of the STUB-regime. This provided potential clues on how to reframe the technical overflows which continued to burden the overall framing of farm-scale plants.

STUB may have rejected the first series of plants and started over, but the challenge of transforming manure into biogas was the same. And so were the overflows. Every plant experienced multiple overflows resulting in a poor technical, economic, and environmental performance for all plants. In fact, a 1981 STUB status report framed the new biogas plants as 'failures' (Raven & Hjort-Gregersen, 2007). Out of an inventory of 21 plants, eight plants were out of operation, five of which were without plans for reinstatement. Three plants were offline and undergoing repairs. Four plants were in operation or starting up but suffered from severe technical problems which prevented a stable operation. Only nine plants were relatively stable but biogas yields were very low.

Once again, the reactor had continued to resist attempts to be framed and pacified. Above all, maintaining a stable biogas production was preconditioned by the manure itself. Scientific studies and experiments indicated the complex and heterogeneous nature of livestock manure was the primary overflow rendering the entire plant ineffective. Studies revealed it came in all shapes and sizes; some dry, some fluid depending whether it had come out of a pig or cattle, the type of fodder used on the specific farm, water contents, etc. Manure was never the same, not even within the confines of the same farm. Even the same manure could behave differently from day to day. It was that unpredictable. As a result, it was not possible to reframe the manure by framing a single solution because it was not a single overflow but many. They had yet to fully understand its unstable and unpredictable behavior when exposed to anaerobic digestion in the biogas reactor. Not being able to fully account for the range of problems, reframing manure and transforming it into biogas remained difficult.

As an illustration of the influence livestock manure had on the other elements, Christensen mentioned how the pumps and pipes installed on all the plants overflowed as well due to the idiosyncratic nature of manure. These were standard issue, but as no one a priori knew of the varying composition of manure, pumps and pipes had not been configured and coordinated to transport it around the plant. Even as they gradually realized that the manure was the main conduit for overflowing, technical problems remained difficult to reframe. Sometimes, manure was so thick and dry it blocked the pipe and the pump lacked sufficient power to transport it. Christensen recalls a situation when the central stir-unit, which kept the manure rotating inside the reactor, also overflowed from the frame. It was haphazardly reframed by a relative to a STUB employee who happened to stop by on a family visit from Norway. The relative was a professor in mechanical engineering from a Norwegian university, who had found a solution to a similar overflow with a stir-unit in Norway (Christensen J. , 2007).

This is how numerous other problems were solved. Every overflow was met with a completely new technical device often framed from scratch to solve the individual overflow of the individual plant. This trial and error pacification process took time and was costly which rendered all the plants uneconomical. Moreover, every overflow was multiplied for each of the different plants as they were based on different layouts and technical principles, thus producing different biogas yields and economical prospects. Reframing meant creating new solutions which in turn expanded the scope of the frame needed to succeed. Although the decision to experiment with various forms seemed logical to determine the optimal layout, it multiplied the pacification efforts needed and number of overflows. Since manure performed and behaved differently for every single farm, the combined biogas agency was not pacifying three general plant designs but in effect pacifying 21 different products and dozens of unique overflows which required a unique solution. What was initially planned as three technical configurations was seven-folded into 21 overflowing frames.

Neither STUB nor the biogas industry at large had succeeded in pacifying biogas plants and transforming manure into biogas according to its initial good intentions. Many farmers lost interest and were discouraged from investing in biogas. In fact, around 1983 all demand vanished and not a single plant was constructed. Critics blamed STUB's plants for being too advanced calling for more simple plants, but STUB rejected the call arguing that 'advanced' was not equivalent to impossible and to pacify biogas plants required time, resources and patience (Henius, 2008). It appeared the previous controversy over simple versus advanced biogas plants had become hot once more. Although having created a biogas market strong enough to implement 21 plants, further market activity was highly unlikely unless overflows were brought under control. Purchasing a plant came with a high risk of financial problems. Seen from the perspective of pacification, it was anything but a well-framed market as the lack of stability and pacification had failed to render biogas plants economical. No farmer would run the risk.

In a move to avoid losing credibility and secure some degree of stability, Henius decided to reduce ambitions and focus on reframing existing technical overflows in effect 'freezing' the intended frame. They no longer found it realistic to create economical plants. Over the next four years STUB came a long way. Compared to the 1981 status report, it was concluded that the technical overflows had been solved with two thirds of the plants operating without technical overflows (Ingeniøren, 1985a; STUB, 1985). For each overflow there was no readily available off-the-shelve solution they could buy from the local hardware store. Instead, overflows were reframed by framing new devices to accommodate the idiosyncratic characteristic of each overflow. While the knowledge could for the most part be re-used at other plants, the fact each plant were based on different production layouts, different suppliers, and above all, different manure meant the same device could not be used with other plants despite experiencing a similar overflow.

Of the technical, economic, and environmental goals of a pacified biogas plant, STUB had barely succeeded with the first. Economically biogas plants were in shambles. In reducing ambitions several crucial objectives had been abandoned, including transforming biogas into an economical good. STUB researcher Johannes Christensen stated in a news paper article that is 'it is plausible that we were too hasty with the first demonstration plants (…) The pioneers were really shafted, financially' (Ingeniøren, 1985a). The economic analysis suggested the farmers had virtually lost their investment. Almost every plant was unprofitable, and at best the economic performance and outlook was still very fragile and uncertain in the event of new technical problems. A STUB report from 1982 estimated the maximum investment most farmers could afford was DKK 250.000, but was insufficient to construct a biogas plant with the stable performance required (Beuse, et al., 2000). As Christensen explained:

> "Even if we did succeed, we all knew in the back of our minds that success was equally dependent on making the plants economically feasible. No farmer will invest a penny in unprofitable technology, no matter how well it performs." (Christensen J. , 2007)

To favor organized action on part of the farmers, thus stabilizing markets, also required a stable and predictable economic behavior to avoid a financial overflow. Farmers did not trust the unstable and unpredictable behavior of farm-scale plants the biogas markets in the mid-1980s had to offer. And as a result, interest in farm-scale plants vanished.

The controversy over whether future pacification should follow in the original low-tech trajectory in light of the failed high-tech approach was hot once more. The grassroots movement, Nordic Folkecenter for Renewable Energy (FC) continued to enhance the technology arguing simple was better. But as it would take years for them to pacify farm-scale plants, STUB argued the only logical future direction for biogas was to develop much larger collectively owned plants financed and operated by a group of farmers in hopes of achieving economies of scale. These *centralized biogas plants*, as opposed to farm-scale, had been tested in 1982 when a demonstration plant was constructed at the government research site Bygholm.

And a 1983-report from the DEA explored the challenges and potential and concluded it was feasible.

2.1.3 Pacifying Attempt #3: Framing Centralized Biogas Plants

STUB closed officially in 1988. Instead, with direct access to STUB's research results the DEA's position as chief authority on biogas grew increasingly more powerful along with a government mandate and control over financial resources and a weak biogas industry. In fact, the government was the only agency with the power, interest, material setup, and financial means to keep biogas markets alive in Denmark. In this section we retrace the steps of a third attempt to pacify biogas plants amid overflows and growing controversy. In addition to demonstrating the framing and overflowing difficulties, I want to expand the transformation to include support nets while underscoring the political element without which pacification and disentanglement could not take place in Denmark.

In January 1981, the government released the second energy policy - Energiplan 81 - focused on security of supply as the primary political concern, but also on lowering prices on energy for consumers. In contrast to 1976, where renewable energy was marginalized, the 1981 plan established the first indicative target of 10 percent for renewable energy by 1990. Along with wind power biogas was considered most promising options. In fact, it estimated almost 20.000 small farm-scale biogas plants to be in operation by 1985. DKK 100 million was allocated for alternative energy projects, including wind, solar, biogas, and other biomass-based projects (Beuse, et al., 2000). As such, there was no lack of good intentions.

The first shipments of Danish oil and natural gas production in the North Sea had arrived prompting the government to begin the construction of a nationwide natural gas infrastructure. Natural gas was a top priority for the government, as it would reduce dependence on foreign oil, and the DEA was consequently allocated resources towards constructing the infrastructure rather than focusing on biogas markets. However, this did not mean biogas market in Denmark remained dormant in the wake of the farm-scale plant failures. STUB's inclination towards *centralized plants*, had been well received in the County of Northern Jutland, where plans of making villages 100 percent self-reliant with renewable energy based on domestic resources were under way. The so-called *Village Energy Project* (VEP) was the brainchild of county officials and local politicians, who had also taken notice of the high prices on energy taking a toll on citizens in the rural and scarcely populated districts of Denmark. County officials saw centralized biogas plants as a vital energy ingredient because of the manure so abundant in the region (Nordisk Ministerråd, 1987).

Also motivating the political interest in biogas was the high unemployment rate troubling the region, the second highest in the nation. Development of renewable energy could create jobs, and promote the region as a regional power house on alternative energy systems. As such, the entered bids for the construction contracts would be assessed on the extent it made use of local work force and business resources. VEPs did not start out as biogas pacification per se as previously seen. Now biogas plants formed an integral part of the pacification of VEPs. As an important distinction from the first generation farm-scale plants, these new centralized plants 'piggy backed' on the VEP frame, i.e. marketization of biogas was only afforded by simultaneous marketization of complex energy systems. Success therefore not only depended on pacifying an entirely new generation of biogas plants, but also to frame a new form of energy system designed to deliver on the socio-economic intentions of local and county politicians. However, specific for centralized plants was that they no longer only catered to individual farmers. Centralized plant would function as a manure 'hub' to distribute the de-gassed manure from livestock farmers to crop farmers who required large quantities of fertilizer. To succeed, then, not only meant pacification of a new generation of biogas plants themselves; it required framing a support net. As we shall witness momentarily with VEPs, that was no easy task.

The idea was to complete VEPs in four different villages in northern Jutland. Villages were invited to participate and the interest was overwhelming. A total of 22 villages volunteered but only four were selected: Vester Hjermitslev, Vegger, Store Brøndum and Try with a total of 1100 inhabitants and a few hundred household. Each plant was owned and operated by a new power company founded and staffed by farmers, members from the local district heating company, and local volunteers. So-called VEP work groups were organized staffed with local government officials, biogas engineers, researchers, specialists, local volunteers and members from grassroots movements with an idealistic interest in the project. The DEA allocated funds for planning and feasibility studies, construction, and for a two-year follow-up program to monitor, collect and publish data. Some DEA officials had been involved in STUB and therefore still very interested in biogas (Sandholt, 2008).

Centralized plants would become power companies by supplying the public grid with energy. One crucial element was the set of legislation allowing biogas plants to be framed and operate as power companies. While it may appear trite, it is important to demonstrate that centralized plants could not be fully pacified nor disentangled and marketized as part of VEPs without the rules and regulation granting them the legal rights and responsibility to form this relationship with the public grid. Unlike farm-scale plants, which had no exchange with the 'outside' world, for centralized plants to be framed as energy producer required a complimentary setup of rules to allow the sale of gas and electricity to local CHPs. As part of the 1981 energy plan mentioned above, the government also passed the Heat Supply Act (Varmeforsyningsloven) still active today. The act required municipalities to implement plans on how to promote natural gas in the co-production of heat and electricity in CHPs, which at the time were estimated to deliver optimal energy production. The act specifically allowed biogas plants to sell gas to CHPs plants in non-natural gas designated areas (Hjort-Gregersen K. , 2006). This paved the way for the marketization of centralized plants and we witness how an often taken-for-granted element in market arrangements is in fact a key element in the eventual disentanglement of centralized plants from its producers.

Construction of Denmark's first centralized plants in Vester Hjermitslev and Vegger was completed in 1984 and in 1985, respectively. The Minister of Energy had appeared personally to break ground on the first centralized biogas plant in Vester Hjermitslev (Ingeniøren, 1983b). The socio-technical assemblages of the VEPs were markedly different from those of farm-scale plants. Domesticating centralized plants used several new technical components to transform manure into heat and electricity compared to farm-scale plants. Agricultural researcher Klaus Illum from Aalborg University had developed a demonstration model of the so-called LOCUS system (Nordisk Ministerråd, 1987, p. 239) which offered the advantage of switching between heat and electricity production depending on seasonal variations in demand. It also featured a wide range of other novelties, not previously assembled in biogas pacification; a pre-sanitation facility to prevent potential diseases from spreading between farms when degassed manure was distributed, high pressure gas-transmission lines, storage systems for excess gas, two engines for heat production, additional heat pumps to meet demand during cold winters, and a newly developed computer system designed to operate the plant fully automatic. Another novelty was to increase the reactor operating temperature. STUB experiments had proven that by operating at 35 C° (the so-called mesophilic level) in the reactor, biogas production increased significantly despite the added power consumption from maintaining a higher temperature. Instead of using the biogas to power the plant, a 55 kW wind turbine would be used because the gas was worth more when sold to the CHP.

Moreover, for manure to be transformed into valuable biogas the framing of a support net was also central. Manure was transported from dozens of farmers to the biogas reactor. Successful framing now also relied on transforming existing trucks into manure trucks.

But as the plants neared completion both the reactor and the support net began to overflow. Initially, transporting manure between farms and the plant was considered the least of challenges. They used existing roads and trucks but in transforming trucks into manure trucks the pumps used failed. Johannes Christensen explained it:

> "With the new large-scale plants the idea was for manure to be transported from the individual farms to the plant site. Well, that turned out to be more difficult than anticipated. The pumps used on the customized trucks were causing major problems. And when we couldn't even get the manure from the farmer then the whole operation just sort of stops." (Christensen J. , 2007)

Incapable of transporting the manure meant the centralized plant did not have the fundamental resources to operate which caused a major glitch in the pacification. Adding the support net to the pacification had also increased the number of potential conduits for overflows, as was the case. Meanwhile, the biogas plants also suffered from technical overflows. Once again, pipes and pumps proved incapable of guiding the much larger quantities of manure through the system. Christensen explained how they had installed the same kind used on the farm-scale plants in an attempt to reuse existing solutions. But in doing so they had not been properly reframed to accommodate the greater quantities of manure, or take its idiosyncratic characteristics into considerations. According to Christensen, some manure was so dry and thick it clogged the pipeline. The pre-sanitation unit also failed. Yet, it was technical problems with the untested LOCUS system, which caused the greatest problem. Without it, no gas was consumed to produce heat and electricity. Kaare Sandholt, a former DEA employee involved in the VEP projects explained how the LOCUS system 'was taken to the extreme resulting in a lot of technical problems' (Sandholt, 2008). Introducing the untried LOCUS system as a key component in the technical configuration of the plant caused the entire system to overflow. As the multiple new advanced components overflowed the VEP task force discovered they were ill-equipped and lacked the necessary knowledge to reframe overflows, let alone operate and maintain the biogas plants.

Since the Vegger plant was based on the same design it inherited many of the same overflows. Making matters worse for Vegger, it operated at much higher temperatures of 55 C° (so-called thermophilic level) to increase biogas production even further, but also here engineers could not stabilize the production. Once again, the manure was biting back resisting the efforts of the VEP work groups to pacify them. As a result the technical, economic and environmental performance was in shambles and deteriorating under the added cost of repairs. Overflow were reframed by manufacturing the specific parts needed in lack a biogas 'supermarket' with readily available components. It was a process of trial n' error resulting in unique assemblages for each plant, much like the approach taken by the original pioneers and STUB with the farm-scale plants. With only vague ideas about the cause of problems, limited track record, and an erratic performance between plants it was impossible to resort to standard solutions and answers. For every overflow and mystery that was solved, new ones evolved. Sandholt describes the situation at that time:

> "They are in an extremely bad situation from a lack of knowledge, too complex a system, and a disastrous organizational setup behind the plants, boards

> consisting of school teachers volunteering who were in over their heads, too much responsibility." (Sandholt, 2008)

According to Sandholt, the people staffing the power companies were not properly equipped or qualified fit to the task of operating a power company, much less experimenting and reframing overflows. Like the farmers of the 1970s and the STUB scientists they too succumbed to task of pacifying, not just the unpredictable livestock manure, but also the many other technical installations that overflowed following its encounter with manure. The trucks, pipes, and pumps of the support net, and different temperature levels all overflowed when exposed to manure.

Yet despite the overflows, demand for biogas plants and VEPs spread to other parts of Denmark. The overflows and lack of pacification had not reached an extent, where it disfavored the organized action needed for new contracts to be signed. The County of Northern Jutland was swamped with requests and it was decided to establish the company Landsbyenergi to market and promote VEPs elsewhere to realize the good intentions of establishing the county as a regional hub for renewable development (Raven & Hjort-Gregersen, 2007; Ingeniøren, 1984a). While planning the construction of biogas plants in the two remaining villages in Store Brøndum and Thy, and trying to resolve the technical overflows on the first two, Landsbyenergi won a contract for constructing a VEP in the village of Skovsgaard. The plant came online in October, 1987 (Ingeniøren, 1987a), by once again pushing the technological envelope with biogas technology. It was the largest and most expensive in Denmark. The latest technological novelty was to combine livestock manure with local sources of industrial waste from local fish and meat plants. Experiments had shown that its high contents of animal fats provided a significant boost in biogas production especially when operating at higher temperatures.

However, Skovsgaard suffered from all-too familiar technical overflows along with new ones. The odds of transforming manure into biogas had not improved by associating it with other forms of industrial waste, whose properties and behavior were just as unknown as manure. Skovsgaard also operated at higher temperatures; a process that also overflowed. Meanwhile, Skovsgaard sparked a new controversy. From the outset, local citizens had objected to its inner city location. The numerous daily transports caused traffic problems, and the lack of relevant technology meant emissions from the plant covered Skovsgaard in the pungent odor of livestock manure. According to my research, local citizens had not previously voiced their opinion. But in doing so, they emerged as a vital agency in the case of Skovsgaard. The pressure on local politicians and the county officials grew stronger especially as the good intentions of creating new jobs and promoting the county as an industrial hub for renewable energy were not met. In fact, by now VEPs had evolved into a political liability as it interfered with the lives of its constituency politicians relied on come election time.

At that point, most central elements had resisted pacification. And when pacification fails so does any hope of biogas exhibiting predictable behavior without which agencies are unable to perform valuations of biogas, let alone for potential investors and buyers to plan actions and decide whether to invest in biogas. In short, the plants did not favor organized actions. Most notably, when biogas productions is unstable and yields are low due to the erratic nature of manure, new forms of biomass, different temperatures, and equally un-pacified components, the local CHP cannot estimate how much oil or coal to supplement biogas with, or county politicians cannot plot a political course on regional technological development, and farmers do not have a stable frame upon which to decide whether to invest in biogas. As a result of the vast technical overflows, vision of self-reliance which remained as such, public dissent, and the increasing controversial nature of biogas the county withdrew political and thereby financial support leaving farmers with serious financial problems. With it, interest in Landsbyenergi vanished as well. The proposed plants of Store Brøndum and Thy were abandoned and all the contracts Landsbyenergi had signed were cancelled as well.

Lack of political endorsement and public funds meant farmers were alone in fund the reframing of overflows as well as future ones. As Sandholt describes, a decision was made to reduce ambitions and abandon some of the good intentions behind the VEP project. They turned to the DEA for assistance and funds, but according to Sandholt help was not available.

> "At that point the project acquires a new objective strictly focusing on getting these three plants to work. The way I remember it, from then on the original Village Energy idea was significantly reduced (…) The DEA offered no help at all. It was about taking notes. A rescue plan was prepared (…) I feel, it was scandalous the way the DEA acted. There was no real desire to help them to survive they just appeared as if they were trying. " (Sandholt, 2008)

At the time, the DEA was the primary authority on biogas in Denmark and considered the only agency able to successfully pacify the VEPs. But they had never been part of the frame, apart from offering monetary support and keeping track of progress. The farmers, the VEP groups of local volunteers, and the biogas industry were left to reframe overflows. The VEPs abandoned the original intention of becoming self-reliant with energy and instead focus on reframing overflows sufficient enough for the biogas plants to transform manure into biogas. As Sandholt mentioned above, the original 'idea' in VEPs was significantly reduced especially after the LOCUS system overflowed. While VEPs were designed to make the villages 55-88 percent self-reliant with energy, their contribution was eventually marginal. In coming years, the Vester Hjermitslev and Vegger plants underwent major reconstruction. Overflows were eventually reframed, including the support net of manure trucks and manure storage tanks, and both plants remain in operation today as the oldest centralized plants in Denmark. The Skovsgaard plant was forced to shut down completely as its close proximity to city center and continuous odor leaks sparked a local controversy of biogas. Failure to successfully develop an odor retention system meant it was dismantled in 1996.

2.1.4 Pacifying Stable Biogas Plants Favours Organized Action

The first period provides strong evidence of the effects on marketization when framing pacified goods encounters overflows and sparks controversies. When technological development of biogas plants are seen through the lenses of Caliskan's and Callon's perspective of pacifying goods we can bring home the core analytical point that only a pacified stable product favors organized action in markets needed for markets to stabilize. I also want to demonstrate that when pacification does fail according to whatever good intentions the plant is designed to deliver on, any fundamental re-framing and re-pacification of technology renders previous stability and effort lost. In other words, stability plays a key role in affording further stability.

Granted, framing agencies and market encounters are equally important and we shall turn to these in the following two analyses of this chapter. However, the period shows no lack of a strong and capable pro-biogas agency. On the contrary. And neither does the story show any problem with completing the transacting and constructing the biogas plants. Over 20 farm-scale plants were constructed in less than five years, and centralized plants took around 1-2 year to construct. It was the lack of pacification that cause the marketization to fail in this first period.

In fact, a pattern of pacification with four phases seams to emerge from the three attempts:

1. Based on several good intentions, a group of actors decide to transform worthless manure into valuable biogas. For each pacification attempt the good intentions are continuously expanded, from producing sufficient biogas to supply a farm to rendering an entire village self-reliant with biogas. Apart from the very first plants constructed in the early 1970s, both STUB and VEP chose to pacify an increasingly complex technical configuration. Rather than reusing or building on the past frames they restart the pacification process but in doing so they also expand the framing and organizing effort required thus increasing the number of sources of overflows. Consequently, whatever stabilization and predictable behaviour framed under the previous attempt, albeit very limited, is rendered relatively useless. In reframing biogas plants potential buyers also have to continuously update reframe its stability and await the outcome of the pacification.
2. While a number of biogas plants are being sold and constructed, the pacification begins to overflow. Mainly technical overflows due to the fragile and complex nature of manure, but as a consequence there are economic and environmental overflows as such. For each round of pacification the inventory of overflows grows, and eventually so do the

number of controversies over biogas. Some farmer's were upset STUB disregarded several plants because they were not framed as advanced plants, and Skovsgaard sparked local controversies over its location. Furthermore, in addressing overflows they discover they cannot reuse previous solutions to previous overflows as a result of restarting the framing process.

3. As the actors realize they cannot deliver on the good intentions, framing ambitions are reduced to focus on reframing existing overflows in hope of stabilizing biogas production with the plants and avoid adding to the overflow inventory. In most cases the framing activity succeeds to some extent, but on each occasion it is acknowledged that livestock manure is the key source of overflow. However, results are mostly disappointing and several key actors leave the frame.
4. Without pacification there can be no organized action and the market fails to stabilize beyond the initial surge in biogas plant transactions. Interest in simple and advanced farm-scale plants as well as centralized plants vanished on all three occasions. Following each round of pacification comes a brief 1-2 year period where no new plants are constructed while awaiting the pacification to restart once more while scouting for new good intentions to realize and allowing the process to restart.

Table 2 summarizes the outcome of this pacification pattern.

Table 2: The Idiosyncratic Outcomes of Pacifying Biogas Plants (1973-1987)	
'Simple' Farm-scale Plant	
Purpose	Production of biogas to fuel individual farms
Technical Setup	Reactor made up by standard glass fiber, pumps, pipes, and gas turbine
Input	Onsite livestock manure
Main Biogas Plant Actors	Farmers, local blacksmith, few academic scientists
Support net	-
Legislation	-
Overflows	Technical and economic

Controversies	Technical feasibility
'Advanced' Farm-scale Plant	
Purpose	Production of biogas to fuel individual farms, and nearby institutions
Technical Setup	Onsite livestock manure
Input	Farmer, engineers, scientists
Main Biogas Plant Actors	Farmers, STUB, the DEA, biogas industry, Carl Bro
Support net	-
Legislation	Funding of STUB. Limited construction grant for renewable energy.
Overflows	Technical and economic feasibility
Controversies	Technical and economic feasibility. Simple versus advanced technology
VEP Centralized Plant	
Purpose	Production of biogas to fuel villages connected to local CHP, job creation
Technical Setup	Pre-sanitation, pipes, pumps, trucks, gas storage, LOCUS, construction site
Input	Livestock manure from multiple farms, experimental use of industrial waste
Main Biogas Plant Actors	VEP work groups, energy company, DEA, local volunteers and politicians
Support net	Manure trucks, decentral manure storage tanks, access to public roads
Legislation	National Energy Policy. Heat Supply Act
Overflows	Technical, economic, and political feasibility
Controversies	Biogas plant location in villages, spread of pungent odor, increased traffic.

Specifically in the case of biogas when pacification failed according to whatever good intentions they were framed to deliver, any fundamental re-framing and re-pacification of technology renders previous stability and effort lost. My point here is that because pacification of biogas ultimately failed to stabilize what Utterback would call a dominant design, biogas markets could not stabilize beyond initial demand fuelled by whatever patience and hope was in place. What is interesting to notice, however, is that farmer's invested and purchased plants up until the main biogas plant contractors, i.e. STUB and VEP organizations publically announced they were unable to meet the original goals. I interpret this not as an indication of the intentions themselves and the promise by key pacifying agencies to be sufficient for farmer's to purchase plants. Rather, from Caliskan and Callon we know that overflows are not just overflows. They have to be detected and made visible. But as no one knew the extent of the reframing effort needed to pacify and 'tame' the unruly livestock manure, no instrument, measuring equipment or status report indicated it was impossible to tame it. As Sandholt indicated, they had no idea of and were 'in over their heads' as they were just beginning to realize the required effort. To this day, the newest biogas plants are 'only' able to extract around 80 percent of the potential energy content of biogas following almost four decades of development. There are still reports of plants experiencing an occasional drop in production because unknown bacteria entered the reactor.

The absence of predictable features and performance made it difficult for potential customers, politicians and others to plan, make decisions, and eventually act. The constant re-framing and re-starting of biogas pacification was not conducive for organized action beyond framing the initial experimental pacification. Just as the contours of biogas was emerging it changed purpose, or adopted an additional purpose which re-configured it and made what little was stable unstable again. It failed to be pacified to the point of achieving a stable and dominant design upon which to build and improve performance even further. Biogas has always been 'under construction'. It appears that whatever work which predates them was not used to as base from which to reframe overflows. Instead, new actors arrived to restart the pacification and thereby construct a new market for biogas plants in Denmark. As a fundamental premise, no market can remain effective and durable in the long run in the absence of a stable good. Compared to the simultaneous development of wind power in Denmark we see a markedly different situation. At the core, wind power has followed the same technological trajectory and dominant design (Karnøe, 1991; Jensen, 2003). And we saw, when pacification ultimately failed on all three attempts thus rendering the possibility of biogas plants to be disentangled, interest vanished and no new transactions were completed. It appears that stable performance is conducive for organized action.

Granted, many other dominant theoretical approaches within technological development and innovation management will elucidate the same point. That without a product that performs according to demand there can be no market. However, the notion of pacification is markedly different in several respects. The dual notions of framing and overflowing grant centrality to non-human and material elements. In fact, all three pacification stories evolved around framing and organizing material entities whereby manure could be transformed into biogas in addition to being the primary conduit for overflows. Not until after repeated attempts to reframe overflows did human actors leave the frame. Neither does framing/overflowing take for granted the processes and materiality needed to identify the source of overflows, measure it, and inscribe it.

The framing/overflows does not operate based on a finite list of market ingredients, i.e. we cannot a priori establish who or what must be framed and organized for markets to emerge and stabilize. By retracing associations in the underlying dataset we discovered several areas of the socio-technical market assemblage vital for markets to exist. For STUB to be created required government subsidies which were allocated following the 1970s oil crisis and the government's decision to implement a national energy policy. Moreover, to pacify biogas plants entailed more than reframing manure from worthless to valuable biogas. Farmers and local volunteers were transformed into local energy producers and environmental activists, respectively. Scientists and government officials were transformed into spearheading new technological development. Local politicians were transformed into diffusers of VEPs to other parts of the country. And so on. But for farmer's and local volunteers to be framed differently required the parallel framing of legislation such as the Heat Supply Act granting them the legal basis to exist as energy producers and supply the public grid with energy. Finally, the notion of a support net became crucial in partly understanding how overflowing manure trucks caused the VEPs to overflow.

Together, they underscore that to transform manure into biogas involves more than the narrow notion of technological development and innovation management. To pacify a good means to favor organized action whereby the good can be disentangled from its original context. But as we can see, to disentangle biogas plants whereby farmer's or VEPs can draw up plans, make decisions, and act require more than a well-performing product. It requires support nets, legislation, and a host of other human and non-human elements to framed and organized as well.

The 1990s and 2000s saw the arrival of several other attempts to re-frame and re-pacify biogas plant technology as a solution to a problem, quite often rooted in a political mandate. Around the same time of VEPs government officials framed biogas as a solution to the environmental degradation occurring in Danish agriculture as a result of unregulated use of manure as fertilizer. It would become the largest market for biogas plants. In the 1990s attempts were made to frame biogas as a solution to waste production, as biogas can be extracted from organic household waste. Around the turn of the century centralized plants saw new technological features to comply with strengthened environmental regulation of Danish agriculture, as we shall witness in coming sections.

While we continue to trace the technological development and pattern of pacification, the analytical theme in the next section is the role of framing agencies with sufficient qualculative capacities to perform valuations of goods. How are powerful agencies with superior qualculative capacities created and enlisted to perform valuations of biogas plants? What shapes and forms to they assume?

2.2 The Perpetual and Material Aspects of Framing Biogas Agencies

In this second section, I want to analyze the framing of agencies to demonstrate how biogas agency properties are *never stable and a priori defined.* According to Caliskan and Callon, market agencies include those who consist of creating, determining, and calculating the values and overall worth of biogas thus play a central role in marketizing goods. Understanding who and what participates in creating and measuring the value of biogas, their qualculative properties, the alliances of which they are apart, providing them with the power to dominate and exclude others are the analytical handlebars of this section. I shall demonstrate that because these agency properties are perpetually undergoing change, we can therefore neither assume agency properties nor the value of goods to be constant. Furthermore, I also want to demonstrate how framing agencies is bound with materiality, much like we saw in pacifying biogas. Reports, analyses, and other textual documents play a central role in shaping valuations of biogas. Biogas, I argue is mediated through materiality. Whether an agency becomes calculative and acquires the skills to perform valuations is the perpetual and temporary outcome of a framing process on its own equally subject to overflows and controversies. As in the previous chapter, to understand framing also entails looking into overflows and controversies over biogas as they are once more brought to the fore; not only as entry points but as a central analytical component in understanding how agencies properties can suddenly change, rendering them incapable of acting and performing valuations that provide goods with the essential value.

The second phase of biogas markets is excellent for illustrating the perpetual and material aspects of framing agencies. We shall retrace and analyze six different accounts, once more in chronological order whereby we will gradually bring home these issues.

2.2.1 Framing Agricultural Pollution: The Role of Materiality

The first phase in the life of biogas markets in Denmark had proven rather disastrous, at least from the perspective of pacification. With over 20 farm-scale biogas plants constructed of which many were subsequently dismantled and a new generation of centralized plants close to a similar fate, the sprawling biogas industry and the innovative first-movers in the farming community were left with a serious economic hangover and a lack of credibility. They were 'shafted', as Christensen said. The political ambition of a market for 20.000 biogas plants remained mere good intentions along with any socio-economic intentions. Similarly, farmers had yet to secure local energy generation, and small villages were still dependent on foreign oil. What we have yet to analyze in great detail is how these underlying overflows, against which biogas have been framed as a solution, emerge in the first place thus helping us understand how some agencies take the lead in furthering biogas market activity. As briefly touched upon in the previous chapter, overflows occur all the time but the human world can only react to those that have been detected, inscribed, and made visible in one form or another. In this first account, we begin by addressing how an overflow is framed and brought to life and its role in providing superior qualculative capabilities and dominating powers to certain agencies.

The 1970s and 1980s saw added attention around the nitrate pollution of the ground water reserves, the primary source of drinking water in Denmark. Water samples from an increasing number of private and public water works showed increased levels of nitrate and phosphor. These are naturally occurring nutrients, but in large quantities were believed to pose a serious hazard to the natural environment. The scientific community, including university marine biologists and government agencies believed that nitrate caused oxygen depletion thereby destroying the aquatic environment and the nation's fish stocks in inner coastal areas. Similar foreign studies using the same sampling equipment and calculations to quantify the nitrate pollution seemed to support their claim (Christensen, Hansen, & Ærtebjerg, 2004).

Danish agriculture was believed to be the only perpetrator with the capacity to orchestrate the large scale pollution of water ways, especially crop farmers who supplemented commercial fertilizer with redundant amount of livestock manure. Manure is rich on nitrate and phosphor which are vital crop nutrients, but for some reason, parts of them found its way into the water ways where it consumed the oxygen. This process became known as nutrient runoff. The easiest and by far cheapest solution for farmers was to spread any manure overflows onto the naked fields during winter until the growth season started in early spring. It was a fully legit process, as no environmental regulation prevented it from taking place.

The scientific evidence and theory designating agriculture as the main source was supported in 1981 when the first cases of oxygen depletion were reported from Danish water channels. Local fishermen were discussing the large number of dead fish that had washed ashore, something none of them had ever witnessed before. They too believed the fish had died from oxygen depletion, allegedly a consequence of agriculture's lax relationship with fertilizer application

(Christensen, Hansen, & Ærtebjerg, 2004). The media found an interest in reporting and circulating news on the dead fish in the summer of 1981, and soon evening news broadcasted live interviews with fishermen dragging dead fish from the sea, and experts blaming Danish agriculture. The alleged scale and potential consequences for the Danish environment and fishing industry activated the Danish government.

Before announcing any legislative steps, the government asked the scientific community and the Danish Environmental Protection Agency (EPA) to gather more data, and in September 1984, the EPA published the so-called 'NPO Status Report'[4] containing all available historic and recently published data and research on the issue. It concluded the agricultural sector was responsible for 90 percent of the 296.000 tons of annual nitrate pollution as a direct consequence of extensive and unregulated use of fertilizer. Municipalities were also found responsible for the remaining 10 percent, arguably due to an under-capacity of municipal wastewater treatment which led the contaminated water back into the water ways (Miljøstyrelsen, 1984a).

From the beginning, the NPO report was covered in controversy. First to object was Danish agriculture speaking uniformly through several of its highly influential industry organizations Danish Agriculture (DA) and the Danish Meat Association (DMA). While not disputing the existence of an overflow as framed in the report and the possible role played by agriculture they did reject the findings claiming that numbers were inaccurate, the scientific evidence invalid, and that other conduits for the overflow may exist. Further protests arrived from within government ranks, as the Ministry of Agriculture (MoA) enclosed a written objection in the NPO report arguing that despite regional differences 'there are no signs of any significant increase in the use of nitrate fertilizer on a national level' (Miljøstyrelsen, 1984a, pp. 7-8). The EPA had used data since the 1930s which was critics argued was unreliable and from a period in Danish history when commercial fertilizer was relatively scarce and therefore used to optimize fertilizer usage, not crop output (Ingeniøren, 1985b). There were other results the task force had failed to agree upon, and in general they suggested that 'these issues are not adequately researched in the report and should undergo further examination, before

[4] NPO: N – Nitrate, P – Phosphor, O – Organic substances

any further changes in this regard are recommended. The representatives of the Ministry of Agriculture of the task force cannot subscribe to presentation on pages…' (EPA 1984: p. 7-8). Apparently, a main problem was insufficient time. 'The Ministry of Energy have from the outset (…) been concerned of the strong time pressure under which the work has been carried out.' Klaus Illum, who invented the LOCUS system at the Department of Development and Planning, Aalborg University, had taken a closer look at the calculations the Ministry of Agriculture was advocating. He found the underlying 'model for calculations is theoretically, methodologically as well as empirically to be vaguely founded. Moreover, according to Illum no attempt had been made to validate the results, e.g. by comparing actual and calculated use of fertilizer from different periods' (Ingeniøren, 1984b). His calculations showed 124 million kilos of nitrate was missing from the ministry calculations. Next step should not be more policy but more in-depth research. In other words, two opposing agencies (and frames) had emerged with regard to the EPA report. The first anti-NPO agency framed agriculture as the primary source of the overflow, whereas the second sought to deconstruct the NPO report itself thus causing it to overflow by framing it as invaluable. In one fashion or another, the ensuing controversy used materiality as a key element in constructing the two frames. At this stage the EPA was taking the lead, above all afforded by superior materiality.

In a contrary move, marine biologists sought to produce strengthen their case by continuing to use the media to convey the image of dead lobsters pulled from the sea on the evening news on television. Fishermen argued they would be out of business. The media empowered their frame by circulating it in the living rooms of every citizen with a TV-set, radio, or news paper. It had evolved into a public controversy in which fishermen were 'victimized', and attempt to argue other sources of pollution were responsible remained static noise. The anti-NPO agency did not possess the apparatus to substantiate their counter-claim with verifiable evidence backed by sufficient measures that could allow them to claim general validity, nor did the media give them much air time. At this stage, it appears the EPA scientists outperformed Danish agriculture with a superior set of qualculative capabilities. The EPA was riding a tidal wave of political and public support. The alliance against Danish agriculture had enrolled the support of the most powerful agencies, scientific experts, media, and ordinary citizens along with the material agency. With a superior qualculative capacity they were dominating the scene, not only in terms of framing agriculture as the perpetrator behind the overflow but also in forming a strong agency which dominated the agenda and excluded their critics from taking any significant action. Numbers may have been questionable or incorrect, but at this stage the EPA possessed the capacities, materiality, and alliances to present a superior frame. Danish agriculture did not.

Despite vast disagreement over the scientific accuracy and its findings the NPO report quickly became the de facto authority on agricultural pollution and was widely circulated among NGOs, environmental organizations, and more importantly, the Danish parliament. At this stage, the material agency had developed a voice of its own as it was circulated among the political establishment. As Sandholt from the DEA explained in an interview:

> "I don't think anyone expected the kind of attention the NPO report would receive. Even the EPA was surprised over its popularity. And not surprisingly, they were interested in seizing the opportunity." (Sandholt, 2008)

Being in charge of outlining legislation as part of a political response only strengthened the EPA's capacity to take further action. A first move by parliament was to pass the EPA's 'NPO Action Plan' in May 1985 (Miljøstyrelsen, 1985). Existing fertilizer practice was prohibited and farmers were compelled to invest in manure storage tank capacity capable of storing up to six months of manure by 1990 (Ingeniøren, Put seks måneders gødning på tanken, 1985c). Cost was estimated at DKK 3.5 billion. It was supported by a regulation known as the ministerial order on livestock manure and ensilage[5] (Miljøstyrelsen, 1984b) developed by the EPA officials and experts and was passed in 1985. The new system regulated the amount of livestock allowed by each farmer by calculating the number of livestock allowed as a function of the type of livestock and the amount of available land. The more land upon which to disperse the manure the greater production was allowed. This guiding principle by which manure production was regulated became known as the Harmony Rule. It demanded a 'harmonious' relationship exist between the farmer's land compared to the amount

[5] Definition: in this context ensilage is the process of preserving the animal/livestock manure in an undried environment in a storage silo

of livestock. In a single move, the government had associated environmental pollution to the farmer's economic interest by regulating their income as a function of their environmental performance. The EPA agency was growing stronger.

The EPA strengthened its position even further by introducing a mandatory measurement system along with new metrics, and calculations to manage the implementation of the Harmony Rule. The so-called livestock unit (LU[6]) measures the content of nitrate and phosphor in manure from different animals, and the Harmony Requirement which established the minimum amount of land needed for each kind of livestock. So-called 'manure accounts' were also implemented for the EPA to monitor farmers' manure production, purchase and use of commercial fertilizer, number of livestock, and amount of available land; all of which farmers were required to report. And finally, to expand knowledge on the effects of nitrate and phosphor on the natural environment the government also initiated the 1985-1990 NPO Research Program.

The government also passed the EPA's Marine Environment Act (MEA) in October 1987, designed for the long-term improvement of the aquatic environment. It demanded a 50 percent reduction in nitrate runoff and phosphor emissions by 80 percent. Agriculture, municipal water treatment facilities, and the industries were held accountable and to this day, succeeding versions of this act remains a significant actor in agricultural activities, and as we shall soon witness, in biogas markets. At a cost of DKK 12 billion investment plan, of which DKK 6 billion was allocated to expanding waste water treatment capacity, agriculture was imposed a 1990 deadline. Critics questioned whether MEA would have any impact at all, since DKK 6 billion were allocated to the municipal waste water treatment facilities found responsible for 10 percent of the pollution. And in the years to come MEA was augmented with the 1988 Pesticide Action plan which imposed limits on the amount of, and types of pesticides crop farmers could use. Never before had farmers experienced this extent of regulation, and the pressure was on to come up with solutions, and to do so rapidly.

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[6] One LU equals 100 kg of nitrate. A large pig (30-100 kg) produces 2.73 kg nitrate which equal 36 large pigs for one LU.

The account given here clearly demonstrates how an overflow, literally speaking, sparked different attempts to present competing frames amid a controversy over environmental pollution. A framing battle which the agricultural sector lost with the creation of a powerful agency dominating the agenda resulting in the negative framing of Danish agriculture. In a short time they had taken the lead in dominating the political regulation of agriculture. But to dominate and exclude others from partaking is not only a question of creating an alliance of multiple actors. Marine biologists, scientists, the EPA, fishermen, DAAS, the media formed a strong alliance with Parliament and arguably also the general public through the media. Common ground was created upon different interests in saving the environment. It appears only agriculture was not represented. However, the distinctive attention to materiality provided in the marketization framework suggests how power to dominate and further action requires a superior set of qualcufying capabilities afforded by materiality. To successfully frame Danish agriculture as the source of overflow leading to pollution of the nation's water reserves requires the framing, configuration and deployment of a material agency strong enough to refute other and often competing forms of valuations. What we witnessed was competing valuations of how to construct, determine and measure the overflow and its original source. The NPO-agency was immensely empowered by such a metrological setup, while adding new metrics such as the livestock unit, computer systems, data collection equipment, laboratories, sampling equipment, metrologies, formulas, etc. Agriculture could not match this arsenal. The story indicates the overflow itself could not have existed in absence of this comprehensive material setup. The underlying theories of nutrient runoff or that agriculture was to blame could not, I argue, have circulated and received such widespread attention and consensus unless it circulated in the material inscription of the NPO-report. Calls for further studies to be sure of the causal relationship and frame established in the NPO-report were simply ignored, even when the scientific credibility of the data was called into question. In other words, the question over agricultural pollution was a 'hot' materially mediated controversy based on scientific facts, large metrological system, mixed with political and public sentiments which provided the 'anti-agriculture' with the power to dominate. I am reminded of Latour's study of the construction of a 'fact' in material laboratories and subsequent publication in articles which are circulated and in time form a durable network without which the fact cannot exists.

Meanwhile, the story also demonstrates the perpetual changes in market agencies. In less than a few years the NPO-report managed to bring an end to a century-old farming practice, the indiscriminate use of fertilizer, and impose a set environmental regulation which continues to dominate and regulate Danish agricultural activities to this day. We cannot assume existing balances of power to remain intact forever. The following three accounts will continue to emphasize both the perpetual and material aspect of framing agencies as we witness how despite an overwhelming pressure on Danish agriculture, they managed to turn the situation around by means of reframing the overflow by means of biogas. This also brings us back to the implications it had for biogas marketization.

2.2.2 Reframing of Biogas As 'Win-Win' to Address Agricultural Overflow

By early 1985, agriculture was required by law to address the overflow, mainly by constructing manure storage tanks. These we simple to construct and would prevent the overflow of manure from taking place, literally speaking. By now dead fish and oxygen depletion was inescapably linked to agricultural practices. Meanwhile in March 1985, the DEA released new guidelines for planning the Danish district heating infrastructure under the Heat Supply Act, in which domestic sources of energy should be prioritized. That included livestock manure. Danish production of oil and natural gas from North Sea deposits had increased significantly since 1981, and the government was stepping up efforts to replace imported oil with domestic resources. Even though the oil crises had subdued and prices on oil had dropped since peaking during the Iraq-Iran war in the early 1980s, security of energy supply was still a long-term political top priority. Energy taxes were increased thus maintaining relatively high prices to promote energy conservation, generate tax revenue, but also to stimulate the integration of renewable energy (Tafdrup, Biogas. En dansk styrkeposition, 2006).

A small group of government officials from the DEA, EPA and MoA realized that new guidelines combined with the new environmental regulation imposed on Danish agriculture could be framed as a backdrop against which to attempt to pacify biogas plants once more, currently suffering tremendously in wake of the

VEPs. Despite signs of improvement after reconstruction efforts on the VEPs, any further demand for biogas was believed to require activation of government agencies. Sandholt explained to me, how instead of investing billions in storage tanks, the interdepartmental group believed biogas could deliver domestic energy to the natural gas infrastructure and help solve the environmental problems in line with EPA policy, because the anaerobic digestion makes the nitrate readily available to crops thereby stopping the runoff (Sandholt, 2008). In other words, biogas was framed as a win-win solution for all agencies. I interviewed Sandholt about the situation, who served as DEA energy specialist on the task force.

> "It was difficult to carry out a sensible discussion on biogas with anyone, because everybody had a terrifying story on one of the miserable biogas plants. STUB was dead by the mid 1980s and had pretty much thrown the towel into the ring. What we did was to take the NPO status report, take advantage of the momentum and say lets team up with the Environmental Protection Agency and produce the green report." (Sandholt, 2008)

To make it visible how biogas could solve the manure overflow, they framed a new material agency by publishing their ideas in December, 1985 in a report entitled 'Centralized Biogas Plants and the NPO Action Plan', better known as the 'Green Report' due to the color of the cover (Miljøstyrelsen, 1986). In here, they argued that centralized biogas plants could be 'a central solution to these multiple challenges' (1986, pp. 18-19). It was found that as much as 17 percent of heating demand could be supplied by biogas in non-natural gas areas, which coincided with the very same rural areas and overflows of manure. Furthermore, it concluded investments in centralized biogas plants were socio-economically profitable by 'integrating biogas with the domestic energy system' (ibid). As such, farmers were framed not only as part of the problem but also as part of the solution in addressing and reframing the overflow. The Green Report provided farmers, the biogas industry, and politicians with leverage to meet common obligations and service individual interests. As they had moved quickly they were able to tap into the political focus on mitigating the pollution. Biogas had been reframed as an environmental, agricultural, and renewable energy solution that served the interest of all the major agencies at that time.

However, as pacification was expected to take years for which neither farmers nor the biogas industry had the necessary resources or expertise, the report called on the government to form a commission to construct a number of biogas demonstration plants. The government circulated it among municipalities along with a letter from the three ministers in charge, encouraging local government to follow the recommendations in the report and take the necessary steps to implement biogas in the local energy system (Nordisk Ministerråd, 1987). Beyond this, however, support of the new biogas initiative was limited. Objection to the looming report was throughout the process voiced by EPA, who participated. Sandholt explains:

> "The idea was that instead of spending billions on manure containers why not take a sensible approach (…) i.e. use the idea of digesting the manure and distributing it on a more equal basis among the individual farms. That was the basic idea. But the EPA was dead set on that at any cost it was important to react now. They [politicians] should agree to construct manure storage tanks immediately and although biogas plants did exist they should not be allowed to prevent the construction of tanks. (..) They were clearly afraid that the report could delay other efforts to curb the pollution. Under no circumstances would they run that risk. Even towards the end, we debated the actual wording in the conclusion, how strong should we emphasized the results." (Sandholt, 2008)

The EPA feared if farmers began exploring centralized plants this would stall efforts to construct manure storage tanks as the government had demanded. The EPA was joined by higher ranking officials in the DEA focused on the natural gas project who feared implementing the demonstrations plants would be expensive. Neither would the MoA support it, as they maintained the pressure for further studies of the link between agriculture and pollution. Even the influential agricultural organizations, the DA and DMA were against the Green report recommendations. Failures with both farm-scale and centralized plants had left Danish agriculture with local problems and farmers with financial problems. Determined to prevent any further diffusion of biogas the DMA hired a person through its consulting services in the city of Skejby, called the Danish Agricultural Advisory Services (DAAS), whose sole responsibility was to visit farmers and warn them against biogas. His message was clear: do not under any circumstances invest in biogas. What we witness are multiple competing frames of valuation, each backed by their own material agency and interest. Despite having framed biogas as the win-win, approval of the action plan depended on securing the interest from these very same actors, whose protests ranged from reluctant to outspoken criticism. The group of officials could only secure support from the political agency, not from agriculture. However, activating their agency to frame biogas as a solution among farmers was critical despite the DAAS counter-efforts.

Far from everybody in the agricultural ranks agreed with the official resentment towards biogas. A small group of 'dissidents', as one informant described them, including senior agricultural advisors, and two prominent agricultural figures, estate owner Jørgen Grosen and notorious farmer and politician Knud Øllgaard began lobbying for funding of biogas development from the Minister of Energy himself. Other delegations followed suit, often enlisting Grosen and Øllgaard. People from the VEPs, owners of biogas plants, along with the biogas industry also advocated for support while presenting the arguments of the Green Report. Carrying the Green report they presented, argued and framed biogas as worthwhile and purposeful. Sandholt explains:

> "It was not the DEA who got things rolling after the report. It was clearly people from the outside. Some farmers working against the official agricultural sentiment on biogas, a couple of agricultural advisors, and a prominent estate manager named Jørgen Grosen who was extremely active. He worked the halls of the Ministry of Energy asking for funding. It was this kind of requests that played a role (…). Meanwhile, top ministry officials were nervous they would be flooded in applications for biogas plants which required their attention. They wanted to calm down the situation and thought a commission could do just that (…) A commission would prevent the flooding and buy them time. (…). So, I think from the perspective of our department it was more a question of holding back rather that pushing forward. The EPA was busy elsewhere with the NPO action plan, and the Ministry of Agriculture was directly against it. " (Sandholt, 2008)

MoE grew nervous at the prospects of being flooded in applications for biogas plants and decided to establish a biogas commission to inquire into potential presented in the Green Report, but stopped short of financing a new series of demonstration plants. Mandated as an inquiry the government could claim to be meeting the public and political demand for action, not compromising EPA plans to expand use of storage tanks, while mitigating the criticism from opposing agricultural circles.

Once again, the story demonstrates the perpetual changes in market agencies. In less than one year a mixed group of actors had created a new pro-biogas agency along with a material setup to go against the might of the EPA. By pro-biogas agency I refer to the group of agencies which despite disparate interest are enlisted in the promotion of biogas. The EPA never framed biogas plants as completely invaluable in addressing the manure overflow. Only the agricultural organization saw biogas as a problem, but apparently no one was listening to them. They were therefore the first to associate biogas with agricultural pollution and convince others of the positive value such an association would entail. In addition to re-demonstrating materiality a central aspect of framing agencies, the story clearly demonstrates the constant dynamics in power balances between agencies and agency properties. In the next section we continue to explore the perpetual and material aspects in framing agencies, as we witness how the biogas industry and other pro-biogas agencies is strengthened even further afforded by a relatively successful biogas plant pacification.

2.2.3 Øllgaard's Material Framing of Biogas as 'Technically Possible'

The Commission for Centralized Biogas plants was instituted in November 1986 with Knud Øllgaard as chairman. He was[7] a farmer, former MP, and a prominent figure in agricultural circles. According to my sources, he was popular, well-liked, and a strong advocate for an extensive diffusion of biogas plant in Denmark. One informant remember how Øllgaard refused several attempts by top agricultural

[7] Knud Øllgaard perished under tragic circumstances on the night of September 28, 1994 when the passenger ferry Estonia sunk on route to Stockholm during a storm in the Baltic Sea.

lobbyists to have him officially withdraw support for biogas, but instead chose to undertake the task of forming a new agency which could further action on biogas in Denmark. He chose a diverse range of people with different backgrounds to staff the commission. Representatives from MoA, the EPA, utility companies, power companies, municipalities, counties and the DEA were all part of the team. Enlisting agricultural specialists and scientists were vital to reframe the notorious manure overflow. Sandholt from the DEA provided the details:

> "We did not have the agricultural know-how and it was important for us to get the seal of approval from agricultural sciences for instance by reviewing the [biogas plant] balance sheets (…) The organizations and board of directors behind biogas plants were small and consisted of volunteers. So it was important they had access to guidance and help to pick up on early warning signals and to prevent things from going wrong." (Sandholt, 2008)

Neither the EPA nor DEA possessed the knowledge or expertise on manure, anaerobic digestion, soil and crops properties, and livestock manure. For this new biogas agency to perform credible valuations of biogas plants to prove their value they needed other actors. This way Johannes Christensen, Klaus Illum, and Ulf Meyer Henius joined the ranks along with DEA's newest biogas expert, Søren Tafdrup. Together, they constituted the core of what would eventually be named the Øllgaard Commission. The first task was to outline an action plan for the integration of centralized biogas in Denmark. They were compelled to work fast because of the 1990 deadline established by the NPO action plan, by when farmers were required to comply. The EPA, MoA, and MoE continued to oppose and argue for a reduction in Øllgaard's ambitions of the action plan but he ignored their calls and delivered the 'Action Plan for Centralized Biogas Plants' six months later in May 1987 (Energistyrelsen, 1987).

The report outlined a new pacification plan for centralized biogas plants by constructing between five to seven new plants in addition to those in Vester Hjermitslev, Vegger and Skovgaard. The primary objective was to prove the technology could be pacified which required further experiments with anaerobic digestion, process temperatures, in addition to researching manure and its potential integration of industrial waste. Øllgaard believed the key to proving its economic performance was mixing manure with other forms of biomass, but also to integrate power companies and local CHP plants in the pacification thus gaining access to the lucrative natural gas infrastructure. Researching the environmental effects, nutrient runoff, avoiding hazardous bacteria, parasites, viruses, and pesticides were also objectives. To prevent decease breakout plants would feature sanitation units.

From the outset the new commission faced attempts by others to limit its agency and capacity to act (Beuse, et al., 2000). MoE wanted a limited development program because they did not find biogas plants to be economically feasible citing the poor performance of the VEP biogas plants. Consistent with previous concerns, the EPA feared that further biogas plants pacification would delay the realization of the NPO action plan targets as farmers interested in biogas would postpone storage tank investments. MoA backed by influential agricultural organizations were very skeptic following the VEP failures. Øllgaard stated that '…with the present funding it would be difficult to complete a relevant demonstration and follow-up program.' (Ingeniøren, 1987b). A trade union representing unemployed engineers from the biogas industry organized a biogas plant conference with Øllgaard as keynote speaker. Engineers were interested in making sure their expertise was not rendered useless in the wake of the VEP pacification failure. In his opening remarks Øllgaard drew a daunting picture of the future of agriculture in the absence of modern technology, and engineers in particular. Farmers were in need of the technological expertise of engineers so that for instance farmers could benefit from the use of biogas technology, otherwise '…Danish agriculture would be dismantled within a short period of time' (Ingeniøren, 1987c). 'The new technology must be used in agriculture in order to intensify the use of all available resources. And we cannot achieve this on our own, so the engineers must help us out in that department', Øllgaard proclaimed. He continued by projecting three future scenarios: stagnation, dismantlement or development with the aid of new technology. In other words, Øllgaard attempted to expand the value of biogas by associating it with the 'survival' of Danish agriculture.

The government responded favourably to Øllgaard's action plan. Knowing full well farmers were knee-deep in livestock manure, not money, and as biogas plants did not come cheap the DKK 190 million plan was funded with funds for alternative energy projects and by making low-interest state guaranteed loans accessible to farmers. The DEA used interviews similar to STUB to identify suitable candidates for enlistment. DEA's newest employee, Søren Tafdrup was reportedly very aggressive to avoid owners from overflowing. Candidates' insight and competencies were scrutinized, to prevent another series of pacification disasters. As such, high school teachers, grassroots idealists, and others not deemed relevant according the DEA criteria were ruled out. From the perspective of framing a strong agency the interviews were instrumental in excluding actors from taking part in creating and measuring the value of biogas, at least as part of the Øllgaard agency. STUB had taken a similar approach when excluding farmers and others not believed to possess the knowledge and interest in building advanced farm-scale plants. With the VEPs no restrictions were imposed on who to participate, which enlisted the very same people Øllgaard was excluding. Øllgaard was taking an active approach in framing biogas agencies and structuring the balance of power.

Eventually in November 1987, Tafdrup isolated four candidates. Between January, 1988 and May, 1991 five demonstration plants were constructed. After four years, it was believed that the commission had succeeded in pacifying centralized plants to the point of making them relatively predictable, at least in terms of stabilizing biogas production. Pacification was attributed to the commission's ability to assemble a powerful agency including agricultural scientists. Along with government funding resources and knowledge had been available on a scale not previously seen. Moreover, a strong and experienced community of plant managers who oversaw daily operations meant that if a problem emerged it was quickly reported circulated among other plant managers with similar problems. It also provided vital input to lab researchers and scientists to address these overflows. It is worth noticing, that seven other centralized plants were scheduled in Denmark at the time outside of the Øllgaard agency.

That is not to say plants did not experience multiple setbacks. Indeed they had. Some overflows were all too familiar, some completely new. Adhering to the tradition, several new advanced features were added; a separation unit, which separated the water from manure reducing its weight considerably, building a post-digestion tank after they discovered biogas production continued long time after it had left the reactor, and sending biogas by a seven km underground pipeline to the nearest CHP all saw the day of light. Progress was also made with pre-sanitation, pumps and pipes, manure trucks, decentralized storage tanks and the host of other components each vital for the plant to operate. Some overflows still required the development of components tailored to the specific setup of the plant.

As part of the pacification, we encounter another example of the role played by materiality in qualifying agencies' capacity towards creating and framing biogas as valuable. The Action Plan was very ambitions and under close scrutiny. To claim biogas production was increasing and stabilizing, let alone claim to be progressing towards fulfillment of its good intentions, the commission framed an extensive metrological setup to measure all kinds of technical, economic, and environmental progress with each plant and the program itself: biogas production, yields, temperatures, manure characteristics, economic performance, and environmental progress on nutrient runoff, etc. Sandholt explained how the use of monthly reports on biogas production was vital to activate other actors and profess that biogas was valuable:

"The monthly progress reports we made were nothing short of brilliant for everyone. It showed the monthly gas production. We designed a simple chart with cubic meter gas on one axis and time on the other. We kept changing the scale to make gas production appear increasingly dramatic all the time. We started out with nothing but in time gas production increased exponentially. This chart was a tremendous sales pitch (…). We used this chart everywhere to show things were improving overall, although some plants struggled. We also prepared monthly reports were we integrated the budget figures for gas production, something that had never been done before, so that they [plant managers] were confronted with their targets. It worked like charm with plant managers as a stick, and if they failed they were held accountable (...) They also helped motivate lab researchers to leave the lab and engage the real world leading to experiments with thermophile, mesophile temperatures and in particular with industrial waste." (Sandholt, 2008)

The use and circulation of monthly status reports afforded by the material setup clearly demonstrates how it helped sustain the commission's leadership in creating and determining the values of biogas as part of an overall mission to frame biogas as a valuable technology in producing renewable energy and mitigating agricultural pollution. Based on an extensive metrological setup this material backbone provided them with qualculative capacity to document progress, as part of a mission to show that realizing the good intentions of biogas were well underway. The outcome was a myriad of status reports, mid-term evaluations, media and news report, and the main commission report which were widely circulated among MPs, members of government, farmers, and other key agencies. The same ability to measure and prove that significant strides was being made also helped direct engineers, plant managers, and researchers in their efforts to address and solve overflows in pacifying the plant.

The final Øllgaard commission report concludes, 'There are numerous environmental, agricultural and energy benefits to be gained from centralized biogas plants. Major economic development have occurred in the past three years and under proper realistically attainable conditions it is presumed possible to construct centralized biogas plants that are economically viable.' (Energistyrelsen, 1991, p. 12). It was argued that technology had matured to such an extent that constructing reliable biogas plants was no longer considered a main problem and within a foreseeable future the need for construction grants would no longer exist. 'As a farmer, taxpayer, and normal citizen I am pleasantly surprised over the positive development of biogas. To my knowledge there is the basis for a broader expansion of biogas', Knud Øllgaard stated at the news conference (Ingeniøren, 1991).

A common plant feature and major change to the technical configuration was the integration of industrial waste to supplement manure. Prior to coming to joining the DEA, Søren Tafdrup worked at the Fangel biogas plant and was among the first to experiment with industrial waste, by adding surplus waste from marmalade production rich on sugar and energy, to the reactor. Adding as little as 10 percent industrial waste from local meat or fish factories, biogas production increased significantly, in turn improving the economic performance. Calculations from the commission indicated it was impossible to render plants economical based solely on livestock manure since biogas yields were too low. Øllgaard argued '…the future of large plants depends on whether it is possible to gain access to sufficient quantities of organic waste compared to the relatively large quantities of livestock manure' (Energistyrelsen, 1991). For some plants, industrial waste had rescued some plants from financial turmoil. But industrial waste also created a new set of overflows which threatened to undermine Øllgaard's value proposition. Firstly, it created a logistical challenge since it was scarce. The waste was enlisted as a standard material entity in the frame, simply because studies showed only then could plants be economical. However, just as pacification had favored organized action a study of the possible locations and concentration of readily available sources of industrial waste showed that while sources of livestock manure where literally overflowing with some 1.6 million tons annually, less than 133.000 tons of industrial waste could be realistically located. Secondly, industrial waste was unevenly distributed compared to plant locations which would increase cost of transportation (Energistyrelsen, 1991).

In light of the dependence on scarce industrial waste, a new controversy emerged over Øllgaard's valuations of biogas plants. Critics questioned Øllgaard's premises for arguing that biogas plants were valuable, especially biogas contractors specialized in plants operating exclusively on livestock manure. Remnants of Landsbyenergi, the biogas company behind the VEP plants, used data from the VEP plants to claim that it was the high contents of water in livestock manure which resulted in low biogas yields, not only the lack of industrial waste although acknowledging its benefits. They argued water took up space in the manure trucks and biogas reactor, otherwise intended for manure alone. If it was separated more manure could be added to the reactor, biogas production would increase, cost of transportation decrease in turn making the plants economical. He encouraged the Øllgaard Commission to develop techniques that would reduce the water contents of livestock manure, but Øllgaard maintained his argument (Ingeniøren, 1989b).

Reframing the technical overflows during construction had caused most plants to be hemorrhaging money in the early construction phase. And despite improvements the entire assemblage was still very fragile, as these few examples stress. Firstly, the relatively stable economic performance threatened to overflow if components continued to require substantial maintenance. Transporting the manure between plant and farm was also a major cost driver. Secondly, the single-largest source of revenue came from selling gas to the local CHPs but as there was only one CHP, biogas owners were very restricted in terms of customers. Thirdly, biogas plants functioned as an alternative garbage disposal, which was cheaper to use by industries because they avoided paying taxes on the biomass waste products they produced. Instead they paid a 'gate-fee' to the biogas plant but access to industrial waste depended on the existence of related markets in meat and fish production. If the local meat factory went out of business, the biogas plant would be in a dire situation.

Øllgaard had also created an environmental value which had been included with the overall valuation of biogas plants. What allowed Øllgaard to conclude biogas plants were cost-effective to society was because he had quantified and included the so-called environmental benefit that came from reduced loss of nitrate and phosphor into the cost-effective calculations. Calculating the socio-economic savings accruing from reduced nutrient runoff was integrated to produce an overall positive socio-economic value from constructing centralized biogas plants. Removing this particular variable from the valuation would change the valuations significantly.

Øllgaard's ultimate goal was to associate and enlist the natural gas agency. Selling biogas to the natural gas infrastructure would empower the biogas market agency tremendously by providing access to 300.000 households rather than supplying a single CHP and a few thousand citizens. But to do so meant framing biogas as a valuable alternative among natural gas companies, which according to the main report faced multiple challenges. Firstly, the biogas had to be cleansed and upgraded to natural gas grade but the equipment did not exist, and no experiments had been conducted. Secondly, there was the issue of plant location in proximity to the underground natural gas infrastructure. Who was to pay for any extension line from the plant to nearest natural gas pipeline? Moreover, the natural gas infrastructure remained an expensive and highly valued top priority project for the government interested in protecting its massive investment. It was politically unacceptable for renewable energy to conflict with the infrastructure (Tafdrup, 2007).

Finally, the arrival of biogas plants activated concerned local communities, fearing the pungent odor of manure from the plants, the numerous daily deliveries by 30 ton manure trucks on public roads thereby increasing traffic and the chance of accidents, the damage to property value etc. A lack of technology to deal with the odor had resulted in several unfortunate leaks of the pungent manure. At this stage, local protests had been mitigated by framing the problems as temporary awaiting the implementation of solutions. But this did not stop the media from reporting on these issues and circulating them to other rural communities where farmers were planning new biogas plants. As we shall witness later on, these local agencies would later form a key contender to the established pro-biogas agency.

Overall, it became the widespread belief that the Øllgaard commission managed to realize some of the good intentions by pacifying and illustrating the value of biogas plants as an environmental solution. Some spectators believed the stage was now set for Danish biogas technology to become a massive export commodity (Politiken, 1991a). Søren Tafdrup offered me this comment.

> "Look, Øllgaard showed it was possible. That is what the final report was all about. After the failures of the 1970s and 1980s it finally got to a point where we could say and document that biogas works, at least from a technical standpoint. It was possible to produce biogas." (Tafdrup, 2007)

Søren Tafdrup explained that the Øllgaard Commission not only helped prove it was technically feasible to pacify centralized plants but also helped frame biogas as a valuable tool in addressing issues such as energy security and environmental pollution. As a clear demonstration of the perpetual changes in agencies and agency properties even the powerful agricultural lobby organizations such as the DA and DMA ended up officially supporting biogas despite initially being a fierce critic. They had taken notice of the popularity biogas had received among farmers and government politicians. Only a few years before had they hired a consultant to warn farmers against biogas plants. The Minister of Energy was also delighted, stating the 'action plan has demonstrated that a common coordination of agricultural, environmental and energy interests in a common program can provide results which would not have been obtained if each sector had worked separately' (Politiken, 1991a).

2.2.4 Framing Biogas as 'Economically Feasible'

The Øllgaard commission had shown it was technically possible to construct biogas plants and produce large quantities of gas and help solve the environmental problems. But as Øllgaard had difficulty in claiming biogas was also economic more work lay ahead. It was to create this value. Otherwise no farmer would invest in biogas unless government support existed. Øllgaard had asked for a follow-up program to enhance biogas technology and monitor the progress 'so we can all be enlightened based on a reasonable foundation' (Energistyrelsen, 1991). The following two accounts will continue to demonstrate the perpetual and material aspects in framing biogas market agencies during which supporters of biogas continue to dominate in creating and measuring the value of biogas plants.

The global community was riding the environmental awareness wave of the late 1980s and early 1990s in the wake of the 1987 UN report 'Our Common Future', commonly known as the Brundtland report. Changes towards the notion of 'sustainable development' were needed on a global scale, most notably with regard to greenhouse gas emissions and thereby reorganizing global energy systems. In light of increased concern for CO2 emissions, renewable energy received further political attention and sustainable development also found its way into Danish energy policy. In April 1990 the government presented the third national energy plan 'Energi 2000' subtitled 'Action Plan for Sustainable Development'. The goal was to reduce energy consumption by 15 percent and CO2 emissions by 20 percent by 2005 compared to 1988 levels, in line with the UN recommendation for Denmark. It was the first time environmental targets were established for the energy sector, the industry[8], and households - all key sources of CO2 emissions at the time. The financial means to achieve this came out of an interdepartmental committee on energy taxes, which proposed to reorganize existing energy taxes into the so-called 'green taxes', namely CO2 and SO2 taxes (Energistyrelsen, 2006-2008). At least on paper, this would make renewable energy such as biogas competitive compared to conventional solutions, as renewables were exempted from CO2 taxes.

Timing for biogas markets was crucial. The 1991 Øllgaard-report had sparked heated political debate over the role of biomass, including biogas in the energy system. In the main report, Øllgaard framed biogas as a cost-effective means to reduce CO2 emissions by calculating the cost of a plant as a measure of CO2 emission reductions released from biogas when compared to coal, oil, and natural gas (Politiken, 1991b). Consequently, biogas could therefore prove valuable in implementing the government's policy. Furthermore, Øllgaard argued biogas

[8] To begin with only the most energy consuming industries were included. In May 1991 the CO2 tax system was reorganized to include the entire industrial sector (Energistyrelsen, 2006-2008).

should be allowed in regions currently dominated by natural gas. But beyond setting new targets for biomass integration in Denmark, the conservative-lead government and several opposition parties still feared that integrating biomass would lead to new expensive investments in technology needed to realize this and because the political system was in strong favor of shielding the natural gas project from any further indebtedness, no legislative changes were made to accommodate Øllgaard. Nonetheless, the DEA remained interested in biogas as a source of energy. Farmers also remained enlisted by an estimated payback time of ten years compared to 20 years for manure storage tanks, and access to state construction grants and low-interest mortgages from municipalities. Although the production grants had been gradually reduced from 40 percent to 20 percent, it was compensated by a new DKK 0.27 per kWh production grant (tax credit) introduced by the government in 1992 to promote renewable energy.

To deliver on these new good intentions the DEA decided to show it was possible to make biogas plants economical. Amid increased political support for renewable energy and CO2 reductions, the DEA decided to continue with a Follow-Up program from 1992-1995. The purpose was to solve the outstanding technical and economical problem, which included focus on biogas yields, researching and quantifying the environmental benefits, and breaking ground on upgrading biogas to natural gas quality thus gaining access to the 300.000 natural gas customers, nationwide. As many of the new plants had experienced faulty equipment and repairs for older plants lowering cost of construction was a primary objective. Choosing the correct odor-control equipment had been an expensive trial-and-error framing process for several plants amid objections from local communities. Debt payments and interests were also burdening the economic performance of older plants, and because production capacity was limited they lacked the financial leverage to fund future repairs. For some plants, economic performance was further impaired when repairs forced them shut down production.

After three years, the Follow-Up Program published its final status report in November 1995 entitled ‘From Idea to Reality’ (Energistyrelsen, 1995). By 1995 an additional six centralized biogas plants were constructed, bringing the total to 15 with several other plants on the drawing table. The results showed significant improvements (Ingeniøren, 1994). By addressing the different overflows biogas yields and biogas production increased significantly following successful integration of industrial waste and sewage waste water. Odor overflows had been reduced by framing odor retention units (such as air filters), and the biogas production process had showed increased stability as a result of research into the anaerobic digestion process. This also improved the fertilizer quality of the degassed manure. As concern for greenhouse gases and climate change was growing stronger in the mid-1990s the DEA had expanded the set of biogas value propositions to include its 'CO2 mitigation' value. Using a few examples and not aggregated results from all the plants the report demonstrated that for one cubic meter of biomass processed the total GHG emission was reduced by 118 kg CO2 equivalent while producing 844 MJ of energy. Being exempted from CO2 taxes, this made biogas by far the most economical solution to reduce CO2 emissions, the report concluded. In an article about the report Søren Tafdrup comments:

> "The results show that significant improvements have occurred since 1987 but a continuous need for further operational enhancements exists. Meanwhile, development shows potential for further advancements, for instance by lowering cost of construction, identifying durable components, and the implementation of new gas purification techniques" (Ingeniøren, 1994)

Despite improving the economic performance to claim biogas was more valuable than ever, they had been unable to upgrade biogas to natural quality thus preventing them from framing biogas as a valuable supplement to natural gas. The problem was that the technology used to upgrade biogas to natural gas grade overflows as well as being very expensive. The price of biogas would almost double. Two new plants featured different cleansing systems but in light of the added cost of cleansing biogas, CHPs did not see it as a 'valuable' solution (Energistyrelsen, 1995, p. 21). It was simply too expensive, and also required a great deal of reframing of the CHP to make biogas valuable in the natural gas network.

Meanwhile, a growing number of local agencies were framing biogas a serious liability and overflow, literally speaking, because of several incidents. The extremely pungent odor continued to leak from many of the plants, but the source of these overflows remained unknown. The 1995-report concluded, because odor leaks and subsequent local protests had previously been underestimated, development was lagging behind in this area. Finding solutions was further complicated by the unique characteristics of the plants meaning the source of overflows and solutions were never the same.

At this stage in our story, the government research programs has allowed us to further demonstrate the perpetual aspect of agency properties and material aspects in framing biogas market agencies. Firstly, we have previously witnessed how the material agencies - from labs, metrics, metrologies, measuring equipment to calculations and status reports - have played a central role in framing the qualculative capacities of agencies by which they can dominate and exclude competing and opposing frames. Sometimes, material agencies developed a voice of its own such as the NPO-report. Other reports played a paramount role in outlining new targets and good intentions for biogas pacification and their circulation helped enlist other actors and strengthen agencies. As such, NPO report, Green Report, and Øllgaard's action plan all materially mediated how to frame the potential value and underlying good intentions of expanding biogas plants in Denmark.

With the advent of government research programs materiality assumed a new role. They were not only used to frame the good intentions of biogas and outline the business case for biogas, but to document the progress on fulfilling them, and as a consequence empower some agencies over others. Combined with a vast metrological setup, including labs, metrics, measuring equipment, computers, etc. material entities were used to provide succeeding pro-biogas agencies with superior qualculative capacities without which they could not create and measure the value of goods against competing frames. In fact, the very notion of biogas would not exist, at least not in the shape we see today. Due to this complex material setup biogas is today accepted by many (but also refuted) as a solution to agricultural pollution, cost-effective production of renewable energy, inexpensive way of reducing CO2 emissions, etc. This constant (re)framing of new metrics, and parameters (biogas yields, production capacity, CO2 mitigation capacity etc.) new status reports, notes, memos, and main reports were central entities by which agencies could claim value in the first place, such as claiming 'biogas works from a technical standpoint' or that 'biogas is now economically feasible'. What this demonstrates is that to qualify as an agency, i.e. to create and determine the values of goods much less to dominate markets, requires a vast material setup.

On every occasion materiality was mobilized to materially mediate and claim certain values of biogas plants, but at across time materiality also played a role in the perpetual change in agency properties. Materiality is what provided the government research program with increasingly powerful qualculative capabilities by which they could dominate market making and exclude others. Simply notice the notable shifts in biogas market agencies as a function of the materiality possessed by different agencies. The pro-biogas agency grew from a position of being completely excluded in the mid-1980s, to a position of dominations less than a decade later. Outspoken critics from agriculture and the EPA formed an interest in biogas and the market expanded its socio-technical territory of technically and economically feasible biogas plants. It is plausible to imagine that had these continuous attempts to pacify biogas plants overflowed as in the past, agency properties and domination/exclusion dimension would have been markedly different. Had Øllgaard not successfully pacified centralized plants technically, and had the DEA not rendered them economic, they would not have been able to mobilize a credible materiality to make such claims. In fact, farmers may have lost interest, agricultural organizations would have said 'told you so', and local protests may have prevented new plants from being constructed, hence prevented biogas markets from existing.

However, what comes up must come down. As will be further demonstrated in the following two stories, agency properties are never stable and a priori defined. Understanding who and what participates in creating and measuring the value of biogas, their qualculative properties, the alliances of which they are apart, providing them with the power to dominate and exclude others are perpetually undergoing change. At this stage, the pro-biogas agency had reached the pinnacle. In the following two sections we leave behind the role of materiality in shaping agencies to see how overflows and controversies accompanying the framing of market agencies can suddenly change agency properties and their capacity to act.

2.2.5 Political Controversy Renders Biogas Unwanted

This account signals the beginning of loss of power and ability to further biogas market activity by the pro-biogas agency, even though biogas plants exhibited a stable technical and economic performance. In this section we demonstrate that even markets for a well-framed and pacified good can collapse if overflows and controversies render agencies powerless to act. This also allows us to gradually explore the relationship between the various forms of framing, in this case between pacification and framing agencies. During the mid-1980s it became obvious that Danish waste production had spiraled out of control causing public waste management expenses to rise. Storage and treatment capacity was scarce and expensive, and the environmental impact was becoming increasingly evident as the EPA intensified its focus and research into waste-induced environmental pollution. Waste disposal on dump sites resulted in soil and air pollution. Hazardous toxins such as heavy metals and chemical residue were found in groundwater reserves. To contain them required expensive permanent waste storage or special treatment. Minister of the Environment, Per Stig Møller decided to implement new waste management policy aimed at reducing waste production and increasing recycling. This strategy was formulated in a series of 'Action Plans for Recycling' beginning with the first one in 1986-87 in which a target of 50 percent rate of recycling by the mid-1990s was formulated (Miljøstyrelsen, 1987).

2.2.5.1 The Helsingør Biogas Plant

The fundamental problem was that without a price on waste it was cheaper to simply dispose of it rather than to collect it for further treatment. The solution was to impose Denmark's first refuse tax in January, 1987 to discourage waste production and a search for alternative and less expensive means was commenced. A new cornerstone in the government's waste action plan was to implement a nationwide sorting of organic and non-organic waste which could be used for alternative means such as incineration or recycling. The goal was that by January, 1996 each household, business, industry and other waste producers would organize waste into two trash bins: One for organic waste, one for non-organic. It was estimated that by 1996 more than 315.000 tons of organic waste material would become available. The question troubling most of the municipalities was what to do with this new source of organic waste. They received little advice from the EPA (Ingeniøren, 1993a; Ingeniøren, 1993b). A report suggested five alternative techniques for optimal use of organic waste: disposal, incineration, biogas digestion, central or home composting (CASA, 1993). Cost ranged from DKK 945-1425 per ton including the refuse tax of which biogas was considered among the expensive solutions with a cost of DKK 1410/ton. According to the article, biogas came out as an expensive solution because the underlying calculations were based on a single plant.

Most municipalities were skeptic of biogas. They felt biogas had a relatively poor economic performance and there was no evidence of combining a biogas plant with sorted household waste. It had to be pacified. North of Copenhagen, however, two adjacent municipalities had been discussing how to comply with the new regulation and decided to cooperate on building Denmark's first centralized biogas plant based solely on household waste. The background for choosing this unconventional solution was among others a set of calculations that suggested the price of digestion in a biogas plant would not exceed the price of incineration in this particular area while providing the benefits of biogas technology documented by the Øllgaard Commission (Ingeniøren, 1990). Once more, we see the role of a material agency as part of performing valuations of biogas plant technology. Calculations showed annual production of 3 million cubic meters of biogas would replace existing use of fossil fuels, revenues could be generates from selling the high grade fertilizer to agriculture in addition to monthly gas revenues of DKK 380, and finally, the reductions in carbon dioxide emissions would reduce Danish greenhouse gas emissions as per government instructions.

In late August 1990, construction of the new plant (Nordsjællands Biogasanlæg) in the city of Helsingør was commenced. Price for the 20.000 ton capacity plant was DKK 54 million. The Carl Bro Group, known from its historic involvement in biogas was main contractor and project leader. The greatest challenge was not to construct the biogas plant itself, but to transform the invaluable household waste into valuable biogas. The manual process of sorting organic waste and non-organic waste into separate bins was unreliable and non-organic waste such as plastic trash bags, packaging, and wrappings was expected to find its way into the organic waste. It had to be removed because it could easily cause havoc to the delicate machinery, it has no energy potential, and equally important, farmers were not interested in scattering plastic bags all over the crop fields. Success also relied ton pacifying a support net. Just like centralized manure-based biogas plants relied on manure trucks, so would the Helsingør plant rely on a support net of garbage trucks and trash bins. Every household received two new trash bins from the city authorities: a green for the 'wet' organic household waste, and a black one for everything else. Garbage trucks were retrofitted to contain both kinds of waste.

The Carl Bro engineers came up with a solution in which specially designed rakes removed the unwanted plastic while a chemical solution converted the waste material into organic acids and other forms of dissolved material. The dissolved material would be extracted from the tanks using a set of separators before being transferred to the reactors for anaerobic digestion. All in all, a new technical configuration involving numerous new components developed from scratch (Ingeniøren, 1990). One year later in September 1991, Denmark's first all-organic household waste biogas plant came online. But during the first 18 months of operation the plant experienced multiple, serious overflows. While the support net of garbage trucks and new trash bins performed well, the rakes and chemical solution overflowed. Not only did the customized rakes not manage to remove all of the unwanted non-organic material, it also removed 25 percent of the valuable household waste. Carl Bro was adding large quantities of water to ensure the organic waste could pass through the system to the reactor, but in doing so, the nutritional value was reduced by a factor of 2-3. As a consequence it became impossible to sell to farmers as fertilizer. Organic waste supplies were also too low. By April 1993, the Helsingør plant was operating at less than half capacity, revenue was only DKK 60.500 well below the budgeted DKK 380.000 per month.

Also overflowing was the odor retention equipment causing multiple pungent leaks of manure to the dissatisfaction of the neighborhood. What we witness here is the activation of local action groups framing biogas as unwanted by means of written protests to city council. Similar complaints had been seen elsewhere, e.g. Skovsgaard plant during the VEPs. However, for the first time the local community was able to spur city council into action. Following months of unstable operation and extensive repairs, a steady series of complaints from the neighboring community over repeated odor leaks meant the local authorities gave Carl Bro twelve months in December 1995 to reframe the overflows (Berlingske Tidende, 1995). Upon failing to solve the problem the plant was required to shut down for an indefinite period in July 1996. An independent task force found the plant in a 'critical' situation and estimated an additional DKK 20-25 million in repairs to turn things around thus creating a valuable enterprise (Jyllands-Posten, 1996). But despite reconstruction efforts the plant would continue to malfunction for another four years without achieving the desired level of stable biogas production or solving the odor leaks. The plant was finally shut down in 2001 after which a legal battle ensued between the municipality and Carl Bro over a liability and damages lawsuit. The property was sold in 2006, the plant demolished, and a recycling center to be constructed in its place. As we shall see momentarily the Helsingør pacification failure not only played an instrumental role in discouraging interest in this type of plants. The biogas industry publically voiced their discontent with the plant, saying it had nothing to do with biogas plants. It had become the black sheep of the biogas industry.

2.2.5.2 Pacifying The Studsgaard Biogas Plant

In municipality of Herning, the Herning Municipal Utilities (HMU) had taken notice of the Helsingør 'disaster', which it was repeatedly referred to as, but was equally interested in attempting a similar combination of biogas with household waste. HMU already operated the centralized Sinding-Ørre biogas plant which had been constructed during the Øllgaard Commission. It was technically and economically well-framed featuring an underground pipeline to transport livestock manure thus avoiding the use of manure trucks. But the region still had 83 pig and cattle farmers, several food manufacturing facilities and others willing to supply resources for an additional biogas plant. Faced with the same challenge of complying with national waste regulation, the municipality chose to adopt a similar 'two waste bin' policy and integrate the household waste along with manure and other forms of organic waste. Calculations showed the household waste would make a new biogas plant economical which prompted city council to construct a second biogas plant.

Although the new Studsgaard plant inherited the pacified Sinding-Ørre plant design, HMU faced the same problem of building a component to remove non-organic ingredients unwanted in the reactor. Seeing how Helsingør had failed, HMU opted for a different approach to domesticating the new plant. Where Helsingør opted for a complex chemically-based solution, Herning opted for a simpler mechanical one. At a separate fully automatic facility, called Knudmosen located between the existing and new plant household waste arrives by garbage trucks after which a specially designed filter removed the foreign objects. A biofilter then removes the odor. The organic waste is transported to Studsgård and mixed with manure and industrial waste. After biogas production the degassed biomass goes through a second sorting process inside a mechanical separator to remove any remaining non-organic elements. The end product was a high grade product and only eight percent of the incoming organic household would be lost compared to the 25 percent lost in Helsingør. Biogas is sold to the local CHP plant for energy production. Although facing a similar pacification challenge the mechanical solution worked. Despite a few technical overflows during the startup-phase engineers successfully reframed them and the HMU felt confident that when household waste sorting became mandatory nationwide, the potential for biogas markets would grow significantly (Miljøstyrelsen, 2002). In fact, HMU found their system so valuable they took out a European patent to protect it from infringement.

However, as Studsgård and Knudmosen were nearing completion in April 1994, the new Minister of the Environment, Svend Auken was engaged in a controversy with the National Association of Local Governments in Denmark (Kommunernes Landsforening – KL) over whether it should be mandatory or not. It is at this point in the story, we return to our analysis of framing biogas market agencies. It came down to a fight over the cost of sorting and digesting one ton of household waste, and who should finance it. Representing the municipalities, KL was interested in finding the least expensive solution to the waste problem. According to their calculations, mandatory sorting was the least attractive option. Auken used HMU's calculations, one of the nation's only successful plants with household waste, which estimated cost at DKK 250-350 per ton, the same as incineration (Ingeniøren, 1995). The high level of energy extraction afforded by anaerobic digestion made the scale tip in favor of biogas. KL rejected the calculation arguing the cost of collecting and sorting depended on the geography and cost of transportation. If the government demanded mandatory sorting, KL offered to do so only if the state paid them DKK 200 per household per year to cover the cost. Auken responded with a new set of calculations showing that if waste was collected on a bi-monthly instead on a weekly schedule the added cost of sorting would be offset by savings from the change of schedule. In fact, he argued the savings would create the financial leverage to construct a biogas plant. The KL official clearly disagreed.

> "All I am saying is that we cannot buy into this. We have always argued that collecting is very expensive and we are not certain that it is reasonable to go for an up-scaled form of collection" (Ingeniøren, 1995)

At this stage, several other municipalities joined the controversy over the value of household sorting and biogas plants. A report from the municipality of Aalborg in Northern Jutland had compared various systems for household waste collection based on their experiences. The least expensive system for sorting would result in an increase in municipal expenditures of only DKK 40 per year per household. KL responded using a report from the municipality of Ballerup which arrived at a completely different set of numbers. The battle raged for some time. Auken had previously tried to enlist the recently elected prime minister, Poul Nyrup Rasmussen in April 1993 to persuade KL. The Danish Natural Conservation Association also supported the KL. Ultimately, a compromise was found. The government reduced the mandatory requirement to a voluntary agreement, meaning whether municipalities decided frame and organize the support net needed by biogas plants to operate was entirely up to them. A government official explained that they had been operating based on 'unrealistic expectations' and had been forced to reevaluate the ambitions with regard to household waste. Following the Helsingør disaster, they had changed the way they performed valuations of biogas plants based on household waste by shifting to plants combining household waste with manure. Although acknowledging a shift in government politics, an official argued the government would not force the municipalities because it all depended on whether they could obtain livestock manure from agriculture at a reasonable price and whether they could there was sufficient demand for de-gassed manure (Politiken, 1995). Neither had been accomplished.

HMU felt they had been abandoned both by KL and the government. Managing Director Niels Nedergaard of the HMU clearly disagreed, stating:

> "Our actions were based on what the minister and KL said, and that was that bio-gasification was the preferred solution to reuse the organic householdwaste"(Ingeniøren, 1995)

> "Three years ago, we were definitely under the impression that according to the plan by January 1, 1996 mandatory household waste sort" (Politiken, 1995)

Responding to the HMU situation, the KL official responded:

> "That is a problem they will have solve on their own. No one promised them the household waste." (Ingeniøren, 1995)

HMU had initially been motivated by the prospect of a mandatory arrangement. They had assumed nationwide sorting would be implemented but ended up with 35.000 tons of vacant production capacity but no household waste. What the controversy over household sorting demonstrates in relations to market making, is that agency properties and alliances can never be to assumed to be constant. Even for a pacified good such as the Studsgaard plant markets can be rendered ineffective by the distinct ways in which agencies compete in performing valuations based on different calculations. Despite successfully pacifying a biogas plant with household waste following the disaster of Helsingør, the government unexpectedly announced it would not support a mandatory household sorting, which meant biogas plants lost access to the support net. It is difficult to say exactly what led the government to change position, as political negotiations are conducted in secrecy. However, that is not the point. Speaking on behalf of the pro-biogas agency it appears the government did not possess a qualculative capacity afforded by a material agency strong enough to enlist KL into the household sorting frame. And apparently, this particular change in agency properties was not only a surprise to HMU but also a change that rendered valuations of biogas plants based on household waste incapable to demonstrating an overall positive valu. In a newspaper interview HMU director commented:

> "Before, we used to have plenty of sorted household waste but no plants to digest it. Now it is the opposite. Plenty of digestion capacity but too little waste" (Ingeniøren, 1995)

For the new plant to remain economical household waste was paramount. Fearing they would run out of waste they wrote to every municipality in Jutland offering them to collect their household waste if they sorted the material. But most municipalities opted for the simplest solution which incineration in CHPs. Herning continued until September 2002 when city council decided to stop the system and return to incineration (Nyhedsmagasinet Danske Kommuner, 2002). The city argued the benefits of biogas was outweighed by the expenses. A study showed that of the 25.500 households around five percent did not properly sort the material. Small items such as plastic and bottle caps found their way into the organic material, and were big enough to cause several lengthy and expensive plant shutdowns such as in 2002 which left Studsgaard offline for two months while the employees cleaned the reactor of foreign objects by hand (Jyllands-Posten, 2002). A new pre-treatment facility would cost DKK 2.5 million to replace but calculations indicated the investment was too large. They also cited a study from the Danish Technical University suggesting the environmental and economic benefits of biogasification of sorted household waste were minimal when its quality as fertilizer was accounted for. The report was later discovered to not exist, but it had already been used to stop the project (Ingeniøren, 2002b).

What had initially appeared to be promising new potential for biogas markets, spearheaded by the Helsingør and Herning plant ultimately vanished. Losing access to sorted household waste was a devastating blow to plans of creating a new market for biogas plants using household waste. By 2002, 90 percent of the Danish municipalities had opted for incineration. Overflows and controversies over biogas can have equally damaging effects on framing the agencies which form a necessary part of markets. Meanwhile, for the first time we saw how markets for a well-framed and pacified good can collapse if the agencies loose the qualcufying capability and ability to dominate markets due to overflows, such as the Helsingør plant, and controversies over the value of biogas in which material agencies play a dominant role establishing credible valuations. Existing alliances, the balance of power between agencies, and qualculative capabilities can suddenly undergo fundamental change amid the controversial nature of biogas markets.

2.2.6 Political Controversy Renders Biogas Unpredictable

With this final account we finalize the analysis of framing biogas market agencies. In the previous section, we saw how household waste overflowed from the market frame due to changes in ways valuations of biogas were carried out following a sudden and unexpected shift in agency properties. Apart from the household waste incidents, the pacification of biogas plants was relatively successful showing continuous technical and economic improvement (Ingeniøren, 1994). Yet, in this section we continue to chronicle the reframing of the pro-biogas agency's ability to maintain biogas plants as feasible and thereby ability to further biogas market activity.

Motivated by positive strides during the Øllgaard Commission and Follow-Up program the DEA continued to enhance biogas technology in another government sponsored research programme for biogas. For the most part the period from 1995 to 1998 resulted in further stabilization of the technical and economic performance. Many technical overflows were solved and re-framed, positive economic results were achieved by increased integration of industrial waste, optimizing biogas production, gate fee revenues, and above all the government production grant which remained the primary source of income. However, the report indicated that progress was not as significant as under previous programmes (Biopress, 1999). A few new plants had been constructed the DEA had gradually reduced its biogas commitment and at the same time the construction grant had been reduced to 20 percent. However, for the first time no new centralized plants were scheduled under the government research program. Activities focused on increasing biogas production and optimizing the performance of existing plants. Research activities were relocated to the Danish Technological University (DTU), believed to be better equipped with the necessary scientific skills and interest in biogas research and development. Farmers were also holding back. One report cited three projects currently under consideration. What had happened to agencies valuations of biogas?

Several explanations were identified. Firstly, most farmers in Denmark had constructed the manure storage tanks demanded by the NPO action plan which meant there was no regulatory pressure to fuel demand for biogas plants, which at the time consumed around three percent of annual manure production. Secondly, local protests against new biogas plants meant it was increasingly difficult to obtain building permits from the local authorities. The controversy over location escalated after an increasing number of plants had experienced massive odor and gas leaks along with circulating stories of failed plants, the Helsingør plant most notably; a problem we shall examine further in the second analytical chapter. Incidents such as the Helsingør plant had prompted local officials and city council to demand more extensive documentation and instituted a more lengthy environmental approval process before plants were approved and building permits were issued. In other words, several local agencies were growing stronger not being convinced that biogas was as valuable as the biogas industries claimed. What we witness then, is a growing local agency framing biogas plants as a local liability; a frame that was receiving attention from local authorities with the legal mechanisms that could stop a biogas plant project.

But above all, the primary cause of concern among farmers and the biogas industry, was a looming privatization of Danish energy markets. As Bruno Sander Nielsen, chief negotiator with the Danish Biogas Industry Organization (BIA) explained:

> "I am not really sure whether I should call this period in the history of biogas, stagnation or dismantlement. One thing is sure, though. Things were going in the wrong direction for biogas in Denmark (…) I think it started with the government's decision to privatize energy markets in Denmark." (Nielsen, 2007)

April 1996 saw the arrival of a new energy plan, Energi 21 designed to reduce CO2 emission. A DEA report had showed CO2 emissions were increasing even after being targeted in the previous 1990 energy policy, called Energi 2000. It was announced that the government was implementing an EU directive aimed at privatizing the EU energy sector. 'There will be changes relating to market, resource, environmental, and price issues' (Miljø- og Energiministeriet, 1996, pp. 3-4) followed by 'Negotiations on a common set of rules governing EU's internal energy market (…) have entered a decisive phase' (1996, p. 12). While the extent of the regulatory overhaul and re-organization would take years to take effect, the mere prospect was enough for the pro-biogas agency to await further development. After the government unveiled plans of privatizing the energy sector it had sparked immense debates in biogas circles of what the consequences were for biogas. A crucial economic parameter was the production grant, which formed the very basis in performing valuations upon which the biogas industry and farmers could determine whether biogas plants were economical. Up until now the price of biogas and the production grant was fixed and known. In a privatized market the price of biogas would fluctuate, and a production grant would be considered an illegitimate form of government subsidy upsetting the 'demand and supply market mechanisms', at least from a traditional economic perspective. As the economic performance was fragile and very sensitive to any sudden changes the effects on agencies' valuations of biogas as a good would be associated with a high degree of uncertainty and chance of overflowing. A fundamental re-organization of the energy sector towards replacing a fixed with an unknown and fluctuating market price on energy would make it difficult to determine and calculate an exact economic feasibility on potential biogas projects. Existing plants could see its current economic performance overflow, especially older plants with relatively low biogas yields, production and need of costly repairs and upgrading. A high risk of agencies' valuations overflowing prevailed and researchers noted a drastic decline in farmers' interest in biogas plants. The government still had good intentions for biogas. Biogas saw its target of 20 PJ was reiterated which was positive new for biogas markets in light of recent improvement in biogas performance, technically as well as economically. To achieve the political goal for biogas an estimated 15-20 centralized biogas plants were required by 2000 followed by an additional 100-150 plants by 2030. However, in 1999 only one plant was scheduled for completion (Politiken, 1999).

The balance of power in biogas market agencies was undergoing fundamental changes, due to regulatory changes which challenged existing calculations of the economic value and predictability created in the past decade of framing biogas plants. Among the agencies involved in biogas markets, the biogas industry and the notoriously powerful and influential agricultural lobbyist organization, Danish Meat Association (DMA), decided to create a new actor with the sole task of keeping biogas markets alive. In November 1997, the Biogas Industry Association

(BIA) entered the Danish biogas scene. Chief negotiator, Bruno Sander Nielsen explained why this agency was framed:

> "We basically decided to establish the industry association because at that time around 1997 it became clear that farmers were very close to complying with the political requirements imposed on them with the Marine Environment Act (…) Most of them had constructed storage tanks. But the biogas industry itself which had evolved in the meantime was of course still interested in creating jobs for its corps of engineers and biogas companies. And they also had a keen eye out for the export possibilities. So in a close cooperation with the Danish Meat Association it was decided to establish the industry association as part of the Danish Meat Association (…) The idea was simply to continue to sell biogas plants to farmers. I mean, you have to keep in mind that farmers were and still are the only customers for biogas plants in Denmark. There are no other potential investors." (Nielsen, 2007)

Believing positive political conditions, most notably the production grant, were central components in maintaining a positive economic valuation of biogas, BIA was designed to lobby for improved conditions for the biogas industry in the Danish government and parliament and. BIA would also operate among farmers to assist the industry in promoting biogas, for instance by assisting farmers in negotiating with local authorities as part of obtaining approvals. It was from the outset a powerful agency. Firstly, it was established, endorsed, and partly funded by the DMA which is among the largest and most influential lobby organization in Denmark. Secondly, it included biogas industry members from biogas producers, biogas plant contractors, engineering and consultant companies, to a few industrial conglomerates all interested in selling biogas technology. To promote biogas among farmers they also teamed up with the Danish Agricultural Advisory Services (DAAS). It was through DAAS the DMA tried to discourage farmers from investing in biogas in the 1980s. With DAAS, the BIA had enlisted an agency with personal relations to the agricultural community and thereby a direct line to its principal group of customers.

The creation of BIA in 1997 was crucial. Newly elected BIA President, Henrik Høegh believed their first challenges was to make sure the energy market reform and political negotiations did not remove the incentive for farmers to invest in biogas by lowering or even revoking the production grant. Known as the Electricity Reform, the new EU Directive was passed by the Danish Parliament in March, 1999. It was a historic legislative overhaul of the energy sector. Primary attention was given to solving issues relating to ownership structure of power companies, utilities and transmission companies. In dismantling the monopoly ownership was transferred to power companies and utilities. In Denmark, reforming the electricity market was strongly related to environmental policies and the long-term prospect of reducing greenhouse gas emissions by substituting conventional energy technologies with renewables. It was believed that the absence of a 'long term policy for renewable energy [was] likely that renewable energy contribution might well fall below existing levels', under a privatized market (Olsen, Friststrup, Munksgaard, & Skytte, 2000, p. 57). The EU solution was the notion of 'prioritized production' as part of the public service obligation (PSO). This made it legitimate to demand utility companies to accept renewable energy at a fixed price backed by a production grant resulting in a price competitive with the price on conventional fuels. To ensure the expansion of renewable energy production, markedly more expensive than conventional energy, a so-called CO2 emission trading system (EMS) and a green certificate market (GC) would be implemented. The idea of using an EMS was to regulate emissions by allocating allowances, or 'rights to pollute certificates' equal to 23 million tons of CO_2, followed by annual reductions in allowances until reaching 20 million tons in 2003. Should a power company exceed the allowance it would be imposed a penalty per ton. Conversely, redundant allowances could be sold on the market. The GC market worked in a similar way. A Green Certificate (also known as Renewable Energy Certificate – REC) represents the environmental value, for instance the CO2 reduction per 1 MWh of electricity. The more renewable electricity it produces relative to its cost, the higher the value of its GC. The purpose is to make renewable energy competitive with conventional energy, but in such a way that it alleviates the state from expenses and that prices are determined by a policy-induced market designed according to supply and demand mechanisms. Demand for GCs and thereby renewables would be stimulated through ambitious targets for renewable energy production established by the government. At least, that was the theory and good intentions.

From the outset, the GC market was controversial. An intense framing struggle emerged between the biogas industry and the government over determining the value of biogas in a GC market with fluctuating prices. Citing calculations from the government research unit at the Institute of Food and Resource Economics (FOI), BIA welcomed the EMS as calculations showed biogas offered the lowest cost of CO2 reduction compared to any other form of energy. But the GC, replacing the production grant, was framed as untried and if it overflowed without compensation (or reframing) biogas markets would collapse as the economic valuations would become negative. Acknowledging the problem, BIA was invited by the government to join a DEA task force, which was given until 2003 to come up with a solution.

While work continued on the fate of the GC market, BIA focused on lobbying for the production grant. In the first draft it was set to DKK 0.33 per kWh, only marginal higher than the DKK 0.27 per kWh that had been in place since 1992. They objected arguing it would put biogas out of business and negate all the government had accomplished in the past decade of government sponsored biogas R&D, and more importantly, bring a halt to realization of the government's good intentions with regard to biogas expansion in Denmark. Using calculations and charts depicting the break-even as a function of the production grant, indicated a need for a considerably higher production grant. BIA argued the GC was worthless as long as the GC market was not in place pending the task force results thereby removing the 'GC market' from the government's valuations of biogas. Moreover, BIA also argued that the untried GC market could go both ways. As a result, the government could not claim that biogas plants would remain economic. It could perform as expected, but there was a high risk that it could overflow which BIA argued would cause biogas markets to collapse. In other words, they were unable to agree on how to accurately frame and perform valuations of whether GCs would render biogas plants uneconomical. If so, it was likely interest in biogas would vanish. Eventually, BIA and the government agreed to a DKK 0.60 per kWh production grant for all new biogas plants constructed before 2002. From 2003 it would then be reduced to DKK 0.30 per kWh which provided four years of stability in biogas feasibility studies.

It was BIA's first political victory. But in performing valuations of biogas plants and deciding whether to invest, farmers estimated the economic outlook for 10-20 years. Four years of 'guarantee' from economic overflows, at least with regard to the production grant, was insufficient. At the same time, the average completion time of a new centralized biogas plant had increased significantly due to lengthy approval processes with local and state authorities. In other words, the plant may just come online by the time the government decides to reframe their valuations for biogas and the production grant. And with the privatization in full swing, there was still a chance future negotiations would reduce the production grant much further. In fact, on October 31, 2001, PM Poul Nyrup Rasmussen called for general elections but lost to the liberal-right wing opposition which won a landslide victory. Although it was an EU directive which resulted in the changed production grant, the social democratic government had consistently supported biogas development. Since 1992 the farmers had been able to depend on stable economic support. After nine years of Social Democratic rule a new government took office. Running on a campaign slogan that promised ‘more bang for the buck’ with public investment in environmental policy and renewable energy, things could get quickly get worse for biogas markets. The new Prime Minister, Anders Fogh Rasmussen, economist by training and leader of the Liberal Party (Venstre) was a firm believer in the ‘free will of markets’, ‘de-regulation’, and minimal state intervention (he authored a book on the subject) and instead use markets to find the ‘optimal’ solution. While under the previous government it was uncertain to what extent biogas could rely on political support, under the new administration, it was uncertain whether political support would even exist.

2.2.7 The Perpetual and Material Aspects of Framing Biogas Agencies

The accounts of this second chapter on the marketization of biogas plants in Denmark allow us to underscore the perpetual reframing of biogas market agencies. In this chapter we have seen how agencies are framed in a perpetual motion that is constantly contingent and defined by its material associations and accompanied by overflows and controversies. Whether agencies are capable of performing valuations of biogas, possesses superior qualcufying capabilities, and ability to dominate or be dominated is the outcome of a perpetual framing process.

Table 3 below summarizes the perpetual and material aspects of framing biogas market agencies. Although simplifying the situation, I have divided agencies into two main groups – one dominating the creation and determination of biogas valuations, while the other is excluded. These are inherited from Caliskan and Callon's domination/exclusion dimension. For each of them I have highlighted various aspects such as valuation of biogas and materiality of these agencies to illustrate the various forms and shapes they assume.

Table 3: The Perpetual and Material Aspects of Framing Biogas Market Agencies		
1984-1986: Agricultural Pollution		
	Dominating Biogas Markets	Excluded from Biogas Markets
Main agency	EPA, dead fish, parliament	Agricultural organizations (DA)
Materiality	NPO-report, Action Plan, metrics	Protests against NPO
Alliance with	Fishermen, biologists, media,	MoA
Biogas valuation	Manure storage tanks were better	Technical and economic failure
Overflows	Obsolete data and numbers	Dead fish, manure
Controversy	The extent of agricultural stake in pollution (cold)	
1985-87: Biogas as solution to agricultural pollution		
	Dominating Biogas Markets	Excluded from Biogas Markets
Main agency	DEA (+EPA)	EPA
Materiality	Green Report	NPO-report
Alliance with	Farmers, government, Øllgaard	MoA, DA, DAAS
Biogas valuation	'Win-win' solution	Disaster. Impede NPO action plan
Overflows	Manure, nutrient runoff	Manure, nutrient runoff
Controversies	Whether biogas is an economic means to solve pollution	

	(hot)	
1987-1992: Øllgaard Commission and Follow-Up Programme		
	Dominating Biogas Markets	Excluded from Biogas Markets
Main agency	Øllgaard Commission and DEA	EPA, natural gas sector
Materiality	Action Plan, charts, reports, metrics	NPO-report and action plan
Alliance with	Farmers, plant mang., DA, DAAS	Government and parliament
Biogas valuation	Technical, economic feasible	Prevent manure storage tanks
Overflows	Natural gas sector	
Controversy	Whether biogas is an economic means to solve pollution (cold) The role of industrial waste in biogas (hot)	
1993-1996: Controversies over household waste sorting		
	Dominating Biogas Markets	Excluded from Biogas Markets
Main agency	KL and municipalities	Biogas industry (household waste)
Materiality	Status reports. Municipal calculation	HMU calculations
Alliance with	Government	HMU and Helsingør
Biogas valuation	Infeasible with household waste	Feasible with household waste
Overflows	a minority of municipalities	Helsingør plant, KL, government
Controversies	Whether biogas can use household waste for energy (cold)	
1996-2001: Controversies over energy market privatization		
	Dominating Biogas Markets	Excluded from Biogas Markets

Main agency	EU	BIA, biogas industry, DEA
Materiality	EU directive, Electricity reform, etc.	FOI reports
Alliance with	Government	(DMA)DTU, FOI, government
Biogas valuation	Biogas economical with GCs	Biogas uneconomical with GC
Overflows	GC calculations	Fixed production grant, government
Controversy	Government sponsorship of renewable in a privatized energy market (hot)	

Comparing agencies of 1984 to those of 1996 clearly demonstrates that we can never assume the agency theatre, their capacities, balance of power (domination/exclusion), and other properties to be constant. Notice the changes in main agency, the forms of materiality deployed, the alliances of which they are apart, how biogas is valued, the growing inventory of who or what overflows, and whether controversies are closed (cold) or remain open and contested (hot).

We also notice that materiality forms a central part of framing biogas plant valuations and the qualculative capacity and thereby ability to dominate biogas market activities. From NPO-reports, Green Reports, and action plans to status reports, feasibility studies, and a plethora of other calculations these are central aspects of the forms and shapes agencies assume and whether valuations render biogas valuable or invaluable. At least from the accounts presented above there is strong correlation between ability to dominate and further market activity and access to material agency which secures a superior qualculative capacity.

We clearly see how framing agencies can be constantly thwarted by sudden overflows, such as when political agencies unexpectedly leave when failing to see the value of a particular policy measure, when a previous positive valuations of biogas is rendered negative by a sudden change of politics, or when biogas overflows spark controversies and reopens the question of the value of biogas. In fact, controversies over biogas valuations can be equally damaging to markets as a technical overflow from a failing pump or reactor. The final account of this chapter was particular interesting in this regard. By the late 1990s it was believed that centralized biogas plants were both technically and economically feasible. Yet, now biogas market activity plummeted towards the late 1990s because political controversies over biogas and energy market privatization rendered existing valuations of biogas invaluable *and* because the controversy remained 'hot' and unresolved. There was no closure. In other words, although biogas plants were technically pacified and relatively well-framed, it was a sudden and unexpected change in a single, yet important, parameter – the production grant which caused biogas markets to collapse. As such, while the pro-biogas agency dominated biogas market activity for a decade, it was suddenly rendered powerless by unexpected shifts in how biogas valuated.

2.3 A Multitude of Ill-Framed Biogas Plant Market Encounters

In this final period of biogas markets beginning at the turn of the millennium we turn our eyes towards the framing and construction of the third form of socio-technical assemblages from the marketization framework: the socio-technical mediating algorithm of market encounters. Unless goods and agencies are brought together valuations cannot take place. Much like a supermarket, which facilitates the meeting place between agency and good and the completion of the transaction whereby the good is disentangled, biogas markets too require such market encounters to emerge and stabilize. However, as this third analysis will demonstrate for goods and agencies to meet each other is no random event that automatically takes place. Just like goods and agencies, it too must be framed and organized sometimes from scratch. At some point in the process the struggle between different and opposing valuations are peacefully settled upon deciding on a price which makes the transaction possible. But in the case of biogas, obtaining a construction grant or production grant is an equally important element of completing the transaction. Everything must be framed and 'peacefully' facilitated by the socio-technical mediating algorithm of the market encounter. Otherwise, there can be no biogas plant marketization.

2.3.1 Framing and Organizing Biogas Market Encounters

We begin with a story from the early 2000s to demonstrate the effort it takes to frame market encounters without which it is difficult for agencies to 'find' and perform valuations of biogas plants. In doing so, we also learn of the process by which biogas plant transaction are completed including regulatory processes, finding a construction site, in addition to determining whether the plant itself will serve the farmers' interests.

The final period of biogas markets beginning at the turn of the century is particular suited for a study of market encounters. Compared to 1973 when farmer Lassen constructed his rudimentary farm-scale plant with the local blacksmith, the market encounter – if we can speak of one - was equally rudimentary. Without knowing for a fact, it probably consisted of a few sheets of paper with designs and calculations over a cup of coffee with the blacksmith in his dining room. The distance to travel from deciding to transact to completing the transaction was very simple, unregulated, involved only a few people and components such as calculator, pen and paper. The only thing missing was that in case of overflows from the 'product' the farmer could not resort to guarantees or warranties on parts and labor. Question relevant to this section, is how can the market encounters of the new millennium be characterized? How are overflows and controversies dealt with to ensure a peaceful transaction?

STUB, VEPs, the Øllgaard Commission all had one thing in common, besides playing a central role in pacifying the unruly biogas technology. The so-called demonstration plants constructed under the auspices were key physical sites by which agencies could perform valuations of biogas plants. In light of its sometime erratic and unpredictable behavior, and the vast difference between seemingly identical plants a physical inspection was often needed. As it would take more than brochures and Excel spreadsheets to frame biogas plants as valuable, the tradition of constructing demonstration plants was kept alive by biogas plant contractors and plant suppliers. Recall how STUB's and the Øllgaard Commission's attempts to pacify biogas plants consisted of multiple pacifications with each new plant based on a new technical design, type of production, new components, organizational setup, etc. Then came the failed plants based on household waste. Depending on a farmer's specific requirements and interests s/he would have to perform valuations of more than one plant.

By the early 2000s a new generation of centralized biogas plants was attempted to be pacified. Due to increased competition from Eastern European farmers, benefitting from low labor cost, and strengthened environmental regulation from the Danish government, Danish agriculture had undergone a significant change in the past decade towards larger and more efficient farms. In 1970 there were 140.000 farms in Denmark which was reduced to 55.000 by 1999 of which 25.000 farms was responsible for 90 percent of national agricultural production. To maintain competitiveness farmers were increasingly demanding solutions to process livestock manure in such a way that nitrate and phosphor was extracted and isolated, thus complying with regulation and thereby obtaining the permit to expand livestock operations. The Harmony Rule instituted by the EPA in the mid-1980s was still in effect. Isolating the polluting elements would make it easier to dispose of, for instance by selling it to other crop farms in need of nitrate or phosphor. Many farmers felt biogas plants had proven too complex to realize and the anaerobic digestion did not make the nitrate or phosphor disappear; it only made it easier for crops to consume them while excess quantities would still result in nutrient runoff. A new kind of *separation technology* which separated the harmful nitrate and phosphor from the liquid manure had already emerged, either as individual stand-alone units operated by a single farm or combined with an existing biogas plant (Christensen J. , 2001). In principle, separation works by separating the 'liquid fraction' with a lower content of ammonium and much less phosphor and a 'dry fraction' containing the nitrate and in particular phosphor. The much less polluting liquid is used as fertilizer, whereas the isolated dry fraction could find an alternative use.

At least on paper it worked, and a host of different solutions existed by early the 2000s, each with different benefits but also with a range of technical problems and high costs. It was far from pacified; neither as an individual technology nor combined with biogas. Several companies from the biogas industry had attempted to pacify separation technology (Ingeniøren, 2001). Green Farm Energy was among the first. GFE intended to offer a combined biogas and separation plant to the tune of DKK 30-50 million. To convince potential buyers they constructed a demonstration plant on one of the two owner's farm, Lars Jørgen Pedersen near the small village of Langå (also known as the Over Løjstrup plant) in Jutland. The GFE plant concept was framed as an all-inclusive solution designed to process the manure from the second it left the livestock to separation and biogas production. Livestock stables were reconstructed to accommodate GFE's new concept for animal and environmentally friendly stables designed to keep the air clean from the pungent manure odor, and automatically transport the manure to the biogas reactor. Prior to entering the biogas reactor a high technology separation unit used a pressurized steam cooker (similar to an oversize pressure cooker) to 'squeeze' the manure which separated the nitrate into a wet fraction from the phosphor into a dry fiber fraction. The wet fraction would enter reactor similarly to other dominant biogas plants with a production capacity of 1-2 megawatt electricity and an equal amount of heat energy. Along the way all potential odor sources were kept under control, the manure was sanitized, leaving clean tap water as the only byproduct at the end of the process. The degassed manure was used as high grade fertilizer while the dry fraction, rich on phosphor could be sold to other farmers or exported. A key selling point for GFE was that the phosphor was fully contained in the dry fraction as required by law, and the Langå plant was constructed both as a laboratory and development site for GFE, but equally as a showroom to demonstrate the solution to potential customers.

The demo-plant was inaugurated in august 2002 as the world's first combined biogas and separation plant. Present were a wide range of high ranking politicians of which the county commissioner, members of city council and MP, Eyvind Vesselbo all spoke highly of the vital contribution by GFE in mitigating the agricultural environmental footprint, notwithstanding the odor problem (Lokalnyt, Hadsten side 3.). GFE was quickly praised for taking the lead with its integrated biogas solution. The Danish Agricultural Advisory Service (DAAS - Dansk Landbrugsrådgivning) also publicly supported them. GFE had also managed to convince then-Minister of the Environment, Hans Christian Schmidt to visit Langå on November 26, 2003 for a demonstration and guided tour. With a production grant of DKK 0.60 kWh GFE announced, that the plants were not only economical they would also enable customers to meet all environmental standards; a vital framing of their product as potential customers arrived at this market encounter. Politicians and the media flocked to visit and report on how GFE and remaining biogas industry was now in place to create the next major export commodity. Among them were also potential investors and GFE made a strong effort in using the demonstration plant to attract new customers. Alan Lunde, currently working on completing a biogas plant in Maabjerg, Northern Jutland was one of them:

"When we were looking around and discussing the type of plant to meet our demands, I remember how Torben [GFE co-founder] called me up countless time inviting me to see the plant [Langå demo-plant]. At that time, they were so confident they had come up with the one and only solution to the farmer's problem. But I declined, as we were looking for something simpler, less high tech. Besides, I was not convinced it actually worked" (Lunde, Maabjerg Bioenergy, 2009)

Lunde explained how in perusing the market for a biogas plant it was only natural to visit existing plants featuring components similar to what was demanded in a new plant and talk to the owners and plant manager. Although Lunde was not convinced, several others were. Upon inspecting the demonstration plant and performing the complex set of feasibility studies several orders were placed for GFE plants. Their first contract was a DKK 70 million plant sold to Overgaard Estate, a large pig producer. The estate was interested in a GFE plant because of a planned expansion of its existing pig production beyond the 750 LU (livestock units) established as the maximum livestock farm size in Denmark. The idea of using a GFE plant was therefore part of strategy to convince the local authorities to permit an expansion of Overgaard's existing pig production. Authorities can permit further expansions provided they possess the technologies to process the extra manure and provided the estate could document the plant ensured the environmental consequences were under control (Børsen, 2004). Estate manager Stig Andersson believed the GFE plant would provide the environmental leverage he needed:

> "By having the environmental issues in place we are hoping for more goodwill from the authorities (…) It should mean that the authorities will show more leniency with regard to an expansion of the production" (Børsen, 2004)

Having included the GFE calculations into the overall valuation, the plant manager was convinced it would provide such leverage. He had also calculated a payback period of 10-12 years 'if it matches the calculations' as Andersson expressed in a newspaper article. The market encounter had successfully presented the GFE plant as a means by which to meet the objective of expanding production following a permit from local authorities. Similarly, the municipality of Hjørring in Northern Jutland wanted to co-sponsor a GFE plant in the village of Dammen with local farmers, and the same was the case for Brønderslev which had sufficient manure and industrial waste for a GFE plant in Krogenskær. Together, they were the first three customers to place orders with GFE totaling almost DKK 300 million. Another five groups of farmers placed orders for preliminary feasibility studies at DKK 350.000 identical to those Overgaard Estate had purchased from GFE. The feasibility study forms a vital preliminary document in performing valuations of biogas plants given the specific circumstances, manure, location, organizational setup etc. for each potential plant.

While all these projects were launched, the Langå plant experienced a series of technical problems. Manure leaks were so severe the local community protested (Politiken, 2003). Timing was highly unfortunate for the role of the plant as a market encounter, as it was about to receive an important endorsement. Two months later in December the GFE plant was scheduled for a so-called ‘farm test’ carried out by DAAS aimed at providing GFE plant with a blue seal of approval from Danish agriculture. DAAS is a respected authority among farmers who solicit advice and consulting services from DAAS. Agricultural suppliers therefore often submit new equipment for ‘tests’. The report is then distributed to municipalities, agriculture, and food industries to form a basis for determining whether to invest or not. A consultant from DAAS provided the details:

> “There is no doubt that this is an incredibly interesting concept, they have. There are a lot of firms out there but the GFE plants have several distinctive features which makes it very interesting, indeed (…) If these plants show stability and show the farmers that it is economic, then I think these firms will pretty busy.” (Børsen, 2003)

The test is an important milestone in verifying the legitimacy of a technology among farmers. The outcome is put on display in the market encounter and circulated elsewhere to be included in performing valuations. Receiving the DAAS blue seal of approval would dramatically increase the value of biogas. However, the GFE demonstration plant on Pedersen’s farm continued to suffer from several severe manure leakages in September 2005 sparking a controversy in the local community over the plant's location, calling on city council to close it down immediately. GFE was asked to keep the community informed via newsletters. Meanwhile, significant problems were also reported on the Overgaard plant. Not only was the separation unit failing, but so was the reactor. A consistent overflow was also the high-tech separation unit, but other key elements – from the reactor to odor retention – failed. GFE spent most of 2004 and its financial means on reframing these technical overflows with the Langå and Overgaard plants. Construction on the Dammen and Krogenskær plants was eventually finished in the spring of 2004, but it was not long before similar technical problems appeared. At all four plants the high-tech separation units did not work and gas and electricity production was far below the threshold for running an economic plant. But GFE had depleted their funds on reframing technical overflows and decided to file for bankruptcy in July 2004. After spending DKK 300 million, the company was unable to show its investors and prospect customers that their combined biogas and separation plant worked.

GFE blamed the local authorities for their demise. Despite having secured three contracts for GFE plants in Northern Jutland, no payments were received until construction had commenced. To begin construction required prior approval from local city authorities, and several of these projects had been delayed by the public approval process. Before the Dammen and Krogenskær plants could receive final approval from the County of Northen Jutland, the so-called district plans (lokalplaner) had to be updated and approved to ensure they had the legal basis to operate biogas plants on the proposed construction sites. And until this happened, GFE did not receive payments from the investors and the transaction could not be completed. GFE was therefore forced to finance the construction in the meantime (Jyllands-Posten, 2004). CEO Lars Jørgensen was very displeased with the decision.

> "This ruins our entire work flow. We had an order book with assignments that supplied us with continuous employment. But now our schedules are displaced by a time factor of eight to nine months. This means, despite four signed projects, we will have a period of time with nothing to do." (Jyllands-Posten, 2004)

With four additional signed contracts awaiting approval from the authorities GFE was wasting valuable time and money. Whether the technology worked or not was irrelevant if local authorities disapproves proposed construction site. GFE R&D Director, Torben Bonde seconded his CEO:

> "It is totally unacceptable that it can take years to get a biogas plant approved. We have no problems complying with the authorities' demands but we cannot live with such slow administrative procedures. It can destroy a young enterprise like ours if we are unable to maintain employment" (Dansk BioEnergi, 2004, p. 15)

GFE had also secured a contract for a plant in the village of Brædstrup where the approval process had proven exceptionally time-consuming. The project was behind by 8-9 months due to difficulty in finding a construction site local government would approve. After two years and 15 different sites they abandoned the project. This demonstrates a particular aspect to the biogas plant market encounter. In terms of facilitating the transaction, GFE and its customers have to await a relatively lengthy approval process from the local authorities. To construct a biogas plant in Denmark is no longer just a matter of signing a building contract and breaking ground on the following day. We have previously learned that following years of overflows from biogas plants have caused local authorities to require further documentation from new biogas plant owners. During this process the local community is also invited to make their opinion visible to others, and potentially object to the proposed plant. The idea is to make sure the biogas plants do not overflow, and in case they do it does not affect any known agency. In the next chapter we shall return to a much deeper analysis of this particular aspect of the market encounter as we retrace biogas plant transactions.

This was of little comfort to GFE customers whose response ranged from furious to patient. In an attempt to save GFE from bankruptcy, and thereby the market encounter, the Overgaard Estate was offered part ownership in GFE if they would invest in the company. The DKK 70 million plant was supposed to have commenced full operation by September 1, 2004. But according to Stig Andersson the plant was far from complete.

> "We have been bluffed by Green Farm Energy (…) The project makers have been blinded by their own theories. Nothing in our plant has worked at a satisfactory level. Too much bad equipment has been used, produced by amateurs. For instance, now we have to replace the vaporizer unit while we have had major difficulties with the pressurized steamer." (Dansk BioEnergi, 2004, p. 15)

Apparently, he felt deceived by the market encounter as it has led him to a favorable and positive valuation which was not realized. A well-framed market encounter also ensures there are rules and procedures and solutions to overflows and controversies that may emerge in the aftermath of the transaction. According to my sources, the Krogskær plant, similar to Dammen came out of the GFE collaboration relatively unharmed. The two owners, Per Pedersen (brother to Lars Jørgen Pedersen co-founder of GFE) and Jan Ulrich were confident they could solve the technical overflows similar to those found on the Dammen and Overgaard plants. Per Pedersen was alluding to the odor problems they had been unable to solve. On November 1, 2005 they were imposed an official deadline by city council by when to comply after which the owners would be reported to the police for failure to comply with environmental regulation (Nordjyske, 2005).

Although the GFE story could easily be analyzed as yet another failed attempt to pacify biogas and re-frame overflows (which it is), it serves a different purpose here. Danish biogas markets have always relied on demonstration plants as a central element in market encounters. This is where agencies come to inspect and perform the primary valuation of biogas plants before signing the contracts stipulating the terms and conditions of the transaction. The Langå plants served an identical market encounter purpose as the plants constructed under STUB, VEPs, and the government commission in the 1980s and 1990s. Recalling their difficulties in pacifying biogas plants as well as the Langå account, demonstrates that not only is framing market encounters an overflowing and controversial process. Because biogas plants are markedly different in terms of production design, technical design, economy, biogas yields, forms of biomass used, organization, with or without separation technology, biogas markets contains a multitude of market encounters many of which are fragile and controversial. The consequences for marketization are serious as DEA biogas expert, Søren Tafdrad explained to me:

> "After the GFE disasters, both their own plant despite all the hype and the other ones, people said 'no' to high-tech. From now on they were finished with high-tech solutions. Only low-tech and proven technologies would be implemented" (Tafdrup, 2007).

As Tafdrup points out the GFE 'disasters' has apparently negated interest not only in GFE plant but also high-tech separation which brings out two analytical points on market encounters. Firstly, failure to contain the overflows and mitigate controversies over GFE meant the Langå plant had lost all market encounter functionality. Not only had the pacification of GFE plants failed to favor organized action, as had been the case on several occasion in the life of biogas markets, the overflows had rendered the market encounter itself ill-framed if not completely useless. Secondly, with the notions of 'high-tech' and 'low-tech', Tafdrup was referring to a technical distinction between two forms of separation technology. High-tech were, as the word implies, advanced and costly solutions while low-tech were more simple mechanical solutions such as a centrifuge much like the ones found in a washer to remove water from the laundry. The same dichotomy had found its way into Danish environmental regulation stipulating the allowed expansion of livestock operation as a function of the type of separation technology used. High tech allowed a greater expansion of livestock operation than low-tech, as it was believed high-tech also provided a greater separation, hence environmental result. Translating the technological difference into a legislative one served the political purpose of maximizing the amount of separated nitrate and phosphor. The rationale for this was that separated manure posed a much lesser environmental hazard. In other words, in performing valuations in the market encounter when choosing a solution, a new legal definitions and metric had been added to the socio-technical mediating algorithm causing valuations to become even more complex. Henceforward, market encounters also compelled agencies to take this technical distinction into consideration along with the dozens of other parameters included in biogas plant valuations.

The GFE story contains more material for our analysis of market encounters. Market encounters are more than mere physical sites to facilitate valuation. The market encounter also facilitates the transaction. They are part of a socio-technical mediating algorithm which guides agencies in a particular direction, provides several options or only one, and ensures agencies can complete the transaction. In the GFE account, the four groups of farmers eventually obtained the necessary permits. But GFE cites difficulties as a reason for its demise before losing a potentially lucrative contract in the village of Brædstrup. In the wake of the GFE plant disaster the government agency, Institute of Food and Resource Economics (FOI) published a 2004 status report which stresses the majority of new proposed biogas plants are terminated in response to intense protests from the local community over plant locations (FOI, 2003). Apparently, people were putting up an intense fight to prevent biogas plants form entered their back yard. FOI found that of the three cancelled biogas projects in 2003, two of them cited difficulties with finding a location the local authorities would accept. To construct a biogas plant requires numerous construction and environmental permits from local authorities and the EPA and DEA, closing contract negotiations with local suppliers of waste, approval of the technical layout, etc. From the perspective of market encounters the approval process including regulations, permits, documentation, and many other elements meant the transaction process had become increasingly time-consuming and a cumbersome partner. Approval of the proposed sites was especially challenging because it required environmental impact studies (VVM-studies) which were often lengthy and expensive. These determine the influence of new installation on the natural environment and neighbours. Experiences from the demonstration plants showed that the preliminary planning phase now took 2-4 years before construction could begin. Only if nothing changed in the interval, the relatively short construction phase could commence. As such, the public and political approval process forms a vital part of the market encounter as the outcome, vital to finalizing the transaction, can go either way.

Farmer's attempt to complete transactions in market encounters, the equivalent to proceeding to the checkout counter in the supermarket, was often prolonged by local protests. Citizens feared the odour which was also fuelled by the negative reputation biogas plants has created in time following incidents with other biogas plants such as the Helsingør and GFE plants. Other concerns included traffic from the many daily truck deliveries, the effect on property values, etc. It was believed that these controversies placed a major strain on farmers' reputation and standing in the small, rural communities, where local politicians risked losing local endorsement come election time if they approved an unpopular biogas plant. Local communities were actively resisting any involvement in biogas frames, even at the prospect of lower energy bills. According to senior biogas FOI researcher, Kurt Hjort-Gregersen the problem is there that there is no standardized way of transacting new biogas plants, let alone any guarantee of success. While the system is designed to enforce the rules of local democracy, and protect various actors from overflows, the outcome is impossible to predict which from a marketization perspective does not benefit biogas plants. Whether a site is approved is up to local government, and whether a site is approved has definitive implications for biogas plants (Hjort-Gregersen K. , 2007).

At this stage in our analysis of market encounters, the GFE story shows how biogas markets are populated with a multitude of ill-framed market encounters. To frame an encounter is the equivalent of pacifying an entire biogas plant, as plants are the primary destination or ‘biogas supermarket’ where agencies perform valuations and decide whether to transact. When market encounters fail, new ones emerge adding to the complexity of the market encounter. Should farmers and contractors come to an agreement and decide to complete a transaction, the analysis showed how the socio-technical mediating algorithm also includes regulatory processes, obtaining various permits, and finding a construction site, in addition to determining whether the plant itself will serve his interests. However, the data clearly indicates that in many cases local officials and the community is very skeptic because they fear the potential overflows from biogas plants. Consequently, the decision to transaction comes with a high risk of failure. The market encounter is highly complex and time-consuming to pass through and as the decision whether to transact or not involves more than choosing technology and agreeing on a price there is also a high risk of reaching a ‘dead end’ in the market encounter, should the vital political approval overflow and refuse to be associated with the frame. At this stage, the biogas market encounter seen here can only be characterized as ill-framed as they make it relatively unlikely for farmers and the other biogas actors to deliver on the underlying good intentions.

2.3.2 Framing Values and Transactions in Market Encounters

Among others, the GFE account demonstrated that 'packaging' of biogas plants is important for producers and suppliers of biogas plants. Whether a market encounter displays one value over another is crucial for a transaction to take place. The story I am about to tell, is very suitable for demonstrating that much like everything else in biogas market whatever value market encounters convey is never just a value we can assume to be a priori established according to universal formulas. For market encounters to present agencies with one specific value over another is the outcome of a complex framing task which includes different algorithms, calculations, devices, and people. And neither here, can we expect the framing process to be straightforward and free from overflows and controversies. I shall analyze how the market encounter for farm-scale plants, which saw a revival around the year 2000, eventually wound up conveying one specific value. Here, another biogas plant supplier was framing a market encounter to sell farm-scale biogas plants. Specifically, we shall retrace the controversial framing of the market encounter each demonstrating a distinct aspect of the market encounter. The first shows how a specific value is conveyed by the encounter, while the second shows the framing activity of a specific part of the transaction.

2.3.2.1 Framing the 'Cost of Maintenance'

Not since the mid-1980s had anybody seen or heard much from farm-scale plants. Farmers dismantled most of the failed ones due to the technical problems that had marked its entrance in the 1970s and early 1980s as described in the first section. While the DEA and biogas community was busy constructing the first centralized plants as part of the VEPs the small grassroots movement Nordic Folkecenter for Renewable Energy (FC) had inherited the remains and continued on pacifying the farm-scale plant design in its headquarters in Northern Jutland. To them it was a simple means to a vital end, easier to construct and maintain than centralized plants. In 1986, FC President Preben Maegaard welcomed a 25-year old chemist from Ghana, George Aboagye-Mathiesen as their new trainee. For George, biogas was a primary interest and since his arrival he took the lead along with German and Swiss biogas specialists to pacify the farm-scale plant (Nordisk Folkecenter, 2000). The reframed and allegedly pacified plant became known as the Blacksmith plant.

Disgruntled by the lack of government support for farm-scale plants compared to the attention centralized plants received with the Øllgaard Commission, Maegaard criticized the DEA in a series of articles claiming there were no reasons why farm-scale plants were ineligible for government support. Their calculations framed blacksmiths plants, although smaller, as equally fitted to the task of solving agricultural environmental problems on-site making the need for transporting manure redundant while reducing the number of permits needed from local authorities. Moreover, each farmer could operate it independent of other farmers and it was cheap enough for a single farmer to invest. Although the DEA maintained that centralized plants benefitted from economies of scale, they agreed that for some farmers, farm-scale could be a better choice (Tafdrup, 2007).

In 1994, the Farm-scale Plant Commission (FPC) was established consisting of agricultural scientists, including Kurt Hjort-Gregersen, members from the DEA and George Aboagye-Mathiesen. A central concern for the FPC was to determine to what extent the Blacksmith plants were economical. It was important to demonstrate this to farmers to protect them from making a wrong investment, as Kurt Hjort-Gregersen described in an interview (Hjort-Gregersen K. , 2008). They used a Blacksmith plant purchased by a farmer from Aboagye-Mathiesen to undertake further research and development. It combined gas storage facilities from which surplus gas generated electricity to the public grid during peak hours when electricity prices were higher thereby providing the farmer with additional revenue. Aboagye-Mathiesen had made a living of selling Blacksmith plants to Danish farmers using his extensive network. Since his arrival in Denmark in 1986, Aboagye-Mathiesen had accumulated many years of experience from being involved in the construction of farm-scale plants in Denmark. In 1986 he founded a one-man company to sell the Blacksmith plant and until the mid-1990s he sold 1-2 plants annually. In 1997 he co-founded Danish Biogas Technology Ltd (DBT) with industrial conglomerate Schouw Ldt. a large well known Danish company and investor in environmental and renewable energy technologies (Jyllands-Posten, 2001). According to Hjort-Gregersen, his plan was to expand sales considerably in the years to come. Using his longtime standing in the agricultural community, experience with the Farm-scale Plant Commission, personal relationships and insight, he knew the farmers well and paid attention to their concerns over how to comply with environmental regulation in order to increase livestock production. To Aboagye-Mathiesen, the FPC served a vital market encounter role. To provide legitimacy for farm-scale plants compared to centralized plants, most importantly by producing an economic feasibility based on scientific merits (Hjort-Gregersen K. , 2008).

At one point the agricultural scientists Hjort-Gregersen and Aboagye-Mathiesen were engaged in a struggle over how to determine economic feasibility. The dispute culminated in preparing the final report from the FPC, when Hjort-Gregersen's and Aboaygye-Mathiesen had arrived at conflicting results. Hjort-Gregersen's concluded the Blacksmith plant was uneconomical while Aboaygye-Mathiesen arrived at the opposite result.

> "At one point we were working on an economic status report for the plants. My calculations indicated that when you subtract the cost of maintenance, equivalent to 25 percent of the investment, along with the mortgage, interest, and other expenses it did not look good. I showed the numbers to George, who objected. His numbers showed a very positive economic picture (…) The difference between his and my numbers were he had not included the cost of maintenance, which is a primary cost driver (…) Naturally, I disagreed. I mean, you cannot prepare an economic analysis and simply omit the cost of maintaining and repairing a biogas plant. They all require maintenance (…)" (Hjort-Gregersen K. , 2007)

The idiosyncratic setup of each farmer's livestock production had made it difficult to create a 'one-size fits all' setup and economic feasibility account representative for all farmers. Quantity, quality and type of animal manure, who could buy the biogas, where to sell surplus degassed manure, and access to industrial waste all determined the economic feasibility of the individual plant. In most cases local CHPs and institutions, such as schools could purchase the gas while industrial waste was supplied by small local factories. All of these lead to markedly different forms of economic performance for each interested farmer. To be safe Hjort-Gregersen based his calculations on previous experiences and calculations with farm-scale plants. Upon comparing calculations, Hjort-Gregersen discovered he had included maintenance cost equivalent of 25 percent of the total investment to cover loan payments, interest, and ongoing maintenance and repairs on the Blacksmith plant. Aboagye-Mathiesen had based his calculations on operational data from the Blacksmith plants he had sold. Hjort-Gregersen objected arguing the numbers provided an overly optimistic valuation of the combined cost of purchasing the plant. Aboagye-Mathiesen warned Hjort-Gregersen against publishing the report without his numbers. If he did, he would leave the group and take any information on the plants with him. It posed a problem to the commission, because he controlled access to information from the Blacksmith plant at the test site and without it the commission could not continue. In the end, Kurt Hjort-Gregersen decided to publish what he called a 'dismembered report' by not including the maintenance cost he felt provided farmers with a accurate valuation thus allowing them to make an informed decision. For Aboagye-Mathiesen the report could be used in the market encounter.

2.3.2.2 Framing the Construction Grant

The struggle over Blacksmiths plant performance escalates in the following years, which provides us with further empirical evidence for our analysis of market encounters. In this section we retrace Aboagye-Mathiesen's framing of the Blacksmith market encounter although turning our attention to how he frames a specific element of the transaction. In 1999 the DEA offered a 40 percent construction grant to new farm-scale biogas plants to increase Danish biogas energy production. For Aboagye-Mathiesen the production grant could became a vital cornerstone in his marketization plans: he had the technology, a widespread network of interested farmers, and numbers showing the feasibility of the investment 'authorized' by the FPC. A construction grant would make it is easier to sell Blacksmith plants. The challenge for him was to frame the production grant as part of the market encounter.

By February 2000, 55 applications for farm-scale plant construction grants were submitted to the DEA of which 34 were from DBT alone drafted by Aboagye-Mathiesen on behalf of customers interested in purchasing his plant:

> "Since we have previous sold exclusively to farmers business did not take off until after documented results were produced to suggest the economy in biogas plants made sense (…) We have a list of over 50 persons or businesses who have shown interest and if all of the projects are realized it will create revenues close to DKK 300 million." (Jyllands-Posten, 2001)

The ‘result’ he referred to was the FPC report. But the DEA did was concerned of the manure/industrial waste ratio of the Blacksmith plant compared to the alleged biogas yields. The ratio indicates the amount of livestock needed by the plant compared to industrial waste which was more potent. Household waste, industrial waste, slurry etc. had proven to significantly boost biogas production and biogas yields. DEA calculations based on centralized plants data suggested plants needed at least 20 percent industrial waste to break-even much less turn a profit. Based on 80/20 manure/industrial waste ratio the best performing plants generated biogas yields of 40/60, i.e. 40 percent of the biogas was produced from 80 percent livestock manure and 60 percent from the 20 percent industrial waste. Søren Tafdrup of the DEA, in charge of allocating the funds, explained:

“The plants they are applying funds for is of the type that only works if the animal manure is augmented with organic waste from the fishing industry, meat factories and the food industry in particular (…) The problem is that this resource is scarce and we have already witnessed how existing plants have been unable to acquire the required deliveries (…) in the long run we need a different type of plant, that is to say the type of plant that can run on animal manure and fertilizer… “ (Ingeniøren, 2000a)

The DEA were not convinced by the ratios Aboagye-Mathiesen had presented. According to him the Blacksmith generated 70 percent of the energy from only 8 percent industrial waste to be economical. As a result the manure/industrial waste ratio was 92/8 and biogas yields consequently 30/70. In other words, the Blacksmith plant exhibited a much superior performance in terms of the manure/industrial waste ratio and biogas yields by producing more biogas with less. Once again, the controversy over what constitutes an economic biogas plant became ‘hot’. It was not the numbers themselves which sparked a controversy as it was the DEA interest in biogas plants based on 100 percent manure (a 100/0 ratio). Industrial waste was increasingly scarce and expensive to purchase, and the DEA was therefore more interested in plants running solely on manure which was abundant and inexpensive. In the early 1990s the DEA had estimated that the energy potential from biogas in Denmark was 32 PJ of which 80 percent was located in livestock manure. But the biogas industry and Aboagye-Mathiesen disagreed with the DEA that 80 percent of the biogas potential came from manure.

> "After five years of efforts to develop farm-scale plants based solely on animal manure the DEA had discovered animal manure does not contain the energy they originally presumed but has consistently used it in their estimates. So it simply is not correct when Søren Tafdrup continues today to argue that 80 percent of the biogas energy potential in Denmark is found in animal manure." (Ingeniøren, 2000b)

Co-founder, Marketing Director and wife of George Aboagye-Mathiesen, Anette Jensen believed no plant could operate economically without other forms of biomass:

> "Last year we made a serious market entry with our product and as it turns out the agricultural sector has accepted the plant layout because the plants can turn a profit. And it is a known fact that currently no other plant layouts that work and have been developed, although the DEA's farm-scale commission have been working on it for 5 years." (Ingeniøren, 2000b)

Anette Jensen was expressing her concern that after five years the FSC had yet to help develop a farm-scale plant that was economical based solely on 100 percent animal manure. She considered it a 'fact' that no such plant existed. In their support, a separate research task force had been unable to make it economical based solely on animal manure. At least 20 percent organic waste was needed. In other words, Aboagye-Mathiesen was convinced that the Blacksmith was a superior biogas plant when comparing the biogas yields.

The DEA recommended the minister, Svend Auken to disapprove the applications arguing that it was the wrong plant layout. Søren Tafdrup was also concerned that by accepting all applications DKK 130 million would be drained from the DKK 165 million funds for renewable energy research. It was difficult to justify spending almost 80 percent on biogas. It was ultimately the minister's decision. In mid-February 2000 Auken, known for his progressive environmental policies, paid a visit to DBT and expressed his intent to promote biogas in Denmark. It would help the minister comply with the reduction in CO2 emissions set forth by himself in Energy 21. Eventually, he followed the advice of his officials and on March 10, 2000 he announced the rejection of all applications, and invited them to a second round with changed criteria. DEA reformulated the criteria in such a way, that projects would now be ranked according to CO2 reduction capability as a function of the investment. The algorithm by which biogas plants were valued had been fundamentally reframed with the stroke of a pen. Now, for Aboagye-Mathiesen to successfully complete these multiple transactions with Blacksmith plants applications had to be reframed. Otherwise, he could not frame the construction grant as part of the market encounter for Blacksmith Plants.

In the following months the biogas industry including Aboagye-Mathiesen was busy reformulating applications to ensure they met the new criteria. And by early October 2000 the DEA had found ten applications out of an original pool of 25 to be eligible for funding. Only three plants did not require organic waste and of the ten selected in the second round, nine plants required organic waste. Aboagye-Mathiesen had three Blacksmith plants approved. The DEA had weighed plant capacity for reducing CO2 and cost of construction and maintenance rather than focusing exclusively on the manure/industrial waste ratio. Due to the construction grant and Aboagye-Mathiesen's favorable economic prospect farm-scale plants enjoyed a revival during the 1990s with almost 17 plants constructed, culminating in 2001-04 with 36 units sold - the vast majority by DBT. In accepting the DBT applications, the DEA also accepted the ratios claimed by DBT.

Albeit using only a few empirical examples, the story demonstrates the complexity in framing market encounters that allow agencies to perform valuations of goods and complete transactions. It can be a process fraught with overflows and controversies. With this story, we dug much deeper into the socio-technical fabric of the market encounter to analyze how the individual values such as maintenance cost and biomass ratios were framed and eventually accepted to allow for agencies to transact with biogas plants. Much like everything else in biogas markets we see how values are never a priori established according to universal formulas. Rather, to frame these in market encounters is a complex framing task on its own right which includes different algorithms, calculations, and devices. It is also process that bound with materiality.

The process is a struggle in the very sense of the word. Whether framing the cost of maintenance or framing blacks as eligible for construction grants, the process is a fragile and controversial endeavor on its own right. What is the maintenance cost or the manure/industrial waste ratio of a Blacksmith plant? In calculating these different arguments, parameters, datasets, and algorithms are mobilized creating vastly different outcomes. Hjort-Gregersen and Tafdrup enrolled data from centralized plants. Aboagye-Mathiesen data from the Blacksmith plant. Similarly, we saw different parameters and algorithms used to estimate these values. When Aboagye-Mathiesen applied for public construction grants Tafdrup estimated a 80/20 ratio as an indicator for when biogas plants become economical whereas Aboagye-Mathiesen used a 92/8 ratio. Once again, different datasets lead to different results.

But as we see the outcome to these conflicting valuations and thereby the value put on display in the market encounter was eventually determined, not by the calculation itself but other actors enlisted in the market encounter frame. Aboagye-Mathiesen himself played a key role in framing and organizing the market encounter. Whether agencies were eventually exposed to Hjort-Gregersen's or Aboagye-Mathiesen's calculations or whether Aboagye-Mathiesen and his group of customers eventually arrived at a peaceful outcome with Tafdrup from the DEA was influenced by more than sheer calculations. For instance, Aboagye-Mathiesen's 'pulled rank' and dominated how the market encounter was framed afforded by his superior access to the Blacksmith plant. A key part of this accomplishment was to prevent Hjort-Gregersen's calculations from entering the market encounter thus avoiding conflicting valuations and ambiguity in farmers' valuations. In other words, actors vital for market encounters to function such as the maintenance cost or construction grant is the outcome of framing processes and not the automatic outcome of calculations based on universal pricing mechanisms. As Stark notes, there are no final settlements, no single optimal metric; there are only clashes through which new values emerge (Stark, 2009).

Eventually, it appears Hjort-Gregersen's original premonition came true.

> "Today, I can see from the data that I was right. The economic outlook George presented farmers with was way too optimistic. In fact, many of his plants are today running at a deficit. Both because the cost of maintenance was not

> included to begin with but also because the plant relied in constant access to industrial organic waste to maintain a high level of gas production. His Blacksmith plants have vacuumed the country for industrial waste, so now we see something new. Now we have waste traders. These people work as middle men by locating waste and selling it to biogas plants at a premium, making life even more difficult for plant owners. They economy is sensitive enough as it is." (Hjort-Gregersen K. , 2007)

The economic outlook for the Blacksmith plant did not adequately reflect reality. From the outset, Blacksmith plants failed to turn a profit. Cost of maintenance far exceeded Aboagye-Mathiesen's economic outlook and the plants required larger than expected quantities of industrial waste to maintain sufficient gas production; a situation which deteriorated from the rapid expansion of Blacksmith plants, driving up the price of industrial waste. What this demonstrates once again, is that it is difficult for agencies to perform credible valuations when the numbers themselves fail to confirm that the good was able to deliver on the good intentions.

2.3.3 Summary: A Multitude of Ill-Framed Biogas Market Encounters

The stories of this section have illustrated some of the work it takes to frame a biogas market encounter. It appears, for demand and supply to meet each other is no random event that automatically takes place. Even if the good is pacified, and the market contains highly capable agencies, the market can still fail to emerge and stabilize if the encounter does not facilitate this meeting, allow transactions to be completed, and convey individual values agencies perform valuations of. These must also be framed and organized – from framing values such as maintenance cost to framing elements such as the construction grant required for transactions to take place.

One vital part of the encounter is often represented by demonstration plants or other actual biogas plants. Because they double function as the physical market encounter, to frame this physical encounter can be compared to the efforts needed to pacify a biogas plants. If we look beyond GFE and recall the outcomes of previous attempts to pacify biogas plants, we can see that biogas markets contain a multitude of encounters. As biogas plants proliferated so did the number and variety of market encounters. There is a GFE encounter, farm-scale encounter, VEP centralized plant encounter, Øllgaard plant encounters, etc. Due to the unique setup of biogas plants setup almost every new plant evolved into an individual market encounter. At times discerning them can be difficult. To perform valuations agencies are compelled to inspect many plants of interest, each with a different performance, setup, production principle, and economic and environmental performance: centralized or farm-scale, all-inclusive GFE systems or biogas production only, with or without a separation unit, high-tech or low-tech separation unit, degree of regulatory compliance, manure-based production or in combination with industrial waste, etc. The 'common' characteristics of each plant are intrinsically tied to the situation of each farmer, hence are difficult to duplicate.

As both the GFE as farm-scale plant demonstrated, for farmers or biogas contractors to perform valuations, make an informed decision, before finally reaching the cashier to complete the transaction involves performing valuations of the biogas plant itself. As we witnessed the maintenance cost, manure/industrial waste ratio, or other relevant value of a biogas plant is the outcome of a fragile and controversial framing process. This is a crucial point, which separates the marketization and framing/overflowing literature apart from the classic approaches described in theoretical review, which takes this for granted. What constitutes feasibility, the price, cost of operation, and overall 'sensibility' is not a priori given but a highly fragile and controversial subject which involves different algorithms, datasets, materiality, and human actors. In other words, to peacefully determine the terms of a transaction framing these values is a complex framing task on its own required for each of the multiple market encounters As it turns out the value of both GFE and Blacksmith plants turned out to be 'false' as they all failed to deliver on the good intentions and underlying values. The market encounters analyzed in this section is anything but well-framed.

The ill-framed characteristic was also made evident by the transactions themselves. Having completed the valuation and decided which plant to purchase, a farmer cannot simply purchase the plant and begin plant construction, but must first obtain a variety of approvals. Continuing with the super market metaphor to structure our understanding of biogas market encounters, for encounters to function satisfactorily requires them to render transaction possible whereby ownership is transferred from seller to buyer. Imagine that in 1973 the market encounter consisted of a relatively simple rendezvous between a single farmer and the local blacksmith to determine whether a biogas plant was worthwhile. This involved a few handmade blueprints and calculations. To this we can add regulation, calculations, metrics, metrologies, labs, many forms of biomass, VVM-studies, numerous public approvals and permits, and rounds of public hearing. And the list goes on. To construct a single plant in today's context the farmer (or group of farmers) has to navigate through many of these human-material check points organized into the socio-technical mediating algorithm of the biogas market encounter. Whether GFE and its customers are allowed to continue down the aisle is determined by whether they successfully frame and enlist a host of human and material actors. Additional 'check points' have been added to biogas market encounters in light of the overflows and controversies caused by biogas markets. As a result, the market encounter itself has grown increasingly complex to avoid and protect agencies from unwanted overflows from biogas markets. In fact, this analysis offers part of the explanation as to why the marketization of farm-scale plants was far more successful than for centralized plants in the same period. For instance, obtaining approval for a farm-scale plant is much easier than a centralized plant as it does not involve as many steps. The encounter is simpler and the distance to travel to complete a transaction is shorter. As a result, 34 new farm-scale plants were constructed in Denmark as opposed to a single centralized plant in the same period. The market encounter for centralized plants is more complex and more ill-framed.

To complicate matters further, the process of framing a market encounter is equally exposed to the presence of overflows and controversies over biogas, as the GFE story demonstrated. From framing the encounter itself, to organizing the transaction process, let alone to frame and agree on the individual values such maintenance cost is a fragile and controversial process. Historically, overflows and controversies from biogas pacification meant it has never been possible to provide agencies with a single uniform market encounter. In fact, as demonstrated in many cases market encounters do not exist but have to be constructed by in the first place by biogas suppliers such as GFE and DBT. What we end up with is a multitude of ill-framed biogas market encounters that can render it difficult for agencies to perform credible valuations and complete transaction of biogas plants, and as a result render it difficult for biogas markets to emerge and stabilize.

2.4 The Fragile and Controversial Nature of Biogas Markets

To ‘marketize’ biogas and deliver on the numerous good intentions of biogas has been no easy feat. Not only do framing goods, agencies, and market encounters in the case of biogas require an immense effort before the underlying socio-technical assemblage can emerge, let alone stabilize. They are also constantly subject to the everlasting presence of overflows and the controversies sparked by its very framing. Whereas each of the three analyses above was designed to demonstrate a unique analytical point and answer towards understanding the marketization of biogas, this section will attempt to deliver overarching explanations. Why have biogas markets more often than not failed to deliver on the good intentions, i.e. how can we understand the framing of biogas plants as an economic good? Specifically, how have overflows and controversies affected the framing and organization of markets and transaction?

2.4.1 The Fragile and Controversial Nature of Biogas Markets

Whether framing and assembling the socio-technical assemblage of goods, agencies, or market encounters the marketization process has been anything but straightforward. Time and again, biogas markets have been re-framed and re-assembled as a consequence of an almost perpetual tendency to overflow and sometimes spark controversies, which resisted attempts to be addressed and solved. In time, for every attempt to pacify biogas plants, frame agencies, and market encounters the inventory of addressed and unaddressed overflows and controversies grew. Although biogas markets have enjoyed a period of relative stability, biogas markets have consistently experienced difficulties in avoiding or adequately reframing overflows from at least one of the three assemblages.

One significant problem has been to pacify biogas plants by successfully framing a predictable technological good thus allowing it to deliver on environmental, economic, technical, and socio-economic merits. To transform biogas from an idea and thing into a good has from the outset required a massive scientific, material, technical, and political efforts and investments. In particular, the manure resisted attempts to bring it under control and frame it into the socio-technical assemblage needed to transform it from thing to a commercial good. Just as the contours of biogas was emerging it changed purpose, or adopted an additional purpose which re-configured it and made what little was stable turned unstable again. Technical and economic overflows meant it failed to be domesticated. When pacification for whatever reasons was abandoned, overflows and controversies still remained waiting for the next round of pacification to take place. The continued reframing of its characteristics often made it difficult for customers to identify it as 'biogas', with predictable features and performance thus allowing agencies to plan actions. In a way, it has always been 'under construction' and fluid providing limited stability upon which to pacify biogas or spawn other types of biogas plants. Compared to the simultaneous development of wind power in Denmark we see a markedly different situation. Seen from the perspective of pacification its core technological 'base' has remained relative stable and pacified upon which to pacify future versions of wind turbines. As Karnøe displayed (Karnøe, 1991), at one point the wind power industry developed the three-bladed dominant design of wind turbines to which all wind turbine manufacturers still adhere to today. At least from this perspective that is where biogas has struggled. And if agencies are unable to qualify it, or agree that is has value market making becomes extremely difficult.

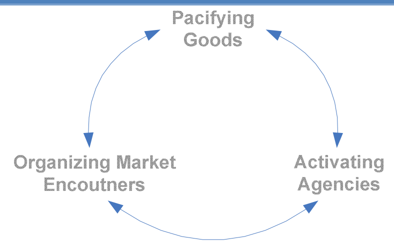
However, it takes more than a pacified good to create a market. Just as key agencies - from farmers and grassroots to local and state governments - thought they could stabilize preferences, plans actions and easily recognize biogas, overflows and controversies unfolded in effect temporarily pausing further action, or possibly thwarting action all together. As plants began to technically overflow, local communities rejected them, or new political regimes saw little worth in biogas. In time biogas became increasingly associated with negative connotations which made performing valuations even more controversial and difficult to agree on. When biogas pacification is reset, so are agency properties, previous valuations of biogas, qualculative capability, and ability to dominate or be excluded all together. At the same time and unaffected by the pacification process, powerful agencies and alliances can also overflow and loose its qualculative capabilities and dominating role in markets causing markets to collapse. This was evident in the late 1990s in which fundamental changes in the agency organization rendered a pacified good invaluable following the energy market privatization. My point is that not only do redefinition and re-pacification of a good have consequences for the pacification of the good itself but markets also rely on the parallel framing of agencies to "catch up" and re-perform valuations according to the good itself.

The same type of fragility and controversy also made *market encounters* anything but simple to frame and assemble. The story shows that biogas plants as a good and market encounters were often embodied in the same socio-technical assemblage. As biogas plants proliferated so did the number and variety of market encounters. The constant changes in and overflows from biogas domestication meant it has never possible to provide agencies with a single uniform encounter. As a consequence, to perform valuations agencies are compelled to inspect many plants of interest, each with a different performance, setup, production principle, and economic and environmental performance. At the same time, market encounters have grown increasingly complex. As past overflows and controversies survive across space and in time, the market encounter has grown increasingly complex for customers to navigate. The process of completing transactions is organized around a number of actors that are sought protected from overflows e.g. the local communities. Consequently, the process by which agencies transact has in time grown increasingly complex. Simply compare the market encounters of 1973 to 2009. In 1973 the market encounter and process by which to transact consisted of a single farmer and the local blacksmith to determine whether a biogas plant was valuable. This involved a few handmade blueprints and calculations after which funds were invested and the plant was constructed. By 2009, that same process has been expanded to include hundreds of farmers, local and state politicians and officials, technical and environmental divisions of municipalities, the DEA, the EPA, local citizen groups, activist groups, environmental organizations, NGOs, agricultural organizations, biogas lobbyists, CHPs, natural gas companies, engineers and scientists. To this human agency we can multiply regulation, calculations, metrics, multiple forms of biomass, public approvals and permits. To construct a single plant in 2009 the farmer (or group of farmers) has to navigate through this complex market encounter. Adding additional 'check points' to biogas market encounters have been necessary in light of the overflows and controversies caused by biogas markets. And eventually, there is a high risk of not being able to complete the transaction. To realize the good intentions it is worth noting, that while the system is designed to protect others from biogas market overflows the fragile and controversial nature of biogas markets inadvertently prolongs the proliferation of biogas plants despite national intentions of doing otherwise.

2.4.2 Mutually Dependent Market Framing Relationship

Creating and stabilizing well-framed markets is made difficult not just by each form of framing, but by the relationship that exists between the three forms of framing in the marketization framework. An overflowing good can render market encounters and agencies' qualculative resources and valuations of biogas obsolete and useless. Sudden changes in agencies' valuations of biogas, such as when biogas lost all value as a solution to household waste production, can have similar damaging effects on the pacification. What emerges is that the three assemblages in biogas markets are mutually dependent as Figure 3 below illustrates.

Figure 3: The Relationship Between Framing Goods, Agencies, and Market Encounters



This expands our understanding of the fragile and controversial nature of biogas markets, which is not directly emphasized by Caliskan and Callon. They only argue that these three are necessary to the construction and stabilization of socio-technical assemblage of markets. Take for instance, how pacifying biogas can have unfortunate ramifications for the parallel framing of agencies or market encounters.

Constant redefinition and re-framing of a good also reset existing valuations, calculations, agency properties, balance of dominance and exclusion, etc. As demonstrated, it takes time and framing effort to configure agency capacities, much like it takes time to replace old habits with new ones. In addition to reframing existing metrological setups, agencies may discover that their current qualculative capability has been rendered obsolete by the fast pace of biogas technological development. Farmers' capacity for performing valuations may be inadequate because plants have evolved from personal energy production to small power companies supplying the public grid, organized in co-operations owned by hundreds of other investors with disparate interests. Or when environmental benefits became part of biogas capabilities. For each change in the socio-technical assemblage of biogas markets every agency may be compelled to reframe its qualculative capacity without which biogas may remain a worthless product.

What emerges from this conflict between goods, agency and market encounter is a dilemma. On the one hand, markets cannot function and create wealth without the continuous development, production, and circulation of new goods. On the other hand, markets cannot produce and circulate products without qualculative agencies or market encounters. I am not arguing against re-pacification of biogas technology, but underscoring that undertaking new developments entails a parallel re-framing of agencies. It becomes a challenge of striking a balance between stabilizing technology while developing it either with a new purpose in mind or towards enhancing and optimizing its existing state of pacification; a balance which is never the same, but constantly shifting depending on the nature of the overall assemblage including the set of overflows and controversies at any given time.

Similarly, there is a mutually dependent relationship between pacification and framing of market encounters. As seen biogas market encounters are many and complex socio-technical assemblage. When biogas 'goods' overflowed and were deemed impossible to fix, pacification restarted in new directions rendering existing market encounters obsolete. A pacified biogas plant allows agencies access through equally well-framed market encounters to perform valuations and plan actions. Meanwhile, the constant arrival of new overflows and controversies the socio-technical mediating algorithm grew in complexity adding more bureaucratic steps, permits, and procedures to the algorithm, in order to safeguard third party actors from the consequences of biogas overflows. This meant it became an increasingly complex and lengthy process for agencies to perform valuations regardless of whether biogas plant technology was pacified or not. Simply think of George Aboagye-Mathiesen who had to reframe the application to the DEA, when the minister decided to change the eligibility criteria in order for farmers to obtain public funding for Aboagye-Mathiesen's farm-scale plants. Or when the Danish government in the mid-1990s began the privatization of Danish energy markets which according to my sources made it difficult to calculate the financial feasibility of future biogas plants.

What we find, then, are two layers of fragility governing biogas markets. We can argue that markets are fragile due to an ability of goods, agencies, and markets encounters to overflow, just as Caliskan and Callon argue. Each human or material actor in these individual socio-technical assemblages is also a conduit for overflowing. But the story of biogas has revealed a second level of fragility based on the interrelatedness between the three forms of framing.

2.4.3 Multiple Ill-framed and Well-framed Biogas Markets

The story of biogas is a vibrant and exemplary study of the complexity in creating markets, and no matter how much consideration and thought is put into designing markets, they can and will overflow and spark controversies in ways we never would have thought of. There is no final solution, no system or network which can prevent technologies, agencies or market encounters from overflowing. No socio-technical market assemblage is the same, and it is temporary at best. In fact, what we end up with are multiple markets for biogas plants, one set of goods, agencies, and market encounters for each attempt to frame biogas in a certain way. The outcome of each attempt to marketize biogas plants was never the same. The outcomes were a combination of ill-framed and well-framed biogas markets: a market for the 'rudimentary' farm-scale biogas plants, a market for 'advanced' STUB biogas plants, a market for centralized VEP biogas plants, a market for centralized Øllgaard biogas plants, a market for centralized biogas plants based on household waste, a market for farm-scale Blacksmith plants, and more recently a market for centralized biogas plants with separation technology. Each market consists of its own good, agencies, and market encounters. In fact, the idiosyncratic nature of every single biogas plants compels me to entertain the idea that each plant is the outcome of an equally idiosyncratic biogas market. The question, however, is to what degree we can speak of well-framed compared to ill-framed markets of good intentions in the case of biogas. How well did biogas plants acquire the economic qualities for it to become an economic goods, and how well were they transacted?

One can simply try to compare a biogas market to any of the more well-framed markets such as shopping in a supermarket which makes the process of purchasing a relatively easy and uneventful process only rarely prone to overflow, let alone spark any controversies. Performing valuations and comparing different goods, making an informed decision, and purchasing goods thus finalizing the transaction at the cash register is easy. There is limited uncertainty. In the event of overflows or even a controversy, there are rules, legislation, procedures as well as courts of law to regulate disputes. A well-framed market is a market where repeating the same transaction is easy. Unlike the well-known markets that qualified beer, milk, and diapers as economic goods the marketization analysis reveals that biogas markets are predominantly ill-framed markets of good intentions. It is difficult and sometimes impossible to determine whether a biogas plant is a valuable solution. They are surrounded by controversy and marked by stories of failures. At times they have been difficult to construct, maintain, and keep financially viable in the long run as the plant broke down, production grants expired or significantly reduced. Politicians may waive support. And the process by which to obtain the plethora of permits from local and state agencies is equally lengthy and likely of failing. Overflows and controversies were not always reframed and resolved. Now that biogas plants can we characterized as pacified, and there is a strong agency in place for biogas plants in Denmark, years of overflows and controversies have meant that completing transactions is now a lengthy process and the outcome is highly uncertain. Taken as a whole, what we witness is that biogas markets in Denmark are anything but well-framed markets due to the constant presence of overflows and controversy. Having carefully tracked overflows and controversies over the past four decades only rarely were they reframed and resolved before the pacification was abandoned, agencies left the market, or market encounters were not able to facilitate the transaction. Fragility and controversies are not the core problem to markets. It is that overflows and controversies are ill-framed, i.e. that most often markets are not framed and organized in such a way that overflows are reframed and internalized into the functions of markets, and that closure is not accomplished with controversies, even if only temporary. The outcome, and this is crucial, is that for the majority of its life biogas markets have rarely been able to deliver on the good intentions for which biogas plants were conceived: from energy production, to mitigation of agricultural production, to reduction of greenhouse gases, to climate change mitigation thru biofuel production, along with the intentions of creating jobs and the next Danish export adventure. Granted, the 60-odd plants alive today are a testament to the immense framing effort of the past four decades. The stable marketization period from the beginning of VEPs until the last government research program ended in the late 1990s shows that it is possible to marketize biogas. The market was stabilized because pacification favoured organized action, agency properties and alliances were stable, and market encounters rendered transactions possible. Combined, the marketization of biogas succeeded and manure was transformed into economic goods that could be transacted. Markets were organized in such that overflows were reframed and controversies solved to the point of stabilizing the marketization of biogas. But as Callon argues, 'framing can function and survive only if there is overflowing'. It is one thing to try and prevent overflow and controversies, which this analysis has demonstrating is impossible and unrealistic; it is quite another thing to simply sidestep and ignore overflows all together. Ill-framed markets are not characterized by overflows and controversies per se, but by the lack of framing of those that become accepted as vital to be reframed and solved.

Currently, there can be no doubt that markets for biogas plants in Denmark are ill-framed markets of good intentions. Only a few plants are under consideration. The problem is a combination of things mainly that the ill-framed state of market encounters for centralized plants makes it very difficult to complete transactions with biogas plants. This raises the quintessential question of whether it is at all possible to transact with biogas plants in Denmark. How are biogas plants brought to life in the current ill-framed state of biogas markets in Denmark, i.e. do they really embody the theoretical description of ill-framed markets of good intentions?

3 Framing Transactions: Devices, Principles, and Resistance

Apparently, what we learn from the previous chapter is that biogas markets in Denmark are not adequately framed and organized to fully deliver on the good intentions of biogas. At least from a marketization perspective, the simple explanation is that the fragile and controversial nature, which for the most part remain unaddressed and unsolved, render these markets unproductive. Especially in its current state, they are markets of good intentions. The government expects 50 new plants to be up and running by 2020. It is not the end of the world. Even ill-framed markets are at times able to deliver by facilitating transactions or market exchanges to take place and eventually be completed although it may be a troublesome and risky endeavour. Simply because market encounters are heavily affected by unframed and unresolved overflows and controversies, we cannot automatically deduct that transactions are impossible to complete. Every biogas plant alive today is the outcome of individual transactions, uniquely framed and organized based on good intentions in spite of all the shortcomings of biogas markets in Denmark. According to Caliskan and Callon, the transaction is a key market characteristics which signals the end of a process in which ownership of given product is transferred from producer/distributor to the customer in exchange for some form of payment, usually money. It can be disentangled. And much like markets, transactions must also be framed; each transaction is the outcome of framing, overflowing, and organizing activities. Sometimes the conditions for completing the transaction may not even exist, requiring those involved to instigate the necessary framing themselves. In light of the fragile and controversial nature of biogas markets seen in the previous chapter, the question relevant in this chapter, of course, is how leading economic agencies engage in the process of framing and organizing a single biogas plant transaction. Is it a simple or complex task to transact with new plants amid fragility and controversy thus delivering the good intentions behind new biogas plants? What does it take?

In this chapter we retrace the steps of two such so-called *biogas frame-makers* and their attempt to use a host of devices to frame biogas plant transactions. Both face an identical challenge of constructing a new biogas plant to ensure environmental compliance to farmers. One failed, the other succeeded in completing the framing of the transaction thus raising the question how they framed and organized the transaction, and which *devices* were used to navigate the fragile and controversial waters of various agencies with disparate interests and so-called *evaluation principles*? The main argument is, that to navigate the ill-framed markets of good intentions biogas frame-makers towards completing transactions they are compelled to frame and organize the overflows and controversies accompanying the process. But to succeed in the competition to establish a superior valuation of biogas plants require devices configured to match the evaluations principles by which other disparate agencies perform their own valuations of the transaction, some of which put up a fierce resistance along the way. In fact, the analyses will demonstrate that because biogas markets are ill-framed the process of purchasing and constructing plants is anything but simple and organized. There are presumably many other explanations to the outcomes we are about to witness. This is merely one explanation in an attempt to broaden our understanding of how the good intentions behind biogas plants are realized.

3.1 When Biogas Frame-Makers Frame Transactions

Behind every transaction we find key agencies I shall denote biogas frame-makers. They spearhead the process of framing the socio-technical assemblages of the transaction which eventually transfers ownership of the plant over from producer/supplier to its new owner. It becomes disentangled. However, to reach this end the frame-maker must travel through the socio-technical mediating algorithm of the market encounter while maintaining among friends and foes in the local and physical landscape that the plant is valuable by whatever economic, social, technical, or political measures mobilized. Sometimes, the framing process may also include pacification if the existing good does not live up to the requirements of its buyer. And like so many other forms of economic activities such market transactions contain *devices* that aim at rendering them economic (Callon, Millo, & Muniesa, 2007). But sometimes devices are undermined by the distinct evaluation principles by which other agencies perform valuations and judge biogas plants by.

This section argues for a distinct theoretical framework to be used to the analysis of the two different transaction accounts. While adhering to the marketization framework and deriving its primary theoretical concepts from the Callon's dual notions of framing and overflowing, I shall augment with the notion of (market) devices and evaluation principles.

3.1.1 Framing Biogas Plant Transactions

On several occasions Callon has used the notion of transaction to define or characterize what he means by a market. Transactions resolve conflicts between various agents in markets by defining a price (Callon, 1998b). More specifically, the transaction indicates a negotiation of a contract between disparate agents such as producers, distributors, and customers. In the recent anthropology of economization framework (Caliskan & Callon, 2009), the transaction signals the end of a struggle between different, and sometimes competing valuations resulting in a price. Cochoy has used the supermarket to define a transaction which is the outcome of process whereby goods and money is exchanged and the customer can leave the store without leaving any further demands, rights or responsibilities (Cochoy, 2007).

Currently, Callon prefers to use the notion of disentanglement. From Callon's concept of framing we know each transaction also consists of a wide range of cultural and social histories, institutional setups, legislation, rules etc. in addition to the products, agencies and market encounters constituting the market making the transaction possible. Together these form the socio-technical assemblage of the frame which 'brackets' the outside world and governs actions that take place within the frame. Transactions result in the disentanglement of the good in question from the outside world, agents are formatted as economic and calculative agents, etc. However, transactions never completely sever the ties to the outside world, i.e. it cannot be completely disentangled from its cultural or legal relations. In criticizing mainstream economics for its inability to account for externalities, Callon argues that a transaction can have unintended consequences for other actors. Simply think of the transaction that constructed the Chernobyl nuclear power plant. No set of legal or technical entities could have prevented it from overflowing. In any transaction 'something' always passes on from the seller to the buyer, thus underscoring it cannot be completely disentangled from its source. As Callon argues, 'the simple fact of framing the transaction because it mobilizes or concerns objects or beings endowed with an irreducible autonomy, is a source of overflowing. Complete framing is a contradiction in terms.' (Callon, 1998b, p. 6). Transactions should be seen as the outcome of contestation and competing forms of valuation that produce actors and the rules under which transactions take place.

In other words, any transaction is always the temporary outcome of framing processes. It is never finally over. Simply think of the Skovsgaard and Helsingør plants from the first chapter, which were dismantled in the 1990s following local protests over odor leaks. At which point can we speak of a finalized transaction? There is always the possibility of an unsatisfied customer returning with a faulty product. As a result, it can be difficult to determine in the case of biogas plants what signals the end of a transaction. The key agencies pictured in this chapter operate toward different milestones which in turn change as the framing process overflows. One may target a building permit, while another awaits the first annual review of the plant. What they initially planned for can suddenly change dramatically setting new priorities.

In describing the market transaction, which key agencies attempt to frame in this chapter we must adhere to the same guidelines as in the previous chapter. Using overflows and controversies as main entry points, we cannot re-trace the socio-technical assemblage according to some preordained list of 'transaction ingredients'. Much like Latour's main argument (Latour, 2005), we must not conceive of the social as a given entity but rather that it is the social itself which requires explanation by asking how it is constituted by associations between human and non-human actors. Only by paying attention to agents and relations involved in any given assemblage can we claim to understand the assemblage itself. In the case of transaction, we must remain open and study the process by which the transaction is framed. As such, we cannot a priori determine which actor or device turns out to be significant in the process. Or a priori identify exactly the sources of overflows or controversies which may appear.

I therefore continue to adopt Caliskan and Callong framing/overflowing literature to understand the fundamental process of how the socio-technical assemblage of a transaction is framed and organized. To construct a biogas market transaction, that is to say to transform biogas plant into a valuable commodity, it must be 'decontextualized, dissociated and detached' (Callon, 1998b, p. 189). We can therefore assume the activities involved in transacting with biogas plants to be viewed as framing biogas plants as an economic good, enlisting actors and 'things', assembling them, while keeping the frame from overflowing amid competing valuations and frames of biogas..

3.1.2 Biogas Frame-Makers' Framing of Transactions

At the heart of framing and organizing the fragile and controversial transactions for biogas plants we find a certain group of people. They are not always traditional market players, such as biogas salesmen or contractors. They can include farmers, mayors, and other often unconventional market players interested in benefiting from the alleged merits of biogas plants without whom, plants would never materialize in the first place. On behalf of other agencies they attempt to capitalize on good intentions and construct new biogas plants. In 1981, Latour and Callon coined the term macro-actors or 'the big Leviathan', a term still in use by ANT researchers to conceptualize those who translate other actors' wills into a single will for which they speak (Callon & Latour, 1981, p. 277). The framing process can therefore be seen as comprising many instances of Latour's notion of *translation* which involves all the framing, negotiations, intrigues, calculations, calibrations, and acts of persuasion 'and even violence' (ibid) by which associations are created and actors enlisted in frames. To use a more accurate description of these Leviathans from Callon's later perspective of framing/overflowing, I turn to Beunza and Garud who identified so-called frame-makers. Beunza and Garud (Beunza & Garud, 2007)studied the role of analyst reports used by securities analyst in performing valuations of the value of stocks. They demonstrated that reports are structured by 'calculative frames' and present analysts as 'frame-makers' thus contributing towards understanding the role of controversies in performing valuations of goods which are ill-framed while inviting a prosthetic view on frame-makers. Likewise, biogas frame-makers play a key role in framing a biogas plant from an idea, a concept into an actual living socio-technical assemblage amid competing valuations, fierce resistance and controversies over biogas. Rather than making a similar demonstration in the case of biogas, Beunza and Garud's work is a starting point. Amid similar competing valuations of biogas plants, the question relevant here is how biogas frame-markers frame the value of biogas plants using various forms of devices in an overall pursuit of the transaction?

At this point, my savvy critics will question how I as a constructionist and ANT-practitioner can stress the individual actions of biogas frame-makers. Does that not infringe on the distributed characteristic of action in socio-technical assemblages? As a fundamental pillar in ANT, action is something that is shared and distributed between a wide range of actors - from humans to material actors such as machines, tools, signs, documents, or architectural elements. In my view, following the *actor* as opposed to *actors* does not compromise this fundamental piller in ANT. I have previously referred to Hargadon who demystified the grand technological achievements by Thomas Edison and Henry Ford who have become synonymous with the incandescent light bulb and assembly line, respectively. Instead, by retracing their steps Hargadon identifies how such technological breakthroughs are the outcome of Edison and Ford bringing existing people and objects together with new ideas. The family resemblance to Latour's idea of action distributed across human and non-human actors is striking. Similarly, there is nothing conceptually illegitimate in granting centrality to biogas frame-makers. They 'pull the strings' and play an instrumental role in framing, enlisting actors, and assembling the host of material actors they deem necessary to include in the frame. I shall explain more on the methodological implications in a subsequent section.

3.1.3 The Role of Devices in Framing Biogas Plant Transactions

What is required here is a framework capable of shedding light on the devices which biogas-frame deploy in the framing process thus expanding our knowledge of who these frame-makers are, and what they do. In this regard, Callon and other colleagues have also introduced the notion of market devices. Market socio-technical assemblages are cluttered with a variety of such devices including the various sorts of technical and material instruments that intervene in the (re)shaping of economic markets (Callon, Millo, & Muniesa, 2007; Callon & Law, 2005; MacKenzie, Muniesa, & Siu, 2007). The central question is how devices participate in the economization process, i.e. how various forms of market devices renders something 'economic' in the first place. The book *Market Devices* highlights several features 'on the material composition in the achievement of purchase or transactions' (Callon, Millo, & Muniesa, 2007, p. 10) by exploring a variety of devices, such as pricing models, indicators, charts, merchandising tools, and supermarkets. Similarly, the previous chapter on framing biogas markets showed a host of devices. Economic, technical, scientific, environmental materially mediated inscriptions of biogas are the cornerstone of biogas markets often used to support qualitative arguments for/against biogas, cause agencies to change valuations, interests in biogas, and not to mention valuations of biogas.

Yet, devices are not just devices. Much like any other actor they are not assumed to exist a priori. Calculating and establishing credible measures for whether biogas is economical or not is a contested and 'hot' matter. There is always room for negotiation and even fraud in determining value. In other words, we must keep in mind that devices, e.g. calculations in a spreadsheet constitute a fragile socio-technical assemblage on their own right which must be framed and re-framed. The outcome is never given. At least seen from this perspective, calculations can be the most pervasive forms of power and are central to establishing the value of the goods in transaction.

Related to the specific economic instance of framing biogas plant transactions, devices include those deployed by biogas frame-makers as part of persuading actors of the values of biogas plants whereby actors are enlisted into a specific frame, as well as the organizing and assembling of the underlying socio-technical assemblage which eventually constitutes the transaction. Against competing valuations of biogas plants devices can also be used to counter the effect of devices deployed by others as part of counter-framing. Devices thereby become part and parcel of the transaction, co-constructing and affecting others when others translate the devices. They are performative in the sense that their application has an effect in the course of the translation, i.e. these devices do not just mirror reality but are constitutive of it. By analysing such devices we can observe their constructive role in framing transactions, configuring other agencies' calculative capacity and by inference enlisting whatever support biogas-frame makers considers vital in securing the transaction.

3.1.4 Evaluation Principles Influence Devices

Callon has several times indicated that devices and metrologies are essential to reframe the inevitable presence of overflows. In fact, framing is a costly matter because it requires the mutual framing of devices and metrological setups to reframe overflows, as we have seen countless times in the pacification of biogas plants. Even in his latest piece with Caliskan he notes how agencies who fail to frame a sufficiently powerful material agency will eventually cease to exist in the market. But as we have also witnessed, far from all overflows and controversies are 're-frameable'. Controversies over biogas can mobilize personal feelings and attitudes with no particular technical, political or scientific merit. Such resistance is not necessarily subdued or reframed even by the most costly and advanced metrological setup. While they have a special interest in preventing biogas transactions from taking place, the idea of 'interest' does adequately explain why costly and advanced devices sometimes fail to reframe an overflow or settle a controversy by convincing the opposition. To understand how biogas frame-makers' devices are sometimes rendered less effective in intervening on behalf of the transaction, I shall augment with David Stark's notion of evaluation principles.

David Stark is particularly inspired by Boltanski and Thevenot who demonstrate there is not just one way of making value but that modern economies comprise multiple principles of evaluation. These involve systematic associations of ideas (Stark, 2009). Market making is seldom the outcome of a single agency isolated from others, nor a single way of calculating or interpreting the worth of technologies. Defining what is 'good, the just, and the fair' is done according to different criteria of judgment which qualify qualifies persons and objects with a distinctive grammar or logic (Stark, 2009, p. 23).

Boltanski and Thevenot show 'how each of the multiple principles of evaluation entails discrete metrics, measuring "instruments," and proofs of worth objectified in artifacts and objects in the material world' (ibid). To apply tools and metrics, to calculate and profess the worth of biogas vis-à-vis others also involves judgment, i.e. to take a position and commit to a course of action or argument entails being attached to a valuation principle and its affiliated instruments; a point Stark and Beunza (2009) also extracted as they found how arbitrage traders not only use tools and metrics, but also use a distinctive set of evaluation principles by which they identify new ventures. And from Starks field research in Hungary he became predisposed to the idea that organizations are settings where multiple principles of evaluation are at play which led him to see the mix of evaluation principles as creating uncertainty and therefore as opening opportunities for action. Similarly, biogas scientists may see the world in a different light than politicians and farmers, or lobbyists who may very well be governed by other valuation principles. Although agencies may be organized around a dominant valuation principle and its array of devices for measuring, analyzing, and documenting, individual devices and evaluations principles are often pitted against those of others resulting in competing frames of valuations and valuation practices.

Chapter 3 - Framing Transactions: Devices, Principles, and Resistance

Adopting Stark's idea of evaluation principles fits very well with Callon's idea of the transaction as the peaceful outcome of struggle between different and sometimes opposing valuations. Markets become sites of contention, not only about the value of goods, but also about which evaluation principles to perform valuations of biogas with. In time whatever frame is associated to technologies is an unpredicted human construction which cannot a priori be derived or extracted from any preexisting 'natural' set of human opinions, laws, or calculations. No pragmatic one-size-fits-all frame exists. It must be constructed by humans, including the devices they deploy and evaluation principles which govern their valuations.

As such, evaluation principles can appear in any shape or form. To illustrate how evaluation principles can render some devices ineffective in enlisting some agencies, I shall distinguish between two forms of evaluation principles borrowed from Porter (Porter, 1995). Objective versus subjective. An objective evaluation principle refers to criteria of judgment which qualifies persons and objects based on rational arguments substantiated by 'objectivity', logical reasoning such as quantified scientific, technical, and economic arguments. Such claims are usually presented using particular devices such as Excel spreadsheets, calculations, etc. A subjective evaluation principle is more emotionally laden reflecting personal sentiments. They do not need statistical of scientific rational arguments to maintain certain claims, and will also resort to devices such as petitions, letters, demonstrations, or a simple phone call to a local representative. It is vital to stress, that each form of evaluation principle can be equally powerful. It depends on the particular situation of which they are apart.

A relationship between framing/overflowing, devices, and evaluation principle is therefore expected to exist. Any device used to frame biogas plants for transaction is translated differently by those involved because they are governed by a distinctive set of evaluation principles; principles depending on the assemblage of this they are part, which can either lead to their enlistment or an undermining of the device. Devices and their interpretation are therefore not purely individual and asocial but in fact distributed across the human and non-human agencies and instruments enacting the market (Stark, 2009).

Chapter 3 - Framing Transactions: Devices, Principles, and Resistance

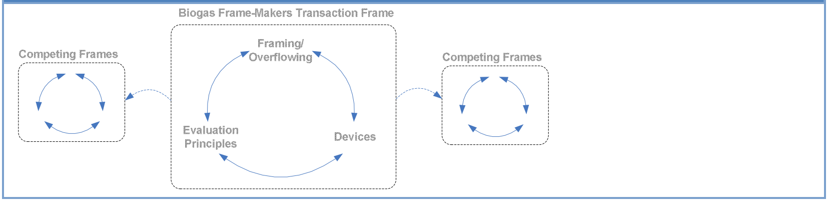
The idea of augmenting the framing/overflowing and market devices with Stark's notion of evaluation principles is to provides a more nuanced and productive way of thinking about devices in framing biogas plant transaction, as it may be able to address why some devices fail to intervene and ensure a successful framing or enlistment of a specific agency. Framing and organizing a transaction, as we shall see, is not simply embedded in socio-technical assemblages, distributed across humans and material devices. Framing and organizing is also distributed across and part of the cognitive aspect here referred to as evaluation principle.

Callon has argued that framing is difficult, complex, and expensive and that in the absence of sufficiently powerful devices framing cannot be completed. I am not accusing Callon for arguing that 'bigger is better', but from my interpretation of Callon the issue of why devices are sometimes rendered ineffective still require more work. In other words, while we must acknowledge Callon's point that devices are essential in the economization of goods (Callon, Millo, & Muniesa, 2007) we must simultaneously acknowledge the existence of evaluation principles which agencies deploy in translating whatever argument or claim devices set forth. Both are present in framing and when pitted against one another in competing frames of valuation, evaluation principles can provide an answer to why devices are sometimes rendered ineffective.

In combining framing/overflowing literature with the notions of market devices and evaluation principles I have outlined a simple theoretical framework for the detailed study of how biogas frame-makers frame the fragile and controversial transactions of biogas plants. More specifically, the framework allows me to analyze how biogas frame-makers frame the biogas plant transaction by deploying various transactions devices to frame the host of human and material agencies deemed necessary in the frame.

What we end with is a framework consisting of the biogas frame-makers' frame underlying the transaction, and one or more competing frames as the outcome of resistance to the biogas plant from different agencies, as depicted in Figure 4 below.

Figure 4: Conceptualizing Framing/Overflowing, Devices, and Evaluation Principles



I have supersized the transaction frame in the middle to underscore that the focus is on the biogas frame-makers, while dotting the line of the frame to stress the incomplete nature of framing and actor's associations and entanglement with the 'outside' world. Framing, devices, and evaluation principles are constantly co-produced by their existence in the socio-technical assemblage. Devices and evaluation principles can undergo transformation as a result of being associated with others much like people can change interests. In applying the framework to biogas markets, with its multiple frames, agencies, devices, and evaluation principles we can pinpoint and understand the various forms or sources of resistance frame-makers encounter along the way from being exposed to competing frames. Is resistance enacted by a particular agency, device, evaluation principle, or a combination? Perhaps, it is the ill-framed nature of market encounter or lack of pacification that makes up the resistance?

3.1.5 Methodological Considerations

The fundamental meta-theoretical and practical steps taken to construct this second analysis is identical to those previously described. Based primarily on interviews with biogas frame-makers, archival studies, and other material I have retraced the framing/overflowing, devices, and evaluation principles according to the framework described above. As such, I have completed an identical qualitative content analysis by coding data in search of framing/organizing activities, devices, and evaluation principles as part of organizing these controversial transactions.

Following the same approach as in the first main analysis, I have detailed the human and material entities of the socio-technical assemblages of the transaction across time, while keeping an inventory of overflows and controversies. As events unfolded, overflows and controversies have been marked as reframed and temporarily solved should that have been the case. The inventory serves a vital role in keeping track of the perpetual reframing. Using the framework described above to analyze the data I have been searching for various forms of framing activities, use of devices such as documents, speeches, calculations etc, and evaluation principles. The material components made up by devices have previously proven abundant in biogas markets. We can expect the type of market devices most often involved in framing biogas transactions to include analyses, reports, Excel spreadsheet, numbers, charts and other technical documents combining qualitative and quantitative re-presentations of biogas plants, as well as field trips or town meetings. The search criteria for devices is whether they help biogas frame-makers (re)frame the host of human and material actors required to complete the transaction. A vital part is the role of devices in reframing overflows and resolving controversies in an effort to enlist opposing actors that are nonetheless deemed vital by biogas frame-makers. With regard to evaluation principles these are particularly difficult to empirically ascertain. In Stark's work on evaluation principles he did not provide specific guidelines to identifying evaluation principles, only by the examples of his own work. I shall attempt to code statements and claims in search of evaluation criteria in accordance with the objective/subjective dichotomy previously expressed. For instance, arguments with scientific and economic merits are considered objective while expressions of 'not-in-my-backyard' are considered subjective.

The two transactions stories have been selected because 1) they have been framed under the recent ill-framed biogas market in Denmark, and thereby have had to navigate among overflows and controversies, 2) hence data is easily accessible, 3) they have continuously been cited by my informants and appeared in my data as particularly controversial and difficult to complete, and as a consequence, 4) they are expected to stress some of the greatest contemporary biogas marketization hurdles. The common empirical denominator in both cases is the interest in building a centralized biogas plant. Both stories take place in regions of Denmark with a high concentration of agricultural production, livestock in particular and thereby also an equally high production of manure. The third Marine Environment Act from 1997 calls for significant reductions in the phosphor and nitrate contents of manure. Failure to comply meant farmers would need more agricultural area (the area and harmonization area requirements) to maintain current production or be forced to downsize. Keep in mind, that the environmental regulation from the mid-1980s remains in force to this day. The so-called livestock unit and harmonization requirements directly regulated the extent farmers could expand livestock production as a measure of the available arable land. The more livestock, the more manure was also produced, but as regulation dictated only a certain amount of manure was allowed per hectare arable land meant farmers were prevented from increasing revenue. And in 2004 a revised act instituted even further reduction targets. The rule was, unless farmers complied they were not allowed to expand livestock production which was exactly what the farmers in the two accounts were interested. In other words, it was the livestock unit as a metric which framed manure as the primary overflow which someone had to successfully reframe. Livestock expansion is of particular strong interest to Danish agriculture amid increased national and international competition with Eastern European agriculture. In both accounts, it was agreed that a centralized biogas plant was the preferred solution. In addition to expanding livestock production revenues would be generated from selling the biogas to the local CPH currently running on fossil fuel. All in all, both transactions are designed to deliver on localized good intentions.

In describing it from the perspective of biogas frame-makers, it may appear as if I am idealizing them as the salt of the earth or emphasizing the sacrifice for others their work to some extent entails. Sacrifice does indeed occur - the personal and financial risks during the lengthy process come to mind. The object is not to normatively illustrate that this particular analytical framework is well adapted to the study of how fragile and controversial transactions are framed and organized. Rather, much like the marketization framework it allows us to explore and describe how biogas plant transactions are framed in the first place, or rather how transactions are the outcome of a framing process. Once again, it is vital to stress, that the idea is not pass judgment, highlight wrong-doing and human failures, or even to reach a conclusion on why one transaction failed while the other succeeded. In short, I have no normative ambitions for this section, but merely a descriptive and exploratory one much like in the previous analytical chapter.

In doing so, however, I am providing their version of the story rather than 'both sides' of the story. I do not wish to argue the usual 'insufficient time and resources'-disclaimer, although it partly applies to this situation as well. Time and geography has not allowed me to gather data from other frame-makers or rivalling agencies. Some will undoubtedly consider these accounts as inadequate, especially in terms understanding why a specific counter-claim was issued by other actors than the frame-makers during a controversy. If I was interested in understanding the reactions and counter-claims by others, for instance to understand the overall controversy dynamics, both sides of the story are required. But the purpose is to understand how frame-makers, and those they collaborate with, go about framing biogas plant transaction. As part of this, we need to understand how others reacted and framed biogas. But understanding *why* other agencies acted and deployed a specific device, for instance to prevent the transaction from taking place, is not of interest in this analysis. In fact, including an analysis of their actions, use of devices, and evaluation principles would be counterproductive to the task at hand as it would distort the analytical focus on biogas frame-makers. Another reason for constructing a one-sided account is to make it realistic. The two biogas frame-makers did not have the luxury of knowing what the other part knew, what devices they would deploy, let alone what evaluation principles governed their thinking. They could only speculate.

We begin by taking a look at a controversy over the location of Denmark's then-largest centralized biogas plant in the village of *Brædstrup*, where socio-economic arguments can be undermined by local citizens who demand biogas not be placed in their backyards. Why were local citizens and city council not persuaded by the frame-makers' 'objective and scientific arguments often backed by numbers, charts, tables etc? In addition to attending to the process by which transaction are framed, devices and evaluation principles are of particular interest in the first story. Next, we follow in the footsteps of the most recent attempt to construct the world's largest plant in an area called *Maabjerg* near the city of Holstebro in Northern Jutland amid a decade long battle to overcome multiple regulatory and legislative controversies. Despite experiencing almost every conceivable setback, how was it possible for this frame-maker to enrol the Danish and local government on countless occasions to complete the transaction? Once again, framing activities, devices, and evaluations principles are central but this account can explain how resistance to biogas plant transactions is not only constituted by opposing political and local agencies, but in the very way frame-makers have to frame and organize transactions. We start out with Brædstrup to demonstrate the relationship between framing, devices and evaluation principles, followed by Maajberg because it stretches on for the better part of a decade thus extending itself to demonstrate various forms of resistance built into the ill-framed nature of biogas market. Eventually, the idea is to analyze both accounts, to explore different ways of framing and organizing biogas plants transactions amid the fragile and controversial nature of ill-framed biogas markets.

3.2 Devices and Evaluation Principles at work in Reframing Overflows in Brædstrup

The proposed biogas plant in the small town of Brædstrup on the Jutland peninsula was to become the first centralized biogas plant in Denmark since 1998 and thereby break the stalemate in biogas market activity, which had lasted since the 1995-electricity reform. Between the farmers in this high density agricultural area, they could muster some 34.000 tons of pig manure and 66.000 tons of cattle manure every year. If successful, it would become the largest plant in Denmark. However, as we shall soon learn framing a biogas plant transaction is no easy feat; even after two years of framing a biogas plant as an economically valuable good among various actors in Brædstrup the biogas frame-maker still had a long way to go. Despite embarking on a journey that should eventually complete a transaction this particular transaction never got that far. Firstly, with this story I want to demonstrate that knowing who or what is 'vital' to frame or reframe into the socio-technical assemblage of the transaction cannot a priori be established. Similary, it is impossible to identity overflows a priori and that it may resources for overflows to materialize as overflows. Secondly, but equally important I shall demonstrate that in addressing overflows and controversies as part of (re)framing biogas plants for transaction is a process determined by multiple devices and evaluation principles. Specifically, the deployment of devices towards framing other actors as part of the socio-technical assemblage of the transaction can easily be undermined by the evaluation principles by which other actors determine whether the transacted good is valuable or not.

In the mid-1990s a small group of farmers, biogas experts, and a member of the city council was organized, which decided to solicit an economic feasibility study in 1996-97 from the biogas consulting agency PlanEnergi. The study concluded that the economic outlook was too fragile due to a marginal annual surplus of only DKK 63.000 which left little room for unexpected expenses. The project was temporarily shelved pending improved conditions, as farmer's needed more financial leverage. When the government increased the production grant for biogas production in 1999 farmers solicited an updated feasibility study from PlanEnergi in August 2000. This time, the analysis suggested a ten-fold increase to DKK 648.000 annual surplus. At the same time, the price on natural gas was soaring from increased demand making biogas an attractive alternative to the local CHP using natural gas. Finally, the county could apply for an EU construction grant on behalf of the farmers. Word of the analysis quickly spread among the community's extensive population of farmers, of which 27 enlisted their support by signing letters of commitment. Interest was high and preliminary studies looked promising but further studies were needed (Horsens Folkeblad, 2000).

In November 2001, the farmers and PlanEnergi completed detailed studies of the technical and environmental challenges. In December 2001, the Danish Energy Agency (DEA) allocated DKK 100.000 for the preliminary feasibility study. It would determine the amount and whereabouts of available biomass, support among farmers, demand for biogas in local municipality and CHP plant, but also to measure the public attitude towards a biogas plant (Landbrugsavisen, 2001). Building individual farm-scale plants (especially those from DBT) had proven too difficult, consumed too much time out of an already long daily work schedule for farmers. Instead, a centralized plant was considered the only alternative along with a separation unit to separate the dry fraction. The farmers were not environmentalists in the idealist and 'greenish' sense of the word, and none of them were investing money simply for the greater cause of mitigating environmental pollution. Farmers where above all directed by a set of objective evaluation principles and had been enlisted in the transaction by a host of similar devices such as calculations and spreadsheets. To them, 'value' was based on quantitative measures and whether the plant secured regulatory compliance.

In February 2002, 50 farmers committed to the project after meeting to discuss the latest results. They remained enlisted by the set of devices, from which it appeared the plant could economically secure regulatory compliance. It was therefore decided to establish the Brædstrup Biogas Company to undertake the remaining tasks and assume ownership of the plant once it was constructed. Much more work lay ahead and a leader had to be appointed to assume the numerous and varied tasks of completing the transaction. Successful framing required close interaction with local and county governments to obtain construction permits, environmental approval, and most importantly: approval of a construction site. This was a time-consuming and lengthy process requiring a number of environmental studies, city council sessions, public hearings, etc. What the farmers needed was a leader with the proper abilities and political insight. To assume the principal role of biogas frame-maker, they appointed Preben Andersen, a prominent local pig farmer and former mayor of Brædstrup, and member of city council and later member of the regional council.

The challenges and potential sources of overflows were plenty and complex for our key frame-maker. He had to locate and enlist a source of industrial waste to boost biogas production by negotiating the delivery of organic waste from a viable source. There were talks of approaching the local poultry plant and the nearby Danish Crown butcher plant scheduled for completion in the near future. There were also a number of technical issues to address such as deciding whether to produce electricity on-site or send the gas by pipeline to for consumption at the local CHP plant. To avoid sparking protests from the local community it was believed that by constructing the plant as a 'closed system' and installing odor reducing equipment the concern over odor was fully addressed. And as the goal was regulatory compliance to expand livestock production, the plant would also feature a so-called separation unit to separate the phosphor and prevent it from polluting the water ways. However, this made it necessary to identify ways of discarding of it afterwards.

They also needed to find a suitable construction site in the area for the plant, weighed against several parameters, least of all the logistical challenge of transporting large quantities of manure to the centralized plant. Its sheer size demanded numerous daily transports, which was a major cost driver in the economic prospect. Other site parameters included distance to nearby neighbors, underground pipeline distance to the CHP, plus numerous other legal and regulatory issues which all required the approval by the local and county authorities.

From the outset, Andersen had inherited an already powerful frame which appeared to find widespread support from other agencies needed towards completing the transaction. At this stage, the frame consisted of 50 farmers enlisted constituting a core agency. It was from the same agency Andersen raised funds to finance much of his preliminary work. Biogas contractor Bigadan was engaged in March 2002 to assist. A DKK 6.5 million construction grant was also allocated by the DEA following an application from Andersen. At the same time, Managing Director of Brædstrup CHP, Per Kristensen, whose plant would consume the biogas (replacing half of the consumed 7.5 million cubic meters of natural gas based on 300.000 tons of manure), was enrolled. He was a strong advocate of the biogas plant, and a firm believer in renewable energy having previously worked with renewables in the power sector before coming to Brædstrup CHP. Calculations indicated the expected price on biogas was competitive with the price on natural gas. In terms of framing the plant as valuable among its key constituents, Andersen was on the right track.

With much of the financial aspect secured in the frame, Andersen moved on to enlisting a suitable site the authorities would approve. Until a proper site had been found and approved, all other issues, however vital to success, were secondary to Andersen. It was an obligatory passage point on the way to completing the transaction. There were other currently unframed entities demanding his attention, such as locating organic waste, but he decided first and foremost to focus on finding a location. But as he took the lead in framing this part he had not imagined obtaining approval would escalate into a local controversy:

> "Well, we all knew it would be difficult. Not only creating an economically viable plant, but also with regard to the location. The problem is not so much in finding a site. In fact, as it turned out, there were several ideal locations [for the plant] in and around Brædstrup. From my insight into local and county political systems both from my time as mayor and as member of the city council gave me little hope that it would be easy. But quite frankly, not in my wildest imagination had I or anyone else for that matter, expected the location would turn into a battle." (Andersen, 2009)

Initially, Andersen knew obtaining an approval from local authorities could become difficult, but not impossible. If located to close to town he feared it would spark protests from the local community, because in the 1980s Brædstrup had constructed a number of wind turbines 'without paying too much attention to what the local community felt', as he phrased it. In the wake, they had protested to their negative effect on the natural landscape and the noise from wind turbines. They had overflowed. These past frames still lingered around in the collective mind of Brædstrup. As biogas shared similar features as a wind turbine it may reactivate any negative associations to the past. Located in an area of scenic beauty or in a sensitive natural environment this would require expensive and time-consuming VVM studies (studies of impact on nature) to determine the potential environmental damage in case of manure leaks. Located too far away, calculations would disfavor the project due to high cost of transporting manure.

His strategy was to use his extensive political network, ties to the farming community, and extensive knowledge of the region to identify suitable locations. Through meetings and phone conversations with the technical division of local authority he would measure potential opposition to a specific site and the likelihood of obtaining an approval before submitting an official application to city council. The technical division was responsible for advising and making recommendations to city council. As alluded to, Andersen had also identified local citizens as a key stakeholder. Enlisting these, Andersen saw as a matter of keeping them informed using devices such as public meetings and letters to the editor published in the local newspaper; both in response to any written protests published in the newspaper, but also as part of an ongoing information campaign.

3.2.1 First Attempt to Frame a Construction Site: The 'Virkefeltet' Site

Their first move was to purchase three hectares of land in the main industrial area of Brædstrup known as 'Virkefeltet' (Horsens Folkeblad, 2002b) north of Brædstrup. It housed a variety of business and factories, one of which was erecting a new office building. Because it was adjacent to industries as well a residential area within the 300 meter statutory limit it was imperative to control the odor. In interviews for newspaper reports, Andersen stated that if required, they would purchase an additional three hectares as a buffer zone. Per Kristensen, director of the CHP, had passed other biogas plants in his car with his head sticking out the window, and remained confident that state-of-the-art technology could prevent odor leaks. Odor, was therefore identified upfront as a potential overflow. The advantage of Virkefeltet was that Andersen would avoid a lengthy VVM environmental impact study as the area was pre-classified to operate factories. But using Virkefeltet for biogas production may not comply with the guidelines for operating in an industrial area. Using his close political ties Andersen informed the technical division of his intent to construct in Virkefelted. As required by law, a public hearing was organized among industries and neighbors of the Virkefeltet site. Especially two companies, Velterm and Nutrio were of interest because they were among the chief employers in Brædstrup and vital for its economic development. Unable to voice its 'own' opinion, Virkefeltet had acquired two key spokesmen speaking on behalf of it. Meanwhile, Andersen himself was concerned of how politicians translated the legal guidelines for operating in Virkefeltet, and whether that prohibited a biogas plant.

Meanwhile, news of constructing a biogas plant in Virkefeltet began circulating in the local newspaper, the *Horsens Folkeblad*, causing the first letters to the editor to appear. Although denoting biogas as an 'excellent idea' the first concerned citizen objected to the Virkefeltet site claiming that when the wind was blowing from a North Eastern direction 'we cannot avoid having all of Brædstrup covered in the smell from the plant.' His house was less than a kilometer south of the location.

Instead, he proposed that they 'moved the plant as far away from the city as possible' citing the Støring biogas plant near Aarhus, Denmark's second largest city as a proper example (Horsens Folkeblad, 2002c). But this was not the only protest. The mayor, Torkild Skifter, who succeeded Andersen in the 2002 county and municipal elections and several members of city council, also feared the future development of Brædstrup if the plant was constructed in the industrial area of Virkefeltet, originally intended for economic development and not for biogas production. For the mayor, it was crucial that the potential overflow was adequately addressed (Horsens Folkeblad, 2003a). According to my interview with Andersen, he knew the mayor was in favor of the biogas plant, but he begun to receive numerous protests by mail from local citizens protesting the location. Using such devices to present personal reasons a competing frame to Andersen's was gradually emerging, and its valuation of biogas was not a positive one. On the contrary.

As success depended on political approval of the plant, Andersen decided to organize field trips to biogas plants in Denmark, as a more direct way of enlisting the political agency. The idea was to frame a market encounter to allow them to perform valuations of biogas in sites carefully selected and organized. Farmers, agricultural advisors, and Bigadan along with the city council and the municipal office for technical affairs came along. Visits included the Fangel biogas plant on the isle of Fun because it was the only centralized plant in Denmark with a separation unit similar to the one Brædstrup Biogas would use to isolate the phosphor from the degassed manure. An identical team with Mayor Thorkild Skifter and members of the city council paid a visit to the Nysted plant on South Zealand to learn how they had constructed a plant in an industrial area, and thereby to see and smell with their own eyes and nostrils how a modern biogas plant could keep the smell under control and not overflow with odor. Despite a technical failure in the odor retention system and the backup system resulting in a significant pungent odor compared to normal operation, the delegation remained surprised that the odor was limited to the plant site around the reactor walls (HF, Behersket lugt ved biogas). Andersen left Nysted confident that despite the unfortunate situation the concern that a biogas plant in Brædstrup would overflow and affect the nearby residential area had been subdued. As yet another example of a device, it appears to have played an important role in enlisting the support of others by providing contributing to the configuration of the ways in which these agencies performed the valuation of what a biogas plant in Brædstrup could entail. Prior to arriving they feared odor was a serious conduit for overflows, but by deploying the fieldtrip as a device Andersen had ensured their enlistment in this frame. But not for all eternity.

As this point, Brædstrup Biogas openly addressed the issue of odor. The anaerobic digestion reduced the pungent odor of manure considerably, hopefully improving their standing in the local community troubled by the unfortunate whiff during spring. Scientific studies suggested that even within a few hours of being applied to fields, the odor was significantly reduced because de-gassed manure penetrates the soil more easily. Interest in reducing the odor was also high. Finn Pedersen, a farmer and member of the task force explained in a newspaper article:

> "There is a strong interest in the project (…) Each week, three to four farmers are calling and also people from the city are interested in knowing whether we can get rid of the odor problems. And my response is, that we are working on the matter. For now it is a preliminary investigation and we are most certainly doing this for the sake of our fellow citizens. It has to make sense for us but we would really like to improve our image among the population." (Horsens Folkeblad, 2002a)

The increased attention to potential odor overflows from the plant caused the farmers to respond by mobilizing what can only be described as a more subjective evaluation principle. Farmer's now also argued the biogas plant served a vital interest in enhancing their standing in the local community by reducing odor. Odor was not just an accidental overflow that would be avoided with odor retention systems, but a core purpose of completing the transaction itself. However, while welcoming the popularity boost the economic requirement remained central. The 'dominant evaluation principle', as Stark refers to it, used by the farmers remained objective in the form of economical compliance with environmental regulation allowing them to expand livestock operations: 'it has to make sense for ourselves'.

Several members of the local community remained skeptic. It was especially the prospect of a significant increase in traffic caused by the multiple, daily arrivals of large manure trucks which alarmed them. With a manure capacity of 40 tons per truck, the sheer size of the plant required around 8.000 deliveries annually. Some parents were alarmed over the prospect of traffic accidents involving their children riding their bicycles to school. Others predicted a deterioration of rush hour and traffic jams. While awaiting a response from Velterm and Nutrio, city council organized a mandatory public hearing in the form of a town meeting to inform the community as well as to discuss the location of the plant. The event was important for our biogas frame-maker Andersen, as it provided him with an opportunity to address these potential overflows and enlist the local by avoiding any protests. For this task he would need a strong device. He also invited Søren Tafdrup from the DEA and chief negotiator, Bruno Sander Nielsen from the BIA to address the crowd. These were easily enlisted and would speak on behalf of the project. Around 150 citizens appeared to hear from the mayor who had also invited the city planner from the technical division to make a presentation. The mayor stressed that the Virkefeltet was currently the only feasible municipal site to accommodate operations with special needs such as the biogas plant. Senior biogas expert, Søren Tafdrup made a strong case for biogas, presenting its environmental, agricultural, and economic benefits while underscoring that centralized plants were a key component in the fight against global warming and a potentially large source of renewable energy. Sander Nielsen seconded the DEA in addition to addressing the public's practical concerns over odor, traffic, and other potential sources (Horsens Folkeblad, 2003b).

Representing Brædstrup Biogas, Andersen informed them about the specific project. He explained, that while he understood the concern of the community, if the Virkefeltet site was rejected it would be another two years of approval process before construction could begin since it was the only municipal site available for this type of purpose. A private site was a different matter pending an environmental VVM study to test for any hazardous impact on the environment and natural habitat. He openly stated that while three other potential sites could be located, they would all either require the construction of a new road to avoid inner-city traffic or that the distance to the CHP would exceed 5 kilometers, thus increasing the cost of constructing the underground gas pipeline. But above all, Andersen concentrated on conveying that the purpose was not to create a cash cow for the farmers, at the expense of the local public. In fact, the plant entailed collective environmental benefits, although he did not try to conceal the fact farmers would be allowed to expand operations (Andersen, 2009). Finally, the municipal city planner addressed the issues relating to the Virkefeltet site, stating that he was concerned of the amount of traffic. According to a local journalist very few 'critical questions' were raised during the meeting. The mayor invited them to continue the debates in an online forum hosted by the municipality. Reflecting on the meeting during my interview, Andersen felt his speech was well received and he left the meeting thinking that opposition was limited to a selected few leading him to conclude that the majority supported the project (Andersen, 2009). In fact he was surprised by the limited reactions, although one did openly criticize them arguing 'you created the problem, you fix it.'

What he had not expected, however, was the response from Velterm which arrived shortly after. Velterm was an affiliate window manufacturer of the large Danish company Velux. Bruno Sander Nielsen from the BIA was actively involved in the Brædstrup project in an attempt to secure new markets for the Danish biogas industry. He explained their response to me:

> "This is an interesting one. Velux argued that the odor particles from the plant posed a danger to the quality of their windows. Somehow, they believed that the particles would be carried by the wind and infiltrate the windows, which would be a major and unacceptable liability for them… I don't know which evidence they used to support this outlandish claim but I am guessing someone from the community worked at the factory, and was able to present some credible arguments. Either way, I was baffled. They didn't have any reports, or documents to support their claim." (Nielsen, 2007)

In addition to claiming particles would somehow be lodged and cause damage to the windows, Velterm also claimed the plant would discourage others from coming to Virkefeltet for business; a purpose it was designed to fulfill. At this stage, the statement, although lacking any proof added to the frame against Brædstrup Biogas.

We see how a growing resistance towards the biogas plant is governed by a subjective evaluation principle that undermines and is not persuaded by Andersen's objective argument that the plant will feature odor retention equipment that will prevent such overflows from occurring. Vice versa, as Andersen and BIA were governed by an objective evaluation principle, the Velterm argument that particles would reduce window quality without documentation was not a persuasive argument.

Subsequent meetings between Andersen and the local authorities sent him a clear signal that they would not approve an application for Virkefeltet to house the plant. Bruno Sander Nielsen had participated in mitigating any concern over the alleged impact from transporting the manure. But apparently to no avail.

> "They were afraid the daily truck deliveries made on public highways would increase the risk of accidents, while others cited that they did not want more heavy traffic on the very same roads used by their children as they go to and from school. We presented them with some calculations that if deliveries were made when traffic was light before or after peak hours such as during rush hour then there were nothing to be afraid of. That didn't help much" (Nielsen, 2007)

It appears the devices Andersen used were ineffective in enlisting local business, the municipality, not to mention opposing elements of the local public. Using the notion of evaluation principles sheds light on why. From their arguments it is obvious that Andersen, Lunde, and Tafdrup are governed by objective evaluation principles. By deploying calculations, scientific evidence, calculations, and field trips to existing biogas plants they tried to frame biogas as a harmless and legitimate tool from which all the involved agencies can accrue certain benefits. Based on rational, objective, and logic forms or reasoning there was nothing to fear. But these various devices are undermined by the subjective evaluation principles of others. For Velterm their products are at peril. For local citizens their property, children, and summer garden parties are at peril. And according to Andersen this means local politicians will follow suit:

As a result, two different frames were emerging and Andersen's devices no matter how complex, expensive, and senior, were rendered useless apart from keeping the alliance of farmers enlisted.

> "Since we have received several requests from local businesses, that the Virkefeltet location is imprudent, we have decided to accommodate them. In my experience, if several business members say the same, so will several politicians. And then we might as well look for another site" (Horsens Folkeblad, 2003c)

The situation was deteriorating. A growing number of powerful agencies were for disparate reasons unable to support Virkefeltet. This diverse set of opposing actors included a choir of business and industry, local government, and a growing number of ordinary citizens dominating the scene, in effect shutting the door on Brædstrup Biogas. The continuous arrival of new protests had gradually formed a new frame pitted against that of Andersen, which used democratic and institutionalized devices to frame biogas as a potential liability for Brædstrup. Written letters of protest addressed to city council and the local newspaper constituted powerful devices, because they were sufficient in presenting their criteria for not wanting biogas in Brædstrup. The online forum created on the municipal website was a similar device, but according to my sources was never used.

With the next location, we shall learn more about the evaluation principles of local politicians. Fact of the matter was that Andersen had not been able to move on with framing the transaction. He still needed a site to render the biogas plant an economic good and to proceed with the transaction. No site, no plant.

3.2.2 Second Attempt to Frame a Construction Site: Brokhøjvej

He pressed on in his search for a more accommodating site. Not by attempting to re-frame Virkefeltet but by framing a new site. It did not take long as he came across a piece of private farmland on Brokhøjvej (the name of a nearby road) which had recently been put on the market. This was a rare and lucrative occasion, as available farmland was few and far between in the area. In the event it also was rejected, Andersen believed he could use for another suitable purpose such as building a golf course. Along with another farmer he purchased the land on February 25, 2003 using personal funds. Once again, he met with local officials to inform them of the new site. In meeting with Andersen, the municipality and the county expressed concerns over the new site. The problem was that the property rested on top of the local underground water supply. And because of its classification it may require an environmental impact study (the VVM study). In fact, most of Brædstrup was designated as a water extraction zone and finding a site in the vicinity that did not compromise environmental interests was therefore ‘virtually impossible’, as Andersen put it. He knew that, if the authorities maintained this interpretation of the regional plans, a time-consuming VVM-study would compel him to abandon the site. Awaiting the county’s decision, another concerned citizen voiced his opinion. By now, the rhetoric had evolved past protesting the location:

> “At the orientation meeting [the public hearing referred to above] city council member Preben Andersen informed us that for it to become economically feasible it was necessary that the gas pipeline to Brædstrup heating plant to be as short as possible. As far as I know no contract has been signed with the heating plant and why, by the way should cleaning up after yourself be economically feasible (…) It strikes me as extremely cynical that because these animal factories have a manure problem the only solution is to inflict other groups of citizens with odor problems (…) do not think that you can keep the smell within a 300 meter limit. Where on Earth does this magic number come from? I have heard a liberal politician use it and Preben Andersen use as some form of positive distance criterion to the neighbors. Do not think that the smell

> can be restricted to 300 meters. The entire Brædstrup city will from time to time be wrapped in the stench of butcher waste and manure (…) The city council stands before a task that requires courage (…) Do you want to be marked as a proper residential municipality or as the municipality that smells like manure in the rural areas and in the city?" (Horsens Folkeblad, 2003d)

This letter is just one example of how protests from local citizens questioned the notion that agriculture should be allowed to use Brædstrup to solve problems they themselves had created in the first place. Several others followed suit:

> "…When one lives in Brædstrup and must accommodate a deterioration of the place, one has chosen to live in, because of other's shit, then it is time to protest. Place it as far away from built-up areas. Regardless, the transportation of manure to and from the plant site will inevitably entail the loss of manure during transport (…) The time is now for the citizens of Brædstrup to influence where the potential plant is constructed. If one waits to be asked, one can expect the decision has already been made" (Horsens Folkeblad, 2002c)

As the responses in the letters indicate, emotions were running high with regard to biogas. Biogas was associated with possibly corrupt politicians or a legislative process under pressure from powerful local agencies, fearing it would compromise the institutional and civil liberties of local citizens. Potential traffic overflows were also framed as causing potential fatalities, as their children used the same roads to bike to school. Criticism was also directed at agriculture in general calling on politicians to delist from Andersen's frame. Other written protests framed biogas as a reasonable idea, but citizens were fully aware that farmers' interest in biogas was primarily driven by an interest in expanding livestock production. Some were against this as they feared other ramifications of such a development, while others lamented the local agricultural community for solving an overflow at the expense of the local community. The rally for local resistance presented in written letters to the editor of the local newspaper left little room to expect citizens, at least those cited above, had much faith in the process of local democracy. In fact, the two politically charged comments above begs the question of whether the criticism was levied against biogas or local politics, i.e. maybe biogas was a reason or means by which to vent concerns over local politicians and the legislative process. It could also be interpreted as a threat come election time.

Once again, it appears the mix of matters raised by local citizens are based on personal and subjective concerns, i.e. concerns which stipulate boundaries and cordon off a local sphere the plant is prohibited from entering. A combination of skepticism towards agriculture, local city politics and politicians, and not-in-my-backyard or NIMBY-syndrome was motivated by local sentiments and interest framed biogas as unwanted. At least those opposing Andersen's frame, wanted to prevent biogas from intruding the personal sphere and upsetting daily life of ordinary citizens. By such evaluation principles it is easy to understand why biogas was considered unworthy, thus why Andersen was met by resistance. The preferred tool deployed by the local community was images printed in written letters of the potential ramifications of allowing biogas to operate in Brædstrup. Although only substantiated by qualitative arguments, they were powerful arguments drawn from knowledge of past failed plants in Denmark and Brædstrup's experiments with wind power in the 1980s; powerful in the sense, they reactivated the framed of past failed socio-technical skeletons in the closet with another potentially failed socio-technical assemblage in the future.

Moreover, it also explains why Andersen's devices, based on a more objective evaluation principle, were consistently undermined and ignored. In engaging in competing valuations over biogas they were primarily driven by two fundamentally different evaluation principles. Take for instance, the question of whether the pungent manure will stay within the statutory 300 meter limit. Even Andersen knew such overflows were potential, and could not be prevented at all times from occurring. But having purchased sufficient land is an indication that Andersen as well as his group of investors was above all guided by a rational and objective evaluation principle. It was not a personal argument, but a rational legal argument. If they complied with the law the biogas plant was legit. This, however, was in stark contrast to the subjective evaluation principle governing the opposing groups. They knew the overflow did not respect the legal boundary but would overflow into their personal property. Consequently, Andersen's devices did not work.

With each new site Andersen proposed, more and more actors were activated due to the associations they shared with the proposed site and would therefore potentially become victims of any overflow from the plant. With Virkefeltet it was restricted to the adjacent neighborhood and those operating at the site. However, with Brokhøjvej they potentially activated everyone else due to the relationship with ground water reserves – something everybody depended on. Every concerned citizen and political agency was a spokesperson for the ground water reserves. By now, local citizens had evolved into a key agency confronting Andersen resisting the pressure to accept biogas as valuable to the community. But he was relatively unaffected by local protests:

> "As far as I remember…I think I wrote a few letters to the editor. Well, I must have once in a while published letters in the newspaper to address the local concerns. We are a small community, so I would also sometimes bump into people on the street by the grocery store where we would talk it through." (Andersen, 2009)

Here Andersen sheds light on other vital devices by which he sought to frame Brædstrup biogas and enlist opposing agencies. In addition to the public hearing, he also used open letters published in local newspaper to address local concerns. He would repeat the same statements and refer to the arguments made by the DEA and BIA representatives. The same applies to random encounters with local citizens when engaged on the open streets. Here he learned that some also supported him. However, unlike the countless meetings he organized with local politicians and municipal officials and field trips he deployed as devices, he could not measure whether letters and exchanges with fellow citizens had any effect. And in the interview, Andersen was not sure whether he had published any letters to the editor. The point is not to chastise him for memory lapses, but to illustrate that communicating with the local agency was not prioritized to the same extent as with the county and local political agencies. I asked Andersen about the extent of the opposition, at least from his perspective:

> "There weren't that many, maybe a handful. I think some of them had it in for me and some of the other farmers. And it was always the same people (…) I guess is happens for some people when they retire. They have too much time on their hands. And they've probably seen me driving around in my big V8 which I owned at the time (…) I remember a lot of people also supported us, people I ran into on the streets (…) Overall, the resistance was limited to relatively few people. It was not my impression the negative sentiments were shared by the broader public." (Andersen, 2009)

In his view, Andersen felt resistance was minimal. Accordingly, while he was fully aware of his initial obligation to keep the public informed at this stage it was not a top priority for him.

The frame against biogas was growing stronger as the local controversy over biogas escalated and Andersen was still without a site – the missing ingredient in his biogas plant transaction frame. A few days later on March 10, 2003, Andersen's attempt to frame Brokhøjvej suffered another blow. The county commissioner declared Brokhøjvej as inappropriate. A deputy county official, in charge of all affairs relating to Brædstrup Biogas, rejected the site because, first of all, it located in a designated water extraction zone, and second of all, it was currently in use by the Brædstrup water works. It was important to the county to protect special areas with water resources. In a newspaper article, the official said:

> "The biogas process must take place in a closed system and it is not the idea that you are allowed to make a mess with manure all over the place. But accidents can occur, the big trucks could tip over and a tank could explode" (Horsens Folkeblad, 2003e)

The county's regional development plan states that any type of operation which could upset the existing natural balance in nitrate sensitive areas, such as ground water reserves, are not permitted. According to the county's interpretation of the regional plans, that included biogas and in any case a VVM-study would be required. It was the one 'detour' Andersen was hoping to avoid to complete the transaction, as it would extent the journey by a few years pending the outcome of the study. To Andersen, the county's interpretation meant that that if applied as a general rule to all locations in the area, it would virtually exclude any location as most of Brædstrup was classified as water extraction zone. At this stage framing a VMM-study was the least of his problems. Instead, Andersen had encountered a passage point in the framing process which he may never be allowed to pass. Farmer Svend Erik Justesen who co-financed the site with Andersen responded in kind to the county commissioner:

> "The way I understood the representative from the DEA, there is nothing preventing us from placing a biogas plant in a water extraction area. I mean, today farmers are already spreading manure on the water extraction area used by the waterworks." (Horsens Folkeblad, 2003f)

The task force found it 'utter irrational' that they were prohibited from placing the biogas plant on top of the exact same type of land where farmers were already dumping the very same polluting manure the plant would process. Here we see the strong rational and objective evaluation principle dominating Andersen and his task force. DEA senior biogas expert Søren Tafdrup tried to intervene on their behalf by contacting the deputy county official directly by phone. From my interview with him, he had a hard time making sense of the county commissioner's argument.

> "Their argument was that the proposed site rested on top of a protected groundwater zone. I looked at the property and I noticed it was physically located across the road, right next to one of the farmers' existing crop fields. If we follow their line of reasoning, his crop field therefore also rests on top of the very same protected area, just like most of Brædstrup. So under no circumstances would he be allowed to pollute. But he is in fact obligated by law to pollute each time he applies the fertilizer, the manure. And that doesn't pollute the ground water, I ask? Of course it does. Besides, as long as the plant is carefully constructed its does not pose a danger at all. Officially, they are afraid that the biogas plant will leak manure into the ground, so they don't

> allow it, even though farmers are permitted to use the very same manure on the exact same piece of land on the other side of the fence. I tried reasoning with them explaining that it did not make any sense. It was gibberish, you know, just pure nonsense. To me it seemed as if they were completely reluctant to accept any sensible argument, even those with a scientific merit to them." (Tafdrup, 2007)

If constructed as a closed system to prevent leakages as initially demanded by the county commissioner, the plant was still considered hazardous to the environment. Andersen was also frustrated by the county's decision:

> "Apparently, the official feared explosions based on the incident at Ribe biogas where the gas tank did in fact explode. But it sounds more drastic than it really is (…) if you ask me, whoever was involved in demanding the VVM at the county commission's office did not know what he was talking about. Pure and simple." (Andersen, 2009)

However, the chairman of the waterworks was not too concerned with the biogas plant.

> "With regard to the daily operations I do not see any problems. And I am not concerned about the plant being located on top of our water, but all plants can experience accidents. And in the case of leaking manure I am mostly concerned that our open filters at the waterworks can allow for the manure smell to enter the water" (Horsens Folkeblad, 2003g)

The idea is not to convey an image of ignorant public officials. Rather, they are simply playing by the rules according to their interest and matters of concern thus using devices in accordance with their evaluation principle. Instead, the idea is to demonstrate the multiple different devices and evaluations principles at play in framing a biogas plant for transaction, and how they lead to the formation of markedly different frames and understandings of what biogas plants are, whether overflows will occur, and their effects on Brædstrup. We not only see how translations of the same device – such as Søren Tafdrup's intervention or regional plans - can lead to different frames and classifications of overflows as potentially dangerous or harmless based on different evaluation principles. Andersen, Tafdrup, and others were fact-oriented and could therefore not understand the argument of why farmers were allowed to apply manure but not allowed to build a biogas plant on the very same piece of property. We also see that because of different translations, agencies mobilize different devices to support claims. County officials, for instance mobilized a legal device as they were more concerned with the potential overflow from a legal basis. The DEA mobilized a different device, scientific and logical reasoning to explain that farmers were already spreading manure and thereby causing the very same overflow the county official was afraid of in the first place. In doing so, the DEA sought to undermine the frame of biogas as hazardous. It is difficult to identify the political agency as being governed by an either objective or subjective evaluation principle but as being somewhere in between which is underscored by their next move. But despite deploying what Andersen believed to be powerful devices in the form of the DEA, BIA, and rational, legal and scientific arguments it was to no avail; much like the town meeting. They had failed to change the opposing valuation hence the decision by the political agency, in turn preventing Andersen to move forward with the transaction.

To allow Andersen to continue, the county commissioner suggested moving the waterworks a few hundred meters away to collect the water from an area the biogas plant could not contaminate. The county then appear to be 'stuck in the middle', in attempt to frame a solution that served the interest of Andersen, the complex local agency – citizens, business, and ground water reserves – as well their own. By moving the water works, this would inadvertently solve another problem for the county. Currently the waterworks was located just north of the Virkefeltet industrial area and thereby prevented its expansion in the only possible direction. For Andersen, it was also the only possibility of framing Brokhøjvej (pending a VVM-study) thus potentially proceeding with the transaction.

Andersen protested the decision arguing the county failed to explain exactly how a biogas plant would compromise the nitrate levels, once again stressing the objective evaluation principles. But he explained to me how the damage was already done. In his eyes, it was a severe setback:

> "It was a defining moment for the project. Moving the water works was not a realistic option. We received even more protests from the public, most likely because of a previous incident some time ago when an environmental study found relatively high levels of toxins in water samples. The sewage treatment plant had apparently used too much of it compared to what was established. It later turned out to be harmless, but there is no doubt it triggered the public (…) the local citizens listened carefully to what the county said and trusted their judgment. From that point on, everything turned for the worse." (Andersen, 2009)

Timing was unfortunate, because in May 2003, the government decided to extend the terms of payment for biogas beyond 2003 securing a DKK 0.60 production grant and thereby securing the economic feasibility, provided other cost variables such as the gas pipeline did not render the plans uneconomical. At this stage, 18 months had passed and while securing the financial backing from farmers, as they continued to value biogas as economic feasibility, Andersen had yet to find a site.

In early November 2003 around 45 farmers gathered to discuss the project, of which 30 agreed to put up DKK 10 million in total securing the project's financial aspect. However, for the first time dissent from within the ranks was noticeable, as some farmers openly questioned whether a separation facility alone would not be a better option than a biogas plant combined with separation. At least in theory and provided they found a buyer for the isolated dry fraction, a separation unit would enable farmers to comply with the environmental regulation by isolating ammonium and phosphor levels. But Andersen explained that separation technology was considered 'untried and expensive' among agricultural experts, the frame failed to gain a foothold against biogas. Once again, we see the objective evaluation principles as work. Besides, no one had come up with a solution to discarding of the separated fibers. Separation alone did not secure any compliance. The alliance for biogas among farmers remained intact, and while retaining

Brokhøjvej as an option, although it was highly uncertain whether it would be approved, Andersen continued the search.

3.2.3 Third Attempt to Frame a Construction Site: The Airstrip Site

By now our biogas frame-maker had examined over a dozen sites[9] for the plant but were yet to find one. While Brokhøjvej remained on the table, Andersen used his knowledge of area resulting in other potential sites in and around the nearby villages of Nim and Troelstrup along with the area known as Laursdal. They were briefly considered but quickly abandoned as distance to the CHP would drive up the cost of the pipeline. Then suddenly, a new chance opened up on a farm next to an airstrip near the small town of Åstruplund, a few kilometers southeast of Brædstrup. Coincidently, the farmer had decided to retire and sell his farm property to Brædstrup Biogas adjacent to the airstrip. Andersen believed neither the airfield nor the economic outlook would be dramatically affected by the site. Despite the extra distance to the CHP calculations showed it remained economically feasible.

Once again, knowing full well the importance of political support, Andersen deployed a field trip as a device and invited a delegation of local and county politicians and officials, along with members from the technical division of Brædstrup municipality to the site. The latter voiced concern over the scenic effects a biogas plant of that size would have in the pristine, natural area of the *Gudenåen* river and nearby valley, not to mention the effects on the environment in case of a manure overflow from the plant. In his view a biogas plant was incommensurable with the natural beauty of the Gudenå Valley. Andersen left the field trip with little hope of avoiding a VVM-study, let alone obtaining an approval. Unlike the Nysted field trip, it does not appear as if the device worked to

[9] Some sites, not mentioned here were abandoned on similar grounds: VVM-studies and distance to CHP plant.

Andersen's advantage, i.e. it did not change the political agency's valuation of biogas and thereby permitting him to advance with the transaction.

In December 2003, Brædstrup Biogas decided to end the search. He felt all possibilities were exhausted and were relatively comfortable with either Brokhøjvej or Åstruplund. A days before Christmas Eve, Andersen wrote and submitted the one-page application listing his two preferred construction sites. As private properties, the chance of VVM-studies was high but with no pre-approved industrial or public sites for biogas production there was no other option. In the application, Andersen stressed these sites were identified out of consideration of the concerns raised by the public, transportation and odor most notably (Horsens Folkeblad, 2004a). Brokhøjvej was listed as the top priority due to its close proximity to the local CHP. To improve the chances for Brokhøjvej, he added Åstruplund as a secondary option well-knowing its sensitive surroundings would inevitably result in its dismissal. Andersen had accepted that at best one of the sites was approved on the condition of a VVM-study. Neither would they ask the municipality to expropriate a new area for the plant, although Andersen briefly considered the option.

In the meantime, the DEA confirmed it would co-fund the estimated DKK 50-60 million Brædstrup plant with DKK 6.5 million. But just as Andersen had submitted the application and he thought he had framed the financial backing, the frame gradually began to fall overflow left and right. Firstly, since the privatization of the energy sector had begun in 1999 the market price on natural gas had fallen considerably since power companies were free to choose from a range of suppliers (Horsens Folkeblad, 2004b). Plans of selling the biogas to the local CHP were furthermore jeopardized since the two parties had not signed any contract let alone been in contact with one other for almost four months. CHP Managing Director Per Kristensen, presented his view this way:

> "I presume that we are still involved (…) Unless they can sell the gas elsewhere. We are of course interested provided the collaboration favors the consumers. But only if that is the case (…) In the end it all boils down to a matter of the price of the gas. The price has to be competitive (…) There has to be an

> incentive to join otherwise we will not. Basically it is an interesting project and an exciting technology but that is not in itself sufficient." (Horsens Folkeblad, 2004b)

In the mean time, Mr. Kristensen had signed a three month contract on natural gas from another supplier. Declining prices on natural gas, used by Andersen as a benchmark for determining the price charged for biogas, and a fragile semi-enlistment of Kristensen would be setback in the transaction process. In fact, selling the gas to the CHP was the only option. They had no other means of selling the gas. Andersen argued to me, that his first priority had been to secure a site. All other matters were secondary at this initial stage, although being fully aware he had no other potential customer than the CHP to his biogas. Andersen also noticed a similar uneasy and fragile enlistment from the farmers (Andersen, 2009). The 2003-2004 harvest seasons had been particular challenging for farmers with declining prices on livestock and crop, production significantly below par causing many farmers to reconsider new investments, especially controversial ones such as the biogas plant. In agriculture the 03/04 season was a crisis:

> "I had already collected fund three times to keep the project going. With the crisis on our hands, I knew it would be impossible to get anymore out of them." (Andersen, 2009)

Thirdly, in addition to the resistance from within the core group of agencies, new protests from the local community in Åstruplund emerged. While the application was being processed by the technical division at Brædstrup municipality in January 2004 before the city council convened, the retired owner of the Åstruplund carpet store, Verner Therkelsen took charge of furthering the resistance against biogas, this deploying a new device. He objected arguing the plant was too close to his home which had just undergone extensive renovation including a new open-air patio. In an open letter to the editor he echoed previous written protests:

> "Ninety percent of the time the wind comes from the south west and we are just 700 meters apart. My property may not be impossible to sell but it will drop significantly in value. We are the ones that will be hurt the most." (Horsens Folkeblad, 2004c)

From his statement, Therkelsen shared an identical and very strong subjective evaluation principle. Yet, unlike previous attempts by local citizens Therkelsen deployed a new and potentially powerful device to frame biogas as a hazard. Invoking his democratic rights, the retiree organized a petition to prevent the biogas plant from being constructed next to the airstrip and his property (Horsens Folkeblad, 2004d). On the very day city council was in session to rule on Andersen's application on February 23, 2004, Therkelsen appeared before the council prior to the meeting with the mayor present, holding 210 signed petitions from Åstruplund against the proposed plant, plus 14 from the airfield club and 40 from the city of Brædstrup. They cited increased traffic, declining property values, odor pollution, and the potential destruction of valuable natural assets in the Gudenåen Valley as primary reasons. The statutory 300 meter minimum distance between plant and neighbor was also berated as insufficient to 'keep the odor in check' (Horsens Folkeblad, 2004e).

On the following day, city council announced that while supporting the project, both proposed locations were rejected. It was argued, that in the event of leaks the potential damage to the water supply on Brokhøjvej would be unacceptable and in the case of the Åstruplund site, the regional plans restrict its from housing a biogas plant to operate in close proximity to nature. They encouraged Brædstrup Biogas to continue the search as they felt confident that an approvable site could be located (Horsens Folkeblad, 2004f). It was an insurmountable setback for Andersen and the remaining alliance of farmers in Brædstrup Biogas. He explained to me that they decided to terminate the project in June 2004, firstly because many of the farmers felt they had pushed the envelope among the local community. Regardless of the outcome, they still had to live the small tight-knit community and they feared advancing the project, partly designed to improve their standing, would cause more damage. Ironically with the decision to abandon the project farmers were eventually dominated by the very same subjective evaluation principle they had been up against throughout the process, especially with the local community. They now saw eye to eye and with it protests stopped. With the economic crisis of 03/04 on their hands the biogas plant had lost all value by objective and subjective measures. Andersen, however, maintained a positive view in offering this comment on the outcome to the local newspaper:

> "I feel sorry for the environment and the surroundings in the municipality of Brædstrup that we did not succeed in constructing the plant. It would have reduced the odor problems to a minimum." (Horsens Folkeblad, 2004g)

And so it happened, after two years and 15 different locations the project was shelved after the frame collapsed. Andersen did not successfully enlist a physical construction site by obtaining city council approval, closure on a local controversy over the proposed biogas plant was not reached, and eventually even farmers overflowed from the frame. What remained ere the good intentions of Brædstrup Biogas Plant. Question is, why? What can we learn from the ordeals of the biogas frame-maker's attempts to frame a biogas plants as an economic good while attempting to complete the transaction?

From a framing perspective, we are not only confirmed of the fragile nature of biogas markets and the perpetual re-framing needed to organize these particular transactions; we also see how it is difficult to ascertain who, why, when and from where overflows may appear and when an actor becomes 'vital' to the viability of the frame. Applying the notions of framing/overflowing once more has demonstrated that is impossible to a priori identity sources of overflows and the effect they can have on the process of framing a biogas plant for transaction. To begin with, Andersen identified farmers, and county and local political agencies as necessary to frame and enlist. Local citizens were kept informed of the plans. But as he embarked on the path to framing Brædstrup Biogas for transaction he himself explained how he had not envisioned that finding a site would turn out be impossible. Nor had he expected to be enlisting ground water reserves, that his objective arguments were overheard by many, that biogas could compromise window quality, that after 14 other sites he would end up proposing a site in another town, that he would encounter a financial crisis in agriculture, let alone for his ‘own people’ to overflow and leave the frame fearing personal ramifications. As the framing process expanded many others were activated becoming ‘vital’ actors to be internalized in the frame, such as Velterm and the local CHP. One could even question whether Andersen himself was vital to the framing in light of the lack of progress made on enlisting a construction site. For each site, these powerful agencies also claimed to speak on behalf of the sites Andersen proposed. Even the one he had purchased and was the legal owner of, had more powerful spokesmen. As Andersen continued the hunt for a site, he never acknowledged local citizens as a vital ingredient to be internalized on par with local political agencies. He focused his framing efforts on political agencies, and only responded to citizen protests if he had the chance; in fact in my interview, he was unsure of whether he had written any letters at all. In my interview Andersen ruled out the petition as playing a role.

> “Knowing the political system from the outside, decisions are based on technical and political considerations. This of course includes the concerns raised by the public, but in my view a small petition has little - if any effect on the outcome. But then again, 2004 was an election year so I cannot rule out the possibility that some may have feared the repercussions.” (Andersen, 2009)

> “It’s politics and I know rules of the game. They were afraid of the consequences of bringing biogas to Brædstrup (…) As far as the protest goes…to me honest I had actually forgotten all about the petition until you mentioned it. In fact, I was surprised to hear they managed to collect that many signatures. How many did you say?” (Andersen, 2009)

The critical reader will at this point say, ‘well of course he cannot – he would be admitting defeat’. The point is not to chastise Andersen for memory lapses or a failure to take the public’s concern into consideration, but to explain the difficulties biogas frame-makers encounter in identifying ‘vital’ actors a priori and thereby potential conduits for overflows in framing the transaction. How do we know when an actor becomes vital to enlist – what does it mean to be vital? Were local citizens 'vital' for Andersen to include? Perhaps. It is difficult to say exactly approximate the level of influence local protests had on the city council decision. However, we know that as the search continued, the local community kept appearing as a key agency and a consistent source of 'trouble' or conduit for overflows. The devices and rhetoric deployed intensified, and with each site they assumed the role as spokesmen. For the most part, they echoed the same concerns as the political agency, which Andersen was keen on enlisting, but did not receive the same attention from Andersen. Echoing similar concerns as city council makes it difficult to identify the party with the most effect on the framing. Seen from the perspective of biogas frame-makers it is impossible to a priori identify who or what to enlist and potential sources of overflows. However, because the local agency ensured the controversy over Brædstrup Biogas was continuously visible, because they shared similar concerns and evaluation principles with the political agency, and finally, because they deployed devices that received the attention of the political agency it was impossible for the political agency to ignore them. And that made them 'vital'.

This brings us the second point, as the story also demonstrate that in (re)framing transactions and enlisting human and material actors, frame-makers deploy multiple devices amid evaluation principles towards changing agencies interests and valuations of biogas. But devices can easily be undermined in determining whether the transacted good is valuable according to their evaluation principles. To frame biogas among farmers he used feasibility studies, plans, and calculations. Knowing that to eventually begin construction on a specific site, he also needed the enlistment of city council and the municipal authorities. In addition to maps over the local area, he also deployed field trips to existing plants. Public town meetings, and associated presentations and speeches were also found from the toolbox along with soliciting devices from the powerful biogas agencies of the BIA and the DEA. As the hunt for a site intensified Andersen continued to deploy field trips along with personal funds to pay for land. When local protests emerged and the controversy over biogas in Brædstrup spread Andersen resorted to responding in letters to the editor of the local newspaper. But as it turned out, despite deploying a host of different devices leveraged at enlisting them Andersen remained on several occasions a voice without steel, so to speak, with the Velterm and water works situations as notable examples. Apart from the Nysted field trip which sought to prove it was possible to construct biogas in industrial areas with odor retention, it does not appear as if Andersen's devices changed the valuations of and interests in Brædstrup biogas. No matter what he threw at them, he did not secure any significant leverage. Why is this?

With the biogas frame-maker's framework I set out to shed further light on Callon's prominent attention to the role of costly devices and metrological setups to reframe overflows or to prevent overflowing from occurring in the first place. He seemed to be consistently advocating for a superior metrological setup, other agencies will cease to exist in the market. Andersen did attempt to leverage different devices towards enlisting support. Bruno Sander Nielsen from the BIA and Søren Tafdrup are among the most seasoned biogas experts in Denmark, whose presentations, calculations and reasoning Andersen consistently used to enlist the political agencies, both at the town meeting and in arguing for the water works site on Brokhøjvej. Of all the agencies in the Denmark, the DEA holds probably the most superior metrological setup of all on biogas. But as Tafdrup noted, they appeared to be by reluctant to accept 'sensible argument with scientific merits'. In other words, the conflicting evaluation principles rendered the devices ineffective, at least with regard to enlisting opposing agencies, which Andersen himself had initially identified as relevant for the transaction to proceed. The notion of evaluation principles brings the conflict between Andersen's objective evaluation principle and the subjective ones by the protesting and political agencies to the front of the analysis. It strongly indicates that no device designed from an objective evaluation principle, perhaps stopping short of bribery, would be powerful enough to enlist agencies governed by a subjective evaluation principle. Andersen's devices were consistently undermined by the subjective evaluation principles governing their valuations of a biogas plant.

What also emerges is that in framing a biogas plant transaction biogas frame-markers must navigate through the ever changing framing process deploying various devices amid disparate evaluation principles, some of which are unresponsive to devices with a different design philosophy. In fact, the account underscores the main point of this project: that biogas markets in Denmark are ill-framed markets of good intentions. Not knowing who is vital to the transaction, which devices to use, whether VVM-studies are actual or not, what responsibility local government has, and above all, whether overflows are reframed and controversies settled, all go to the heart of the primary argument. For the most part, the framing transaction seems highly ill-framed. Frame-makers are unaware of who and how to approach in the process of purchasing and constructing a plant. Imagine buying your groceries, and you do not know who is 'vital' to solicit for product information, what devices to deploy to extract the information, and so on. Such uncertainty precludes well-framed biogas markets from existing in Denmark. I leave this analysis where I started in the words of Andersen. I asked him whether a plant would ever see the day of light in Brædstrup:

> "No, never. Biogas is dead in Brædstrup". (Andersen, 2009)

Are such statements indicative of a well-framed biogas market? Following the next story where we track a more tenacious framing process lasting almost a decade before return for a more comparative analysis of both stories to continue our analysis of devices and evaluation principles.

3.3 The Long and Ill-Framed Road of Framing Transactions

Some 90 kilometers northwest of Brædstrup in the city of Holstebro, another biogas project was taking shape in early 2001. Facing an identical challenge as the farmers of Brædstrup with regulatory compliance to expand livestock production, a few hundred farmers in this agricultural power zone also began investigating the possibility of constructing a centralized biogas plant. But almost a decade should pass before the main character of this account, biogas frame-maker Alan Lunde, could begin to see the end of framing the transaction. As he said during my interview him:

Chapter 3 - Framing Transactions: Devices, Principles, and Resistance

> "For the first few years, whenever we made some headway I would celebrate it. But after almost ten years of constant trials, problems, and struggles with authorities…I mean just about everything has gone wrong, detours, and what have you…I am no longer surprised, even this close to the finishing line. I have stopped pulling out the champagne like I used to." (Lunde, 2009)

In this particular story we retrace the steps of Alan Lunde, our biogas frame-maker in a similar attempt to construct the largest biogas plant in the world. Once again, framing/overflowing, devices, and evaluation principles are central in framing a biogas plant for transaction. However, unlike the Brædstrup which was halted in the early phase of locating a construction site, this story is especially powerful in demonstrating how the road to completing the framing of a transaction is long and paved with resistance to biogas plant transactions constituted, not only by individual political and local agencies, but by the ill-framed nature of the biogas markets. To complete this transaction required elements of pacification, framing agencies, and framing market encounters amid overflows and controversies. Consequently, the purpose is above all to demonstrate that although constructing biogas plants in Denmark is not impossible, neither is it a well-framed and well-organized accomplishment. In fact, this particular and very recent story brings home the core issue of this project from the perspective of framing transactions, before we conclude on this project in the next and final chapter.

During the 1990s succeeding marine environment acts had strengthened the requirements by gradually increasing the level of reduction. A biogas plant 'only' makes phosphor and nitrate nutrients from the de-gassed manure more accessible to crops thus preventing it from running off into the aquatic environment. Yet, any surplus nutrients would still run off. The two agricultural communities from the adjacent Holstebro and Struer municipalities comprised 200 livestock and mink farmers they produced 500.000 tons of manure. With 500.000 tons the runoff would still be extensive. Similar to Brædstrup, they would combine the biogas plant with a separation unit to isolate the high contents of phosphor and nitrate. But neither this was enough. To be compliant the group had to figure out how to discard the dry fraction, for instance by selling it. Isolation only meant transforming one source of pollution into another. As such, for the transaction to be valuable they also had to frame the dry fiber fraction as valuable commodity, thus internalizing it into the frame while simultaneously framing the entire plant for transaction among other agencies.

If they succeeded, it would become the largest biogas plant in the world. To this came an additional 40.000 tons of industrial waste from local meat and dairy factories (Danish Crown and Arla), waste water, energy crops, household waste, and dead livestock and mink. Preliminary calculations estimated daily deliveries of 1500 tons or 50 truckloads within a 20 km radius would produce 14-18 million cubic meters of biogas annually, reduce phosphor levels by 75 percent (500 tons) and nitrate levels by 25 pct. (550 tons), and reduce CO_2 emissions by 50.000 tons – 20.000 from replacing natural gas with biogas and 30.000 from farmers using degassed manure with significantly lower levels of methane and nitrate dioxide. As a result, it would free up 25 percent of the farmers' valuable arable land as required by law for further livestock expansion.

Faced with the task of pacifying a new type of biogas plant based on different types of biomass and the need to frame a solution to the dry fiber fraction the group of farmers invited engineers from the Rambøll engineering division into the group, in addition to the municipal-owned Vestforsyning utility company, the waste management company Nomi, the environmental technology provider Enervice, and the incumbent power company Elsam (currently DONG) which owns the nearby CHP plant. Together, these actors had an interest in the plant, either by supplying knowledge or equipment, investing, delivering biomass, or consuming the biogas.

To undertake this framing and organizing activity they selected Alan Lunde as the biogas frame-maker of this story. As senior agricultural advisor for the *Heden & Fjorden* agricultural consultancy company, he was hired by the group to spearhead the process of bringing the world's largest plant to life. Most of his career had evolved around agriculture, especially consulting and guidance on the political aspects of agriculture. After 26 years Lunde was well-known in the agricultural community, having accumulated a vast political network, from local to state politicians including several MPs and ministers in the present government along with an extensive insight into political and regulatory processes. These were considered vital qualifications to construct a biogas plant especially with regard to navigating through political networks. Named after the area north of Holstebro, Maabjerg BioEnergy (MBE) was founded in 2002.

In retracing the Lunde's steps we shall follow him down two framing tracks towards the finish line of constructing the plant. The first consists of framing the biogas plant itself (also known as pacification) and the second consists of framing the plant as an economic good and completing the transaction, identical to what Andersen attempted in Brædstrup. Beyond finding a construction site and obtaining a number of mandatory permits from political agencies, least of all the local political authorities, we know relatively little about the framing process and devices needed to enlist the human and material agencies which may or may not appear to be vital in the frame. To respect the chronological order of the story we shall jump between the two forms of framing as events unfold.

3.3.1 Framing a Technical Configuration, Reframing the 'Dry Fraction'

A first priority for Lunde was to frame the technical configuration and design of the plant itself. Key was to figure out how to discard of the excess phosphor and to identify how to finance the behemoth project. In doing so, Lunde could outline future steps, who and what was necessary to enlist in the frame, while keeping tabs on potential sources of overflows. Lunde described to me how past failed attempts to construct biogas plants in Denmark were a major source of inspiration in planning his own framing and organizing of the MBE plant. Unlike Brædstrup, this is reflected by how Lunde framed it; not so much as a biogas plant but more as a 'gigantic treatment plant' for manure much like a traditional sewage treatment plant.

> "Our intention is not really to produce biogas but rather to clean the manure from the animal pollution in the area and the optimal approach is a combination

a biogas plant and subsequent separation into a wet and dry fraction" (Ingeniøren, 2005a)

I my interview with Lunde, he provided the same response which indicates a markedly different framing of the transaction. The idea was to disassociate the MBE plant from the negative associations (Helsingør, GFE etc.) many have of biogas plants thus preventing attempts by others to frame and valuate the MBE plant as 'just another failed biogas plant'. He was also fully aware of the credibility issues left behind in the wake of the recent experiences with Brædstrup. From the information at this stage, we learn that Lunde and those he speaks on behalf of are primarily governed by an objective and rational evaluation principle. Like in Brædstrup, the purpose is to comply with regulation. The plant must be economical, and to achieve this Lunde performs valuations from a rational and almost pragmatic perspective by only including 'proven' solutions such as the low-tech separation unit. As we shall see, his objective/rational perspective is also reflected in his pragmatic approach to deploying devices towards enlisting whomever or whatever actor was vital.

As a first proof of his approach to framing and preventing known technical overflows from occurring he chose to focus on existing and proven technology whenever possible. Constructing a centralized biogas plant itself was not considered a potential source of overflows. By now, over 20 centralized plants were economically stable leaving Lunde feeling confident in this particular part of the frame. Separation units, however, did not benefit from a similar track record. In my interview with Lunde, he explained how for instance the failed GFE plants had resulted in framing advanced and high-tech separation as immature. Not a single GFE installation had worked. Using state-of-art technology from GFE had proven hazardous for its investors, and he concluded that advanced untried technology was unwanted in the MBE plant. Lunde recalled how GFE tried several times to sell him their high-tech installations but Lunde was sceptic as the GFE plants were still experimental and unpredictable; a simple demonstration of how un-pacified and ill-framed technology disfavours organized action. Instead, Lunde opted for a low-tech separation unit to separate the phosphor from the manure leaving behind a 'dry' and 'wet' fraction. Designed much like a washing machine, a low-tech mechanical centrifuge spins the manure at high speed separating it into a dry and wet fraction. The dry contains the phosphor, while the wet fraction is returned to the farmer as a much more potent but less pungent fertilizer. Nitrate levels are reduced as the digestion process makes it more accessible to crops thus reducing the chance of nutrient runoff.

However, the plant would also require many other new components. The plant alone would need eight biogas reactors and take up 6-8 hectares of land. To transport and return the manure a combination of manure trucks and an extensive 350 km underground system of double pipeline would be used to pump the manure directly into the reactors and return the degassed manure the same way. Five manure depots would be constructed at centralized locations for farmers to store manure. From here pipelines would pump it to the plant. This would require a new computer system to keep track of each farmer's input and output. In addition, the plant would require all the usual plant gadgetry: pretreatment facility to kill of any germs and bacteria to avoid potential deceases to spread as the manure is returned, pressurized truck halls, air filters, and flaring equipment to prevent or eliminate odor problems. Finally, the valuable biogas would be transported by pipeline directly to the nearby Maabjerg CHP plant for electricity and heat production using a new customized gas turbine. It would supply 4600 households with heat and 11.000 with electricity in the two adjacent municipalities of Holstebro and Struer in effect providing 100 percent renewable energy. At an estimated cost of DKK 250 million the plant could be ready by January, 2007. There were plenty of good intentions in the MBE project.

Several other challenges, each vital to a successful transaction were also in the way to completing the transaction. Firstly, Lunde was faced with enlisting the support of numerous and disparate interest. As a crucial ingredient, he had to frame the plant as technically and economically feasible, i.e. render it an economic good among the farmers. Secondly, the list of necessary approvals from local authorities was long and time-consuming to obtain. Environmental impact screening (VVM-studies), compliance with regional planning, construction site approval, other environmental approvals, technical verification of the plant layout, building permits, and compliance with a new EU directive Natura 2000 prohibiting human activities in predefined nature zones, were all necessary stops along the market encounter. Moreover, a 2002 EU-directive establishes guidelines for the transportation of biomass materiel in order to reduce the risk of spreading hazardous and contagious deceases, thus impacting how truck arrival halls, and the decentralized drop-off tanks were designed. Finally, time was of the essence because to obtain the government production grant of DKK 0.60 per kWh the plant had to be in operation by late 2008. Otherwise, economic feasibility could no longer be guaranteed. The project had already generated enough interest among the vast circle of agencies to secure the funding along with a DKK 30 million grant from the EU. Enervice had filed the application on behalf of Maabjerg Bioenergy in a consortium with a British and Dutch energy project totaling DKK 75 million. While two-thirds of the grant would be allocated to plant construction and technical feasibility studies, a key condition was to construct a visitors and educational center next to the plant.

But above all, discarding the dry fiber fraction was the greatest concern and challenge. Separating the phosphor into a dry fraction was only the first step towards framing a technical device able to secure farmers with regulatory compliance. From a regulatory perspective, separation itself did not equal to compliance and thereby permission to expand livestock operations. The dry fraction had to be discarded one way or another, i.e. it too had to be economized along with the biogas plant itself. What was missing was a solution to effectively discard the dry fraction upon separation. Up until now no one had come up with a solution Lunde found viable. Who needed 500 tons of additional phosphor every year? Other plants had relied on selling it to crop farmers or plantations in need of large quantities of concentrated phosphor but they were few and far in between. Moreover, as existing phosphor levels in Denmark are already too high its use in fertilizer was banned. Another idea was to export it to Eastern European countries where phosphor represented an economic good but Lunde turned up empty-handed in search of potential clients. Instead, a Rambøll engineer suggested it be incinerated for energy production, just like other forms of biomass material (straw and wood whips). Biomass is the largest source of renewable energy in Denmark followed by wind power. Rambøll calculated that the phosphor energy yield was sufficient for the nearby Maabjerg CHP to consider it valuable. And as the power plant was equipped with the necessary kettles it was the preferred choice which required limited retrofitting. The response from Elsam was favorable.

Transforming separated dry fraction into a valuable source of biomass was a new untried concept in the Danish energy system demanding further technical and economic analysis, and approval from the local authorities. Among others, it would need a special weight system at the plant. But Lunde quickly discovered a much greater problem preventing this solution from taking place: phosphor was not approved by the government as a biomass resource to be used as a source of energy. To do so, it must be listed in the government's Biomass Directive which stipulates the forms approved forms of biomass such as wood chips, straw, and so-called energy crops. Being listed also provides the additional value of being exempted from waste taxes. Instead, Lunde found livestock manure on the list of hazardous waste by-products which required expensive waste treatment and was imposed waste taxes. Lunde calculated that discarding phosphor as a waste product, would result in a DKK 25 million tax penalty, subsequently making MBE uneconomical. There was only one solution. Convince the government to allow the incineration of livestock manure. Until then, phosphor remained an invaluable waste product. Until it was permitted entrance to this prestigious list and subsequent tax exemption, there could be no plant in Maabjerg. To accomplish this he had to enlist the Danish government. In late 2003, Lunde wrote then-minister of the Environment Connie Hedegaard, informing her of the MBE project and the need for regulatory changes. In parallel, Lunde used his personal ties to high-ranking government officials to advance the process and ensuring it was brought to her personal attention. In fact, a key reason for being appointed project manager was his extensive network which included ministers of the Danish government or their relatives, as Lunde explained to me. On this occasion, Hedegaard responded favourably to Lunde's letter, stating she would instruct her officials to look further into the matter and solicited all available data on the project. According to Lunde, it was not only his personal ties to the government but also the value the MBE project represented to the government. Since the 2004 energy policy, the government had hoisted biogas plants as a vital instrument in mitigating climate change and increasing Danish renewable production. They expected 40 new plants by 2010, and in the revised energy policy from 2007 the target was increased to 50 new plants by 2020. But so far only a few plants had been constructed. The MBE plant was also instrumental in implementing environmental and agricultural policies in which biogas plants were often framed as an important device.

3.3.2 Enlisting The Local Community, Reframing Biogas Plant Overflows

We shall soon return to see how Lunde deployed devices towards changing the government's valuation of MBE as part of an effort to have them change the legal definition of livestock manure. Meanwhile, a new overflow suddenly emerged threatening to provide Maabjerg with a similar fate as in Brædstrup.

In December 2003, a local citizen heard rumours of the plant circulating in the close-knit community. He happened to be a member of the local house owners' associations neighbouring the Maabjerg CHP towering 125 meters a few miles north of the residential community. Concerned of the prospects of the biogas plant he informed the remaining community including his chairman, Per Nikolajsen. It was also the first he had ever heard of the plant. In February 2004, the local newspaper reported the chairman was upset he had not been informed by Lunde along with minister Hedegaard. Lunde had expected some type of response once plans of constructing the world's largest biogas plant circulated. Lunde decided to organize a field trip to the Holstebro sewage and wastewater treatment plant. The plant featured the same odor reduction technology planned for the MBE plant, and fitted Lunde's framing of biogas as a similar treatment facility for manure. Lunde organized a tour and presentation of the plant with the plant manager, who he knew personally, followed by an opportunity to ask questions. Lunde personally arranged to pick up some of the local residents in his car on a cold winter night in February with everybody else following behind. En route to the plant, emotions ran high from the back seat of his car as they accused Lunde and the MBE project of only looking out for the special interests of farmers. Lunde listened but refrained from entering the dialogue prematurely and decided to await the outcome of the field trip. He hoped the guided tour would change their negative framing of the biogas plant.

> "I knew they were concerned of the consequences for their community, especially odour problems (...) I wanted them to understand that the plant was no different than the sewage treatment facility, which had been in operation for years and had not created any problems. (...) I chose the tour because I knew people were concerned. I live here myself, so I knew what would work and what wouldn't if it was me. Plus, we knew how terrible it had gone for Brædstrup (...) The best I could do, I thought, was to provide them with a chance to see for themselves that a biogas plant would be just as harmful (...) I mean, the plant would use the same kind of [odour retention] equipment as the sewage plant. And in principle it is the same thing they do." (Lunde, 2009)

The hostility towards MBE was noticeable, but according to Lunde after spending an evening at the sewage plant, it had successfully mitigated most of the concerns. From my interview with Lunde, it is apparent that he had recognized that citizens had personal and subjective issues with plant. In valuating MBE they were not concerned of the socio-economic cost much less the agricultural reasons for building the plant, but above all concerned with the personal consequences of allowing the plant to operate in the their community. In other words, a dominant subjective evaluation principle governed the valuation. And Lunde knew this. In addition to adopting a pro-active approach to it as opposed to waiting for the controversy to escalate, what is interesting to notice is how Lunde selects and frames a specific device designed exclusively to successfully frame MBE in such a way that the local community is enlisted as part of the MBE frame. He explained how he and the sewage plant manager spent a lot of time setting up the device itself to allow the citizens to personally see how the potential overflows would be solved by existing and pacified technology. Guided tours are not standard practice. It had to be organized and set up. An invitation had to be distributed, people contacted, the venue prepared with tables and chairs, presentations outlined, and the tour itself had to be organized in such a way that visitors learned about the odour retention equipment. In deciding how to mitigate local resistance Lunde identified them as a central agency, took their matters of concern into consideration before designing the device around these concerns. From the marketization perspective, the device performed the same task as a market encounter by bringing key agencies and the good together to provide a well-framed venue to perform valuations.

What we learn here is that Lunde deployed a device designed to address the specific subjective evaluation principles governing their thinking in a way a flyer or open letter to the local newspaper could never accomplish. In doing so, he enlisted the local community by reframing the potential biogas overflows, at least on paper. Whether the plant once constructed avoids overflows is an entirely different matter. Local citizens feared biogas overflows were harmful to them, but by means of creating a market encounter with what Lunde considered the next best thing, he had reframed potential overflows. Another device such as a flyer could not have accomplished this because a flyer cannot reproduce a biogas plant on paper the same way a sewage treatment plant can do, let alone create a personal association with opposing agencies. Similarly, the sewage treatment plant cannot adequately satisfy agencies governed by objective evaluation principles. Farmers for instance, would also require calculations, reports, and design blueprints to inscribe that the plant is economical, that odor retention systems works, etc.

On the way back in the car, and in the days and weeks to come, Lunde noticed a markedly different sentiment from locals. They were no longer criticizing the plant for its potential harmful overflows and newspaper articles on the subject ceased. However, they were not 'fooled' stressing that they knew full well the reasons for constructing the plant. Some citizens, including chairman Nikolajsen were fully aware of the underlying purpose of the plant and the regulatory situation Danish agriculture was in.

> "After all, we are talking about what will become the largest plant in the world…At the end of the day, what this comes down to is for farmers to be allowed to produce some more pigs." (De Bergske, 2004)

It was Lunde's perception that the tour was a success in its ability to avoid a permanent overflow to build roots and spiral into a local controversy over the plant.

> "I would like to stress, that I am always ready to engage in dialogue with the concerned citizens in the area, or any other interested in information about the biogas plant. That is why citizens were invited along to the sewage treatment plant…We would love to talk about what we are undertaking here, because we have nothing to hide. We hope it [the biogas plant] will benefit our entire community, so not only farmers benefit from it" (De Bergske, 2004)

In my interview with Lunde, he elaborated on why he resorted to arranging a guided field excursion as opposed to distributing a letter detailing the same information.

> "I am okay with people contesting the project. All I ask is that people do not pass judgment without the necessary knowledge and information (…) So, yes that is how I always work, pro-actively. (…) When some new problem emerges I address it head first. I don't leave it hanging, allow it to build momentum only to hurt the project later on." (Lunde, 2009)

Since the field trip, resistance from the local community has been limited. To this day, Lunde receives an occasional letter of protest usually by email. He responds to each of them either by phone or by email. If he notices any significant organized protests against the project he will resort to a similar approach to mitigate it. In doing so, it appears Lunde has achieved a closure on a potential local controversy over biogas. But the occasional letter of protest and Lunde's vigilance towards renewed local resistance only underscores the temporal nature of controversies. They can become hot at any time. Meanwhile, Lunde was able to continue creating the necessary changes to frame the plant for transaction. And once more, another device was needed to change interests and valuations of MBE.

3.3.3 Enlisting the Danish Government, Reframing Legislation

Key for MBE was to change the Biomass Directive to allow for the tax-exempted incineration of the dry fiber fraction. On first inspection, the legislation had overflowed when Lunde decided to incinerate the dry fiber fraction. It was not so much the Biomass Directive Lunde needed to enlist, but rather the Danish government as they were the only agency with the authority to institute such change. And it would require more than a letter advocating for change. During the autumn of 2004, Lunde continued lobbying for the regulatory changes using every possible channel of communication he had to the Danish government. Specifically, he told me he knew several Danish ministers on a personal level, which he used to promote MBE and argue for regulatory changes. Several other organizations including the BIA and its very influential parent organization, the DMA also got involved. But with the government nearing the end of its first term, PM Anders Fogh Rasmussen called for general elections in January 2005 putting the entire legislative process and political system on hold. Lunde had known all along an election could derail his plans, and he feared the worst:

> "If we do not get the phosphor included in the biomass regulation on par with straw (…) we risk having to pay DKK 20 million in annual fees to the state for burning the phosphor and that pretty much makes it impossible to realize the project." (De Bergske, 2005)

Luckily for Lunde and MBE, Fogh Rasmussen won the election and Connie Hedegaard could return from the campaign trail to her office. Following the election, an important move by Lunde was to remind to Connie Hedegaard that levying waste taxes by burning the phosphor was imprudent and impractical. His calculations showed that unless they were allowed to incinerate 4500 jobs would be lost in area as many farmers were forced to reduce operations to comply with environmental regulation (De Bergske, 2005). To assist the government, Lunde hired a company to analyze and estimate the consequences of constructing the largest biogas plant in the world. The report was financed using DKK 500.000 he had obtained from the county commission in early 2005 for an examination of the regulatory challenges. According to the report the plant alone would reduce nitrate runoff by 440 tons annually without affecting livestock production or employment in the sector. But to do so required regulatory changes. Lunde included the information in a document, along with detailed information, calculations, and architect drawings of the MBE plant. Called the 'Maabjerg Paper', the storyline was that MBE was a win-win solution for all the agencies involved. His plan was to circulate it whenever he came across vital agencies in need of a presentation of MBE. In early March, Hedegaard re-instructed her team of government officials to look into the calculations. As we shall see now, the Maabjerg Paper would become a central device for Lunde in changing interest and valuations of the MBE plant.

The Minister of Food, Agriculture and the Fisheries, Hans Christian Schmidt responded to Lunde's call by establishing an interdepartmental task force consisting of members from a wide range of ministries, governmental agencies and agricultural and environmental organizations chartered to 'uncover existing barriers for the use of livestock manure for energy production and promote the development of a sustainable and renewable energy supply' (Ritzaus Bureau, 2005). In effect, Lunde had managed to convince the Danish government to set up an interdepartmental task force with the sole purpose of looking into how legislation should be changed to accommodate the MBE project. According to the official charter, however, it was stressed that under no circumstances were any subsequent legislative changes allowed to lead to an increase in public expenses, especially with regard to changes to the waste tax. Bruno Sander Nielsen from BIA was also invited to participate in his capacity as key spokesman for the Danish biogas industry.

But the taskforce got off to a bad start. Sander Nielsen reported to Lunde, how a 'pessimistic and resigning mood' reigned among most of government officials especially from the DEA representatives. Including phosphor to the Biomass Agreement required parallel regulatory changes with regard to taxes, environmental affairs, and energy, and moreover many of them had difficulty understanding how a single biogas plant warranted such extensive work. As on previous occasions, Lunde deemed they did not fully understand the consequence and importance of the task force and responded by sending them the 'Maabjerg

Paper' detailing all the environmental, socio-economic, and energy-related benefits the MBE plant would entail along with sketches and architectural drawings of the plant itself. He considered it absolutely critical to frame them as part of the transaction. Signs of reluctance or outright resistance were translated by Lunde as a sign of lack of understanding and thereby lack of relation to the MBE frame, to which there was only one response: enlist them by framing a device that would provide them with knowledge of the importance of their association to the frame. As in the situation with the opposing local citizens, Lunde sought to provide the vital agency, in this case the government task force, the ability to perform valuations of the MBE.

> "I made sure the government task force understood the consequences of their work for the project. So, I sent in copies of the paper to the taskforce. And after that, the mood completely changed. I remember, Bruno calling me on the phone saying the most amazing thing had happened. All of the sudden, they were working together and were very excited about the project. While, there were still rogue elements at least now they understood why the changes were necessary." (Lunde, 2009)

Upon reading and discussing the material in the task force, Sander Nielsen had noticed a dramatically change mood among in the task force. In my interview with Lunde, he could only contemplate as to why the Maabjerg paper helped bring about this change.

> "The paper itself did not do it alone. Bruno Sander Nielsen also played a role in motivating the taskforce. But I clearly remember, how it [the paper] was the first thing he mentioned on the phone. I mean it was the only thing that had happened in the meantime, and the change was so dramatic that I am sure the paper had something to do with it. I was surprised myself." (Lunde, 2009)

In combination with Bruno Sander Nielsen advocating MBE in the taskforce, it appears the paper as a device played helped enlist a sufficient member of the task force. With numbers, drawings, calculations, and explanations of the need for a legislative change he had explained how the taskforce and its recommendation were critical to the realization of the project. From the perspective of framing agencies, it can be argued the device participating in calibrating and configuring the qualculative capacities of task force, but from the perspective of evaluation principles it appears the paper satisfied the criteria by which members of the task force judged the situation. Judging their reaction based on the influence of the paper, they did not oppose the task force per se nor were they upset over the time and resources it consumed (although many properly had other things to do) but did not comprehend its purpose. Upon translating the device in the context of the priority the government was giving biogas at the time, they responded by acting in accordance with the charter. This indicates they were primarily governed by the same objective evaluation criteria as Lunde, i.e. they did not personally oppose it but were organized in a task force to complete a task for the government.

As mentioned above, the device was part of a distributed effort by many to frame and enlist the support of central agencies. Biogas was riding on a tidal wave of attention from state legislature following the election in which climate change mitigation had been a central campaign promise by the government. As part of the focus on legislative barriers for biogas, the Parliamentary Committee on Energy held a hearing on biogas on April 20, 2005 while the task force was still working. At the event, Alan Lunde from Maabjerg, Preben Andersen from Brædstrup, Henrik Høegh and Bruno Sander Nielsen from BIA were among the keynote speakers. It was an opportunity to address Members of Parliament and other key stakeholders on energy at one time. To their advantage only proponents of biogas were present. Bruno Sander Nielsen stressed that biogas was among the cheapest solutions to reduce CO2 emissions at a cost of only DKK 40 ton/CO2 compared to the governments threshold price of DKK 120. In addition to this, the environmental benefits 'came for free'.

In early June, 2005, the task force recommendation was ready. The report recommended using the dry fraction for energy production as it was an optimal socio-economic alternative. It had identified several legislative barriers currently preventing its use, stressing that the legislative barriers were unintended as no one had previously thought of using separated fiber fractions from livestock manure as a source of energy (Ministeriet for Fødevarer, Landbrug og Fiskeri, 2005; Ingeniøren, 2005b). Reframing the legislation would require policy-makers to amend regulations in four different policy domains relating to agriculture, the environment, energy and taxation. A week after the report was published a press release from the Ministry of Food, Agriculture and Fisheries dated June 9, 2005 announced that the government would make the necessary legislative changes in accordance with the recommendations thus allowing livestock manure as a source of energy. Although, the legislative process would still take some time, and pended EU approval, the press release was a signal from the government encouraging MBE to continue with the project. By spring 2006, almost 18 months after Lunde initially decided to enlist the government he had succeeded. The final regulatory changes passed through Parliament, and both the minister of finance and minister of taxation promised to work with the EU Commission to secure their approval.

3.3.4 Reframing An Overflowing Economic Feasibility Study

In the meantime, Lunde had been preparing the tender for public offering required under EU regulation. In obtaining co-finance from the EU this particular aspect of the transaction process was prolonged as Lunde had to comply with specific procedures and criteria. He could not just pick a contractor. As such, the tender itself constituted a vital device i.e. when relying on EU funds only by means of a public tender was Lunde allowed to proceed in the transaction process. Updated calculations estimated a total cost of DKK 350 million and construction to finish by 2008, a year later than originally estimated but still in time to obtain the state production grant. The sheer size and complexity in the technical configuration of the plant meant no single biogas corporation had the necessary resources to undertake the project. Lunde planned to frame a consortium of constructors and suppliers. Several biogas contractors had already indicated a strong interest in the project and on August 1, it was submitted. Construction was set to begin in autumn 2007.

Lunde prepared the numerous detailed technical, environmental, and economic analyses needed to estimate the final feasibility and cost of construction for the public tender. However, updated calculations showed the kettle used to incinerate the dry fiber fraction had become too expensive. Local authorities had informed Elsam that they refused to allow the CHP to incinerate the dry fraction, arguing environmental legislation prevented such practices until it was fitted with necessary technology to cleanse the smokestack from any hazardous particles. Consequently, the local power company and owner of Maabjerg CHP, energy incumbent Elsam withdrew from the project arguing that retrofitting the kettles would be too expensive to accommodate the dry fibers. In the meantime, two years of waiting for regulatory changes had also increased prices on components for the plant by 12-27 percent bringing the price of upgrading the kettle to DKK 50 million. But with a DKK 0.60 production grant, MBE could only afford the DKK 30 million. In other words, the economic feasibility study, an important device for Lunde and the farmers, had overflowed. Being dominated by an objective evaluation principle, Lunde decided the only correct course of action was to temporarily postpone the MBE project, which he announced on November 21, 2006 pending improved economic conditions. In the media, he explained the reason to shelve the project. Once again, we witness the strong objective and rational evaluation principles behind Lunde's decisions and actions.

> "When it comes to the construction of what could become the largest biogas plant in the world in Maabjerg things are not preceding as fast as they should. A fixed price on electricity, increases building cost, and a lack of approval from the authorities is the reasons why the plant as of January has been set on hold" (Landbrugsavisen, 2007)

> "If we started construction now, we would most definitely be bankrupt. We have had to put the project on hold for the time being. It is a very complex project, which is why it takes time." (Lemvig Folkeblad, 2007)

It was a setback. Just as the legislative barrier had been removed, the project was now on standby due to two other overflows, one exacerbating the other. Firstly, Elsam had lost interest in the project because they were not interested in retrofitting Maabjerg CHP according to the legal requirements, let alone paying for it. Consequently, pacification of technical configuration had been re-opened. With no other way of discarding with the dry fiber fraction, Lunde instructed the Rambøll engineers to design a new kettle which could be annexed the MBE plant to incinerate the dry fraction onsite. Secondly, combined with increased building cost the project was no longer economic feasible. Pacifying a new kettle of at the cost of DKK 50 million was still not fully financed with the current DKK 0.60 production grant for biogas production, unless other cost came down. To resubmit a tender, MBE needed an additional DKK 0.11 per kWh. Lunde had no other option than to await the outcome of the upcoming energy policy negotiations. In the meantime, Lunde continued with the kettle.

The 2004 Energy Act established a target of 40 new biogas plants over ten years, but as only one plant had been constructed the government decided to step up its efforts. Meanwhile, the government was also responding to concerns over climate change. Following the government's latest revision of Danish energy policy, called *The Visionary 2025 Energy Policy* from February 2007, the government had been negotiating a new national energy policy and terms of payment for renewable energy production. With a long-term vision of an energy system based on 100 percent renewable energy and considerable reductions in CO2 emissions, renewables had become a long-term goal. Biogas in particular had become a top priority, due to effective lobbying by the BIA. Under the new energy policy, 50 new plants were expected by 2020.

By October 2007, negotiation between the government and Parliament remained unsettled, and then for the second time, the MBE project was affected by a general election. Three weeks later Fogh Rasmussen could call himself Prime Minister for a third consecutive run, and negotiations resumed. By now, the MBE project itself had become a vital device in securing a higher production grant. Representing the biogas industry, and by inference the MBE project, BIA lobbied for a DKK 0.74 per kWh production grant that was index-regulated as a measure of the inflation for all new and old biogas plants. Meanwhile, several MPs were highly interested in seeing MBE succeed. During negotiations in Parliament they kept Lunde continuously informed of any progress. Lunde explains:

> "As they were negotiating and they were getting closer and closer to a result, [MP] called me all the time to ask whether this [size of the production grant] would be enough to get MBE rolling again. I would respond, and then he would go back and then come back out again, call me up again to check whether this was enough." (Lunde, 2009)

Despite the series of overflows and prolonged process of completing the transaction, the MBE project was simultaneously granted the attention by highest levels of the Danish government. Lunde was well-connected and it appears the MBE project itself had become a vital device with which the production grant, vital to its economic feasibility, was framed. Apparently, MBE struck a chord with MPs and the government. On February 21, 2008 the new minister of climate and energy, Connie Hedegaard announced a new energy policy for 2008-11. For biogas the policy resulted in a historic improvement, most notably an index-regulated DKK 0.74 production grant for biogas. Just a few weeks before in December, MBE and the task force had convened to discuss whether to abandon the project all together, not knowing that once again regulatory changes were just around the corner. Later, at a conference in Holstebro on energy and climate change, the minister Connie Hedegaard openly admitted that just about everything possible had gone wrong for MBE, but believed the last overflows were reframed. Afterwards, she personally talked to Lunde, asking him for a complete list of other potential overflow with regard to MBE, where she could be of assistance.

3.3.5 Enlisting Maabjerg CHP, Reframing the Kettle

At this stage in the framing and transaction process, we have seen several examples of overflows from the transaction frame. Just as one human or material actor is in place, another one overflows. Unfortunately for Lunde, new calculations showed that the production grant was not sufficient to finance the pacification of the kettle in accordance with environmental regulation demanding the smokestack be properly cleansed of toxins and other hazardous particles. Chairman Merrild explains:

> "The energy act shows politicians have tremendous ambitions for biogas...Now the price is right, which is great. But now our problem is how to incinerate the separated fibre fraction, which is vital part of the Maabjerg-project. As it is right now, local authorities are setting the same technical standard as those of a waste treatment facility. Consequently, this entails a very large investment and huge cost of maintenance…The economic foundation cannot support it, even with the increased production grant…We are encountering one problem after the other (...) We are in this fantastic situation that we have the location and almost the environmental approval. But what good does that do if we cannot proceed" (Landbrugsavisen, 2008)

Despite the increased production grant, the local authorities' understanding of environmental regulation still held MBE to a high technical standard with regard to the kettle which required a vast investment from MBE.

Furthermore, as in the case with Brædstrup it is impossible for MBE to a priori identify new conduits for overflows. What gradually emerges is another form of resistance in completing biogas plant transaction; a resistance that does not stem from any particular actor or agency, but rather by the ill-framed nature of biogas markets themselves; a mixture of lack of a pacified good, an unstable alliance of agencies with constantly shifting properties, and an ill-framed and highly disorganized market encounter that makes it difficult to frame and organize the transaction. There are no rules and procedures in place in Holstebro to identity and reframe overflows as they appear. Instead, Lunde himself continuously plays a central role in reframing overflows in his capacity as biogas frame-maker. As the story develops, we shall look further into the resistance constituted by the overall ill-framed nature of biogas markets and the role of frame-makers.

Meanwhile, Lunde came a big step closer to a solution when he learned the new energy policy inadvertently forced energy incumbent DONG back into the MBE project. Focused on increasing renewable energy contribution the government had also instructed the state-owned DONG to increase biomass-based energy production by 700.000 tons. With 500.000 tons of manure, now classified as a valuable biomass material for energy production, MBE could in one blow bring

DONG close to compliance. Meanwhile, following the a major reorganization of the Danish energy[10] sector in which Elsam merged with DONG the Maabjerg CHP leadership had been reorganized introducing a new leadership with new interests. Shortly after the new energy policy was in place, the new Maabjerg CHP management team informed Lunde they would reverse the previous decision and re-enlist in the MBE project. The new Maajberg CHP manager informed Lunde there was no point in constructing a kettle when the existing one would suffice. A turnaround compared to one year ago, when they backed out.

> "I was really frustrated. We spent all this time and money on designing a new kettle after Elsam originally backed out. Then the new owner, DONG comes back and tells us that is completely stupid when they already have a perfectly capable kettle. I told them, "You are absolutely right. It is completely stupid, and that is what I've been saying all along!" (...) Nonetheless, it was good to have them back onboard." (Lunde, 2009)

Once again, we see how the constant shifts in agency properties and overflows have tremendous effect on whether MBE is framed as an economic good and is able to proceed with the transaction. For the first time we witness how this was not the outcome of our biogas frame-maker, but the unexpected outcome of other agencies efforts to inadvertently frame biogas as valuable. This put MBR back on track towards a successful transaction as calculations now showed it was once again economic feasible, in addition to reducing the effort required to pacify the plant significantly, thus avoiding another detour and instead taking an unexpected shortcut by using the existing kettle. It would still require some degree of retrofitting. Meanwhile, Lunde had also secured the initial environmental approval of the MBE plant from the local authorities but according to environmental regulation, any technical changes to the CHP plant automatically required updated technical, environmental and economic studies along with a new round of approval from city council, which in turn depended on another round of public hearing.

[10] In 2006, the Danish energy sector underwent massive structural changes as part of ungoing efforts to deregulate the sector. DONG was the merger of several power companies, including Elsam which owned the Maajberg CHP

Despite progressing further in framing the MBE plant transaction in the past six months than in the previous two years, local bureaucracy kept Lunde busy.

Although the economic feasibility had improved, Lunde's began noticing the first signs of dissent among the farmers. As shareholders in MBE, their combined investment of DKK 15 million would be lost if it was forced to shut down. At a meeting on July 2, 2008 it was decided to improve the economic feasibility even further. By changing the ownership structure they could obtain state-guaranteed loans at a more favourable rate compared to conventional means of loaning. Before, farmers owned 51 percent of the plant which would be financed through personal funds or bank loans on regular terms using the farms as collateral. However, by handing over the shares to the municipal-owned Vestforsyning utility company, which already owned part of the shares, it could fund the plant using state guaranteed loans at 1½-2 percent lower interest it had access to through the municipal credit company. Avoiding the large capital investment, farmers instead created an association of livestock manure suppliers with whom MBE would negotiate contracts for delivery of the manure. MBE would negotiate contracts with DONG concerning the 15.000 tons of dry fibre fraction and 18 million cubic meters of biogas. The move constituted a vital element in framing the transaction, as the farmers were no longer interested in putting up further funds after eight years. Also, Lunde had 'peacefully' established the rules and procedures for delivering the biomass, the dry fraction, and the biogas. In fact, to frame and organize the MBE transaction depended on framing and organizing the terms, rules, procedures, contracts, etc. for these three other transactions.

Similarly, during September Lunde was busy reformulating the public tender and pre-qualification of potential contractors for the construction work. In November 2008, two years after the first unsuccessful attempt, the tender was resubmitted. MBE was nearing the end, but the string of overflows and vital actors was not over yet.

3.3.6 Enlisting the Aquatic Salamander by Framing a Breeding Device

After reforming the Danish public sector, reducing the number of municipalities from 273 to 100 and replacing the counties with five major regions, the local municipalities had assumed the responsibility for environmental affairs. Until the new Holstebro municipality acquired a staff of its own, they hired a private consultant to undertake environmental analysis and perform other services. He was particularly concerned of the environmental impact of the MBE plant in case of manure leaks, and decided to investigate the proposed site.

> "There, he had reportedly seen the shadow of the so-called aquatic salamander in a water hole in the ground. Now, I was unaware of this at the time, but apparently this creature is protected by the EU habitat directive. It is an endangered species (...) The municipality had never heard of the directive in the first place, but the green guy [the consultant] had made sure to bring them up to speed." (Lunde, 2009)

It was another classic case of overflows, in which the MBE plant could have unintended consequences for parties outside the confines of the frame. Speaking on behalf of the aquatic salamander was local environmentalist and the EU. According to the EU habitat directive, areas inhabited by species listed in the directive had to be removed to a secure location and consequently verified to be in good health. In fact, to ensure its wellbeing the relocation was not complete until the salamander population had doubled compared to the number initially determined to be affected. Lunde had several issues with this. Firstly, having lived there for many years the aquatic salamander is not an endangered species in Jutland; they are abundant and located throughout the area. But such regional differences are not accounted for in the EU-directive. If an animal is listed as endangered it applies as a general rule. Secondly, Lunde deemed it impossible to locate a suitable piece of property whose owner would allow the local authorities to drill multiple water holes to secure a breeding ground for the salamander. And finally, the cost of rescuing a few dozen salamanders was estimated to be high, and Lunde had no intentions of paying for it.

> "The local official who takes care of all the matters relating to our project, she treats us really well and we have had an outstanding cooperation with the local authorities, but I told them that there was no way we were paying for it and I doubted if they ever found farmer who was willing to allow them to dig up his land for the safety of salamanders. We are talking about a lot of holes because the directive requires that to be sure the removal is successful we have to confirm twice as many are alive than the number we initially estimated to be there (...) And she did feel guilty, because at this stage we had already been through enough. The project was important [to the city], and now the salamander was threatening to pull the plug on us. It just was not fair and we were running out of patience" (Lunde, 2009)

For MBE, it was yet another pause to an already strenuous framing process nearing its tenth year, and before construction could begin they still awaited the outcome of a public hearing before obtaining final approval and a building permit from the local authorities. At this point, Lunde was growing impatient. In addition to the constant arrival of new overflows and actors vital to the MBE transaction it had put a financial strain on the project, and the salamander problem had almost caused them to start over with finding a new construction site. As with Brædstrup, without a site there could be no plant. Lunde, being frustrated with process, demanded the municipality assume the full responsibility for finding a site including dealing with all potential overflows related to this particular aspect of framing the transaction. They willingly agreed, as they feared future overflows could derail and discourage Lunde and the MBE farmers from continuing the project. As Lunde said to me, they did want to cancel the project in the eleventh hour. According to Lunde, the municipality felt guilty for putting them through all these cumbersome and lengthy trials, especially in light of the strong interest in the plant and the progress made.

The local authorities eventually found a suitable site and after spending DKK 400.000 on drilling new water holes, bringing new salamanders into the area, and verifying their existence in the water holes, the aquatic salamander had been re-framed and added to the MBE project. In this case, it appears the city framed the necessary device themselves to comply with the EU directive. They had no subjective objections to the MBE plant, and their decision and actions clearly demonstrates that above everything else, they were governed by a similar objective and rational evaluation principle. They were interested in helping Lunde progress but not at the expense of the aquatic salamander or their responsibility of acting in accordance with the law. Similarly, Lunde did not object to the habitat directive itself nor did he take charge of reframing this particular overflow as on several previous occasions. Instead, he made sure of activating and enlisting another powerful agency to ensure the overflow was addressed and reframed, otherwise the proposed construction site would overflow as well.

> "It would insane to stop the project after 10 years, being so close to the finish line, just because of – and I mean this will all due respect to nature – the aquatic salamander. But it wasn't a one-time thing. It followed in the wake of a series of other incidents which the municipality knew had caused a major delay to the project (...) No doubt, they felt guilty and therefore assumed the full responsibility for finding and approving the site." (Lunde, 2009)

In agreeing to solve the problem, they had also assumed responsibility for part of the transaction and Lunde had secured a key ally in framing future regulatory entities should they emerge. But there was more to come.

3.3.7 Reframing MBE as 'Safe' By Framing A Safety Device

Lunde's patience comes under further pressure. Riding into the equation once more is the EU. According to another directive, Lunde was also required to complete a so-called safety report, which among others detailed the location of fire extinguishers. The purpose of this particular device was to document that the MBE plant was safe for employees to operate. Much like the habitat directive, it was a requirement no one was aware of even existed during the initial rounds of approval, not even the local authorities. This one represented a Gordian knot. On the one hand, city council needed it to issue the building approval but on the other hand, according to EU guidelines, to finish the report required the plant to physically exist. Lunde pleaded with the local official in charge of all issues related to MBE, arguing it could not be done.

> "In all fairness, no one ever knew it existed, least of all us. And neither did she [municipal official]. In fact, no one knew what this was but apparently someone had come across it and so they had to comply (...) she insisted, saying according to the EU she needed that report. So I hired a consultant to finish the report, well knowing it would be sketchy and only outline the intended safety measures. Low and behold, the 40 pages report was to me useless. At a meeting where the local fire marshall was also present, he said the same thing: that it was useless, and we had to await the construction of the plant. But she [the local official] was happy. She got what she needed, even though I might as well have handed her 40 clean sheets of white paper." (Lunde, 2009)

If and when the plant is constructed the safety report will be completed once more. As a device the report granted Lunde permission to continue with framing and organizing the MBE transaction. He had successfully framed another device to pass another checkpoint in what can only be confirmed as an ill-framed market encounter. At the same time, local authorities mobilized a specific section of the livestock regulation which the municipality translated into requiring individual environmental permits of each of the decentralized manure storage from the 200 farmers supplying manure to MBE. The MBE project relied on manure trucks to pick up the livestock manure directly from the tanks. As each of them were liable to overflow, literally, approval was mandatory. At the time of writing, this issue remains unframed but to proceed, it appears that Lunde has to enlist 200 potentially overflowing manure storage tanks into the frame as well.

The point is not to present the local official or the regulatory system as incompetent. As previously stated, the actions and interest of the local authorities clearly indicate the objective evaluation principles governing their thinking which perfectly explains the legitimacy in demanding the report. And in this case the new breeding ground and report met the underlying objective criteria as demanded by EU regulation. From the perspective of local authorities whether the MBE plant was valuable or not depended on Lunde's ability to satisfactorily frame the plant according to many different aspects pertaining to the same thing: whether any human or material actor including the aquatic salamander, employees, local citizens, private property, the natural environment, etc. could potentially be affected by an overflow from the MBE. Speaking on behalf of all these different actors the response to Lunde was the same: frame a device by which these actors are reframed. Not just any device, but a device which satisfies the specific objective evaluation principles of local authorities in effect granting him permission to proceed to the next overflow.

Construction is currently scheduled for August 2009. But as Lunde indicated at the outset of this story, he will not be surprised if the process overflows again and he once more has to frame new devices amid different evaluation principles. New vital actors can emerge, interests in the alliance can change without warming, new reports can surface, and the municipality can hire new people with other interests. We are reminded of the fragile nature and perpetual re-framing needed to frame and organize transactions. It is difficult to a priori ascertain who, why, when and from where overflows may appear and when an actor becomes 'vital' to be enlisted.

In late February 2009, Holstebro city council approved the technical configuration of the MBE plant. At the time of writing only a public hearing and final approval of the VVM-study stands in the way of obtaining the building permit allowing Lunde to sign the contracts and construction of the plant to begin. As protests from environmentalist such as the Danish Natural Conservation Association are expected, Lunde has already contacted them to tackle concern they may have knowing full well that it will take more than a Maabjerg Paper as a device to reframe them. How and by what device(s) Lunde will attempt to enlist the DNCA, remains to be seen. Regardless, Lunde will have to create a device that is not undermined by whatever evaluation principle governs their thinking. Although, many other problems may emerge under and after construction, seen from the perspective of framing and organizing transactions the MBE could become one of the first successful biogas plant transaction in Denmark in the past decade, albeit an arduous one.

Above all, what we learn from this account is that the road to completing the framing of a transaction is long, ill-framed, and unpredictable, at least as a measure of the number of overflows and unanticipated actors which emerge as vital for Lunde to (re)frame in his push to complete the transaction. The account underscores vividly that to transact with biogas plant it must be framed as a valuable economic good, which means the possibility of succeeding with the transaction is not a given but the outcome of a fragile and at times controversial framing process. In addition to consuming the better part of a decade, the Lunde account can best be described as a process of trial and error by which frame-makers reframe and enlist one actor after another, each of which Lunde did not a priori expect to be vital. The idiosyncrasy of each required Lunde to frame a different device configured particular to whatever the 'rite of passage' dictated. From the classic economic feasibility studies and technical and economic calculations used to enlist farmers and other investors, to safety reports, governments, field trips, and breeding grounds for the aquatic salamander. Complicating the process of framing the transaction further, there is never any guarantee that devices will achieve the desired outcome. Lunde could not be sure the field trip would achieve closure on the emerging local controversy over the location of the plant, or that the 'Maabjerg Paper' would be instrumental in shifting the interest of the government task force; it may just as easily have been undermined by the evaluation principles of the task force.

What we end up with is a complex process of framing and organizing biogas plant transaction. For every overflow solved, a new one evolved neither of which were expected. This complexity is not necessarily a problem on its own right. Many markets and market transactions are characterized as being time-consuming, such as a merger between two corporations which require approval from the proper authorities to avoid granting the new organization monopoly powers, and may therefore drag on for years and experience setbacks. Overflows and controversies are inevitable, i.e. local political agencies must protest agencies from overflows and when the law is breached, and local communities will object to biogas plant constructed in their backyard.

Each overflow activates powerful political agencies, stipulating what course of action is allowed and what is prohibited. Framing biogas plant transactions are in particularly politically regulated made evident by the numerous encounters Lunde had with the state and local political agencies. For every overflow to be solved and re-framed, local municipal authorities are required in the socio-technical assemblage. I am not accusing political agencies of foiling biogas plant projects. Political agencies simply act according to their interest and follow the rules of the game. They play by the rules of local democracy by organizing hearings, inviting the business community and public to comment.

What is demonstrated from Lunde's decade long attempt to complete the transaction is a different form of resistance compared to Andersen. In the former case, resistance came from specific agencies such as the political agency and local community but in the latter case resistance was constituted by the lack of a well-framed and organized process by which biogas frame-makers can progress from the decision is made to the biogas plant is constructed. The problem is then, that in contrast to a well-framed market, there are relatively few pre-established rules, procedures, or powerful agencies to address and engage overflows as both cases have illustrated. In fact, Lunde and Andersen automatically assumed the responsibility of addressing and solving these. To ensure the functioning of markets, thus the ability to frame and complete transactions, it must be able to respond to overflows and controversies in one fashion or another. If Andersen and Lunde did not either frame devices to reframe overflows, or delegated the responsibility to some other agency as Lunde did, the transaction will come to an abrupt halt. Instead, frame-makers are directed through a complex maze, dictating its direction based on interpretations of what biogas may or may not do. In Andersen's case he reached a dead end while Lunde, it appears, found a way out of the maze. Seen from the perspective of framing and organizing a biogas plant transaction, this situation makes succeeding highly unlikely and thereby not characteristic of a well-framed market.

What is more, the 'maze' itself is never stable but constantly undergoing change as new overflows or actors emerge as vital. To bring a new biogas plant to live in Denmark is not only a question of assembling the human and material means, but to do so where there are no clearly defined rules of the game which regulate interactions between human and non-human actors. To bring a new biogas plant to live means entering unchartered territory in which interaction is not governed. Instead, what guides them is a check list of actors to enlist and frames, but it is constantly undergoing change as new ‘to-do’ items are added, and other items are re-opened. David Stark’s analogy of putting the puzzle together as the pieces and master plan itself changes seem to fit (Stark, 2009). Behind every door Lunde found a new choice to be made between door A or B. And on several occasions he had to backtrack, only to discover a new set of doors. Put differently, the resistance Lunde encountered stemmed from a lack of well-framed framing process. As such, Lunde’s account in particular fuels the impression of biogas market transactions as being ill-framed. And when the entire framing process itself is ill-framed, completing transaction, thus delivering the good intentions of a single plant, becomes very difficult.

Having analyzed these two accounts of biogas plant transaction using the biogas frame-maker framework it is hard to identify well-framed aspects of biogas plant markets in Denmark. Not so much because of the distance frame-makers must travel, but much due to the constant arrival of new vital actors, overflows, mix of evaluation principles, the multiple set of devices needed, and finally the organizational resistance stemming from the lack of an organized process. Brædstrup failed, and Maabjerg has been on the verge of failure on more than one occasion. Although progressing much farther than Andersen the MBE transaction is not yet fully framed and completed. Lunde has yet to receive the final approval and obtain a building permit for constructing the plant, let alone able to begin biogas production. Simply put, they are not framed and organized to ensure the implementation of whatever good intentions for biogas are in place. A well-framed market is defined by how easy it is complete the same transaction over and over again; not as a measure of speed but to what extent the socio-technical assemblage of the market frame has the capacity to reframe overflows and reach closure with controversies as they inevitably emerge. Simply think of any ordinary market such as shopping for groceries at the local supermarket, purchasing a car, or even a house. These are all examples of well-framed markets. The entire process by which the transaction is completed, ownership is transferred, and potential overflows are addressed are internalized into the market frame. At least in theory, there are no unexpected surprises, or new unexpected checkpoints along the way. And as overflows emerge new rules and solutions are devised and integrated in the frame to keep the perpetual framing of well-framed market going.

In the next section, I shall discuss the broader implications of this particular form of organizational resistance in framing transactions.

3.4 Discussion: Challenges of Framing Biogas Plant Transactions

The purpose of this chapter has been to understand how leading economic agencies engage in the process of framing organizing a single biogas plant transaction. Is it a simple or complex task to transact with new plants amid fragility and controversy thus delivering the good intentions behind new biogas plants? I think it is safe argue, that delivering on the good intentions of new biogas plants by framing and organizing a new transaction is anything but simple. As a result, the obvious question now becomes, what does it take to frame a biogas plant transaction amid the ill-framed nature of biogas markets in Denmark? What are the challenges biogas frame maker's face in framing and organizing transactions amid different devices, evaluation principles, and organizational resistance?

3.4.1 The Relationship Between Devices and Evaluation Principles

The first topic relates to frame makers' use of devices in relation to the mix of evaluation principles we have seen at work. The framework brought the role of devices and evaluation principles to the forefront. The idea was that whether a device is capable of enlisting other actors, changing their valuation of biogas plants, or otherwise causing actors to act in accordance with the interest of the biogas frame-maker was influenced by evaluation principles, i.e. the criteria which govern how valuation is performed.

When it comes to biogas plant transactions it is difficult to describe the framing process without noticing how devices and evaluation principles take center stage. Framing and deploying ‘correct’ devices towards framing various (opposing agencies) governed by disparate evaluation principles is a key task for biogas frame-makers. It prompts us to discuss what makes material agencies and transactions devices effective or ineffective in their capacity to attach others to a frame. Why did Andersen, as the driver behind the transaction, not effectively mitigate the concerns of others? Did he fail to address their concerns, possibly because the tools and thereby his valuation principles, were inapt and not properly configured? Likewise, in Lunde’s optics how did his devices help securing the enlistment of agencies, even opposing ones?

Comparing the biogas frame-makers’ choice of device, the evaluation principles of actors they sought to enlist along with the outcome shows an interesting relationship. When farmers argued biogas would reduce the odor of manure using scientifically proven odor retention equipment, the public replied ‘no it won’t – on the contrary’. When the public argued the wind would carry the odor all over the entire community, the farmer’s argued distance from the plant to nearest neighbor was within the statutory limit of 300 meters. When the public feared road traffic safety, Andersen argued trucks would not operate during rush hour. When Andersen in an alliance with the BIA and DEA argued biogas was not a threat to groundwater reserves, county officials argued it could. When Velux argued manure particles would reduce overall window product quality and deter other business, Andersen offered to buy a significant larger site to create a buffer zone. None of these agencies were internalized and moved by Andersen’s devices. The framework reveals ‘objective’ versus ‘subjective’ evaluation principles by looking over the claims and counter-claims issued throughout the process. Whenever Andersen argued for biogas, he presented the objectified socio-economic, environmental, and national merits. He sought to enlist the public with objective claims printed on paper in letters to the editor, speeches at town meetings or through random encounters in the streets. In a response, local agencies presented subjective arguments based on evaluation criteria on how biogas would affect them personally in and around their home. Moreover, when the local community upped the ante by deploying petitions and letters to attract city council to their frame against biogas, Andersen maintained the same scientific and objectified arguments. By his own account he did not count local resistance as a key factor, and therefore never change tactics by framing another device more in tune with their subjective evaluation principles, such as a field trip, perhaps more effective in persuading some opposing actors, if not all. While they kept the alliance of farmers strong for two years and politicians relatively convinced of the socio-economic benefits, Andersen reiterated the socio-economic and environmental benefits of biogas but fell short of swaying the public in his direction because they did not address their particular subjective evaluation principles. It appears Andersen's devices were not properly configured to address these subjective issues. Interestingly, while he organized field trips for the city council to frame a direct and physical market encounter, which according to their statements was successful, nothing similar was organized for the opposing public agency.

Facing an identical challenge of framing and organizing a transaction we see a markedly different approach and outcome in the case of Lunde. His strategy was to counter whatever agency was activated by the MBE project, proactively with a mix of different devices. Lunde encountered similar resistance as Andersen from the local community. However, in framing the local agency Lunde framed a field trip to the sewage treatment plant as a device. Rather than arguing the biogas plant would not become a local liability using open letters in the media or flyers as devices, he chose to show them by framing a physical market encounter similar to the field trip Andersen used to enlist the political agency. As a device, the physical encounter was more effective in addressing the subjective evaluation principles of the local community because it was framed around their personal and subjective concerns and therefore more in tune with a subjective evaluation principle. Later, when the EU and municipality entered Lunde's frame as the key spokesman for safety and the aquatic salamander there was only one device that would allow Lunde to pass by these two particular check points, i.e. whatever the directive demanded Lunde would have to deliver. In this case, we find an objective evaluation principle in the sense that either the deliverables comply with the legal requirement or they fail which is why Lunde responded they only way he could: by relocating the salamander and outlining a safety report. Had he ignored the requirement, as he initially felt inclined to according to his subjective evaluation principle the transaction would have come to an abrupt halt, as the local official indicated to Lunde. In short, it appears Lunde was more efficient in reframing overflows and achieving closure with controversies, thereby avoiding the escalation Andersen faced. In fact, the MBE biogas never became controversial because the biogas frame-maker quickly addressed the overflow before it grew in momentum with a device framed to 'match' the evaluation principle.

I initially introduced the notion of evaluation principles to augment Callon's underexposed view on what cause devices to fail. He has argued that framing is a costly and difficult matter because to frame or reframe overflows or solve controversies requires a complex and expensive human-material setup of seasoned experts and a vast material metrological setup. Although Callon is not arguing that the chance of success increases as a function of the cost of the device deployed, this study finds that complex and expensive device can be overruled and undermined by the evaluation principle governing how other (opposing) agencies perform valuations and thereby decide whether to enlist. Especially in Andersen's case both the political agency and local agency did not respond to his objective arguments and calculations and were consequently not enlisted. Not even the country's most senior experts could convince them that biogas was worthwhile and completely harmful. Andersen's costly and complex devices failed to enlist the local agency because they failed to take into account their subjective evaluation principles. A device such as a field trip would have proved more effective as it is congruent with the subjective evaluation principle we have witnessed. Vice versa, Lunde continued to progress towards completing the transaction because his devices were more *in tune* with the evaluation principles of opposing agencies: field trip to sewage treatment plant, the government task force, the safety report, etc.

What emerges is a relationship between devices and evaluation principles. In framing a device it must be done so in accordance with the type of objective or subjective evaluation principles by the receiving actors, otherwise the device may be rendered ineffective and undermined by their evaluation principle, and the enlistment will fail. Failing to pass any scientific scrutiny, the stronger the opposition it is not only a question of framing complex and costly devices or metrological setups but also a question of framing it as a function of the objective or subjective evaluation principles governing by which criteria valuation and judgment is performed by actors deemed of vital importance to the transaction. In other words, Stark's notion of evaluation principle has helped explain why certain devices fail to enlist other actors and change their valuation of biogas and interest in the project.

Naturally, there are many other explanations. But I believe to have illustrated an interesting relationship between the process of organizing fragile and controversial transactions and the devices deployed to enlist vital human and material actors in light of their evaluation principle. It appears devices no matter how costly and complex can be overruled by the very evaluation principles governing how agencies perform valuations of technology, something which Callon's framing/overflowing literature has left underexposed. Exactly why some devices fail and others succeed is difficult to say. It will require more research to understand the specific characteristics of devices needed to address particular actors and overflows. However, the analysis and discussion here indicate that among the host of evaluation principles it is not irrelevant how a particular device is framed to frame a particular agency.

3.4.2 Biogas Frame-makers and Organizing Dissonance

At the same time, it would be naive to think Andersen could have enlisted political and local agencies by merely framing another device more in tune with the local and political agency, such as organizing a field trip for all of Brædstrup. In fact, after 15 different locations I doubt whether any such device exists. It was as if biogas was not wanted in Brædstrup, no matter how well Andersen tried stopping short of bribery.

Lunde's account clearly fueled and brought home the impression from the first chapter that as a superseding characteristic biogas markets were ill-framed markets of good intentions and the process whereby biogas plants become economic goods and are transacted is highly disorganized. The road to completing the transaction was a long maze of when new vital actors unexpectedly emerged to be enlisted, overflows to be reframed, devices to be framed, and evaluation principles to be taken into account; whether he consciously did so or not is an all together different matter. Lunde explained how he saw it:

> "In the past ten years, I have encountered just about all the political and administrative obstacles you can think of (…) the bureaucracy exceptionally difficult to dance around with because of its sheer size. (…) I have also witnessed lack of coordination between the various layers of authorities, unclear guidelines and delimitations of who is in charge of what, not to mention the number of times I have had to deal with local officials and staff (…) I know it is the cautionary principle we have adopted in Europe, but the bureaucracy is simply not geared to promote biogas." (Lunde, 2009)

This statement resonates a previous one from a newspaper article from 2007, by when Lunde was growing increasingly frustrated:

> "It appears, no one possesses the overall insight into all the directives, laws, and regulations which affect such a complex plant, and sometimes to me it appears to running in circles."

Lunde expresses concern not only over the complexity of the market encounter leading to a lengthy framing process, but more importantly over a lack of well-framed market both in terms of creating a direct path from start to finish but also in terms reframing overflows and solving controversies that have been identified in this project as key aspects of biogas markets. He acknowledges the 'cautionary principle' whereby state and local authorities seek to protect all living creatures from potential overflows, but in the current state of biogas markets this principle is not balanced by an principle of framing and organizing the process completing transactions. Instead, we find our biogas-frame makers undertaking the task of framing a biogas market where none exists to begin with. I interviewed Torben Skiøtt, Chief Editor of BioEnergy, the main biogas news feed in Denmark:

> "I should stress I don't know the Brædstrup story in any great detail to account for its demise but in my view we failed to take the concerns of the citizens seriously enough at an earlier stage. When we first discovered that the odor problem was really their main concern the damage was already done. We should have taken a more proactive approach and I am certain they will do so in the future" (Skøtt, 2007)

By his account, biogas frame-makers failed to fully appreciate, understand and take the matters that were of grave concern to the public into account at a much earlier stage. They automatically assume the responsibility of taking 'the concerns of the citizens serious', as if knowing beforehand there was no existing well-framed market organized to mitigate potential problems or finding solutions to controversies over biogas plants.

Meanwhile, we also find further evidence of the market making activity of frame-makers in the MBE account. For instance, Lunde automatically had the responsibility of finding proper solutions to the multiple overflows and controversies. From defusing local resistance, safeguarding a breeding ground for salamander, and pinpointing the whereabouts of fire extinguisher in security report towards framing the political and local agency were his responsibility. He eventually secured a deal with the local municipality, in which they assumed the responsibility for finding a suitable site, following an extensive period of multiple encounters with the local bureaucracy prolonging the project. However, this deal was proposed and negotiated by Lunde himself, and not predefined and inscribed into the market frame regulating behavior, allocating right and responsibilities, etc. As a consequence, the MBE transaction could easily have shared the same fate as Brædstrup.

It appears that biogas frame-makers organized what Stark calls an *organization of dissonance* (Stark, 2009). In his new book he presents the argument that in searching for what is valuable, dissonance - disagreement about the principles of worth – can lead to discovery by the generative forces and friction that arise from clashes between different groups. He is in other words advocating for overflows such like Callon is. Andersen's field trips to existing biogas plants, use of town meetings, and Lunde's field trips to the local sewage treatment plant, calls for a government task force, and personal encounters with top government officials were more than attempts to frame and organize a transaction and enlist actors into the frame. Both Andersen and Lunde sought to frame various local and political agencies by framing the various overflows and controversies over the plants. They were attempts to organize dissonance or frame the capacity to make overflows visible and come up with solutions; a capacity the ill-framed market of biogas plants currently does not possess. As such, they were attempts to frame a market where none existed to begin with. While often failing to agree on the economic properties of biogas, these clashes sometimes led to discoveries arising from the friction in the form of solutions to overflows or closure to controversies over biogas.

Following our visits to Brædstrup and Maabjerg from the front rows of market making the previous analysis is now complemented by a much richer analytical point about market making: biogas markets and the transaction they produce depend on the capacity of frame-makers to organize dissonance in markets where such an organization is absent. This issue is of vital importance to biogas markets, because unless as the overflows and controversies we have witnessed are not addressed and resolved, even if temporarily, they render biogas markets and transactions difficult to frame. Organizing dissonance is therefore a major challenge in organizing transactions.

I do not by any measure intend to criticize any particular group for deliberately and actively preventing biogas plant transaction from taking place. All of the agencies we have encountered in these accounts are simply playing by the rules which regulate and determine the legitimate actions within the frame. Political agencies abide by the law and deploy the right to prevent biogas plants. Local agencies deploy their constitutional rights by protesting biogas plants based on various personal interests and scepticism towards agricultural agendas. Nonetheless, what I have identified are instances where local governance structures are not sufficiently organized to organize markets in light of the fragile and controversial nature of technology such as biogas.

As such, in answering the central question of the different outcomes in Andersen and Lunde's transaction, the plausible answer is more complex than simply a question of choosing a device as a function of evaluation principles. Overriding this aspect of framing transactions is the forms of resistance encountered along the way. I doubt whether Andersen would have been able to enlist the political and local agency by any device, as resistance was embodied into the very fabric of the market (or rather lack of) through which he had to navigate in addition to the agencies he had to persuade. In Lunde's case he managed not only to enlist various political and local agencies by framing transactions devices as a function of evaluation principles (knowingly or not) but also to navigate past all the checkpoints in the extensive algorithm. Yet, regardless of how well Andersen and Lunde managed to frame and deploy devices as a function of evaluation principles the process of framing and organizing biogas plant transactions is thwart by the lack of an organized maze. You can compare it to doing errands in your local grocery story, but can never find the checkout counter, customer service, or the exit for that matter.

Indeed, in characterizing biogas markets we cannot by any measure speak of a well-framed market. What the values of biogas plants is, how to frame the transaction, who to include, who not to include, what devices to deploy, how to effectively address disparate evaluation principles, what endangered species to protect, and where to affix fire extinguishers all go to the heart of demonstrating the enormous fragility, and controversy in framing and framing and organizing biogas plant transaction in Denmark. When looking beyond the marketization framework it is obvious that the road to success is paved with challenges and in light of the present evidence we are left with little reason to be optimistic about creating well-framed markets. Whatever market assemblages are constructed they are by definition fragile, controversial, and always on the move. There are no easy fixes, a magic button to press, or solution to implement to create effective markets.

4 Markets of Good Intentions and Beyond

By 2020 the Danish government intends for 50 new centralized biogas plants to triple the production of renewable energy from livestock manure and other forms of biomass waste by-products, while achieving significant reductions in agricultural pollution such as nutrient runoff. But as this research project demonstrates, the markets necessary for biogas plants to be constructed in the first place, are not capable of this. They are neither adequately framed and organized to transform biogas plants into valuable goods, nor able to facilitate their transaction. Simply put, unless steps are taken to rectify the current situation what we end up with are more markets of good intentions. The problem is not so much the fragile and controversial nature of biogas plants *per se*, such as the technical and economic overflows or local and political controversies over biogas which render these plants undesirable or impossible to transact. Rather, what is preventing biogas plants from becoming valuable goods and preventing their transaction is a lack of attention aimed at creating markets capable of reframing and resolving the overflows and controversies that inevitably emerge as a function of marketizing biogas.

In light of this research into framing and organizing the fragile and controversial nature of biogas markets, what is now needed is a perspective that acknowledges that to implement technical solutions, and to realize the underlying good intentions, requires well-framed markets which focus on reframing and resolving the host of overflows and controversies that affect whether biogas plants can be exchanged as valuable economic goods. As such, farmers and the industry should stop asking for improved policy. Likewise, politicians should stop asking how much financial support biogas plants need. Instead of demanding 'better' technology and policy, this project strongly suggests a need to ask for 'better' markets. Only by being able to recognize overflows and controversies, make them 'calculable', visible and debatable can we arrange what David Stark calls 'organized dissonance', i.e.

clashes through which solutions to market barriers can be framed. Otherwise, what we end up with are more markets of good intentions.

4.1 Summary of Main Findings

The purpose behind *Markets of Good Intentions* has been to study the framing and organizing of biogas markets amid fragility and controversies. By studying the marketization of biogas plants markets in Denmark since its appearance in the 1970s, whereby biogas plants are framed as economic goods, and markets are created to render transactions possible, it has become possible to understand how overflows and controversies affect the framing and organization of markets and transactions. How are they reframed and resolved – if at all. Across the two main analytical chapters the project has developed answers to this question.

We began our journey into biogas markets by analyzing the past four decades of biogas plant marketization in Denmark to examine the framing and organizing processes whereby biogas plants are framed as economic goods, and markets are created to render transactions possible. The overriding question was to what extent can we speak of well-framed markets as opposed to ill-framed markets of good intentions in the case of biogas? Of particular interest, the analysis focused on the impact of overflows and controversies.

The analysis clearly demonstrates the fragile and controversial nature of biogas marketization in Denmark. They are the signature hallmarks of biogas markets. Whether relating to pacifying biogas as a good, framing biogas market agencies with capable qualculative capacities, or framing biogas market encounters, the marketization process exhibited a consistent tendency to overflow and spark controversy. In fact, the analysis identified a strong interrelatedness between the three forms of framing, i.e. if pacification overflows and is accompanied by controversies similar effects are felt on agency properties and market encounters. If one form of framing fails so do the others. Overflows and controversies can arrive at any time potentially cause the market assemblage to collapse. Especially in transforming a living and highly unpredictable organism as livestock manure into valuable biogas, the pacification process can easily overflow. Likewise, agency properties can quickly change and market encounters can be rendered unable to facilitate transactions. As such, markets cannot be assumed to exist, but are temporary outcomes of framing and organizing processes.

However, the main problem is not overflows and controversies themselves. The problem is that biogas markets are not framed and organized to address and solve them. As a consequence, pacification fails to favour organized action, agency properties are constantly shifting, and ill-framed market encounters fail to facilitate the transaction When overflows and controversies were not adequately reframed and solved, markets could not be stabilized. In the 1970s and 1980s it was mainly due to technical and economic overflows from the pacification process. The 1990s also saw its share of technical and economic overflows, but many were reframed. Instead we saw agencies were conduits of overflows, starting with the political agencies removing support from household waste sorting and later came the energy sector reform. Meanwhile pacification of biogas was progressing. In the past ten years, market encounters have overflowed and been accompanied by local controversies over biogas plant sites. When the technical and economic performance is unstable, when political support is waived, when controversies over plant site are not reframed and resolved markets cannot perform satisfactorily. As a result, the market is not adequately framed and organized to render biogas into an economic good while completing a transaction comes with a high risk of failure as there are no guarantees that local controversies over biogas plants will be peacefully settled to allow for plants to be constructed, or that biogas plants can obtain the necessary amount of industrial waste.

It was never long before a new attempt was made to materially inscribe biogas plants as a solution to a new kind of overflow. And as such, the marketization process could start over once more. With each attempt to pacify biogas plants and frame it as a valuable energy or environmental solution, came a new type of biogas plants, new agencies with different shapes and forms, and new market encounters as well as a number of unaddressed overflows and controversies lacking closure. What we end up with are not one universal biogas market, but multiple markets for biogas plants; markets for low-tech farm-scale, markets for farm-scale under STUB, markets for centralized as part of VEPs, markets for centralized plants, markets for centralized based on household waste, markets for centralized integrated with separation, etc. Each market with its idiosyncratic socio-technical assemblage of goods, agencies, and market encounters. Biogas marketization cannot be described as one gradual enhancement and expansion where the marketization of the present is afforded by the marketization of the past. Rather, markets are constantly evolving, restarting, and collapsing.

Biogas plants cannot be assumed to acquire the necessary economic properties simply because it has been pacified, or because agencies have performed favourable valuations of biogas, or because market encounters have been created to facilitate the transaction. Unless all three forms of framing succeed simultaneously, according to whatever good intentions are established, well-framed markets for biogas plants cannot emerge. The three forms of framing are not mere suggestions for well-framed markets. They are mandatory.

That is not to argue, that biogas markets have not experienced stable periods with well-framed markets. The late 1980s to mid-1990s saw a very stable period when pacification succeeded according to the set of criteria that were established. Here we witnessed how the government research programs were able to reframe overflows and mitigate controversies over biogas. Afforded by the successful pacification of biogas, the research programs were able show biogas was a valuable economic good thus able to dominate the marketization activity. Meanwhile, the market encounter was framed and organized in such a way, that it was relatively easy to complete biogas plants transactions thus ensuring the planned number of plants was constructed. However, it has never been more difficult to marketize biogas plants that in the past decade. Interestingly, the list of overflows from the pacification is very limited, i.e. it is both economical and technically well-framed. There is also tremendous support from the main agencies including farmers, biogas industry, and even the Danish government. This time the main issue relates to the market encounter, in the sense that completing a transaction is faced with unresolved controversies over construction sites, and potential overflows from biogas production. In fact, the past decade has showed an almost consistent lack of capacity to adequately reframe and resolve a growing number of controversies over biogas, the market encounter included. But as we can see, as long as closure is not reached on controversies over construction sites and solutions are not developed to allow incineration of manure, what we end up with are more markets of good intentions.

As such, the main problem with biogas markets today is not so much the fragile and controversial nature itself. No framing process can ever be expected to perform without occasional overflows and controversies. And on many occasions overflows and controversies can be productive. Rather, it is the fact that no one seems to be focused on framing and organizing markets in such a way that the fragility and controversies are reframed and internalized into the market function. The analysis established a strong relationship between whether markets are framed and organized to reframe overflows and resolve controversies while biogas plants are simultaneously framed and transacted as valuable economic goods. The 'more' well-framed, the 'better' good intentions were realized. Without rules, procedures, solutions, agreements, etc. in place to handle their inevitable presence markets cannot transform biogas plants into economic goods, and markets cannot ensure a successful transaction.

Well-framed and ill-framed markets of good intentions are not two distinct forms of market modes. They represent two extremes and biogas markets usually range somewhere in between. Currently, it appears biogas markets are approximating the characteristics of an ill-framed market, most notably due to unframed and unresolved overflows and controversies in relations to market encounters. However, that does not automatically entail that it is impossible to complete the transactions that ensure biogas plant are constructed. At this point, the second analysis raised the quintessential question of whether it is at all possible to transact with biogas plants in Denmark amid unframed overflows and unresolved controversies, let alone the capacity to achieve this? Surely, even in an ill-framed market it possible to transact with biogas plants?

After retracing the steps of two biogas-frame makers' attempt to construct new biogas plants the answer ranges somewhere between 'maybe' and 'most likely not'. In fact, the two transaction analyses clearly demonstrated that because biogas markets are ill-framed the process of purchasing and constructing plants is anything but simple and organized. Above all, the analysis showed that biogas frame-makers were central in reframing overflows and resolving controversies as they emerged. If there was no market to frame their particular plant as valuable and complete the transaction, they would have to frame and organize a market where none existed to begin with.

Navigating the ill-framed market while framing and organizing the remainders requires a host of different devices vital. However, biogas frame-makers often found their devices undermined, ignored, and overruled by the evaluation principles of those they were trying to enlist. In Brædstrup, local citizens were more concerned over the personal impact potential overflows (such as odour leaks and traffic) would have, than the socio-economic and environmental benefits of biogas. To succeed these had to be weighed against the evaluation principles of whomever or whatever frame-makers sought to enlist and reframe. The analysis also indicated that one of the biogas frame-makers was more effective in effective framing devices to enlisting actors that were vital and reaching closure with certain controversies.

However, once more the fragile and controversial nature of biogas markets is brought to the fore. Not only do overflows and controversies appear to emerge unexpected by the attempt of constructing biogas plants. The very prospect of overflows form the plants activated a host of opposing forces. Meanwhile, the process of framing and organizing a transaction in biogas markets can best be described as an ill-framed and unorganized maze in which the biogas frame-maker seeks to navigate. Furthermore, the maze is still under construction, and the frame-maker therefore finds himself responsible for framing and organizing the rest of the market in order to show the values of biogas and complete the transaction. The frame-maker is in effect framing and organizing the very market as well as the transaction. It is the ultimate proof of the ill-framed state of biogas markets in Denmark – they simply do not exist. They are markets of good intentions.

What has happened is that over the years a growing number of overflow and controversies have emerged in relation to biogas plants but have never been fully reframed and resolved. In other words, the very ill-framed state of biogas markets has activated new agencies voicing their opinion in turn keeping controversies hot and overflows unframed. Biogas markets are in some perpetual ill-framed state. The controversies over construction site have remained hot since the VEPs of the mid-1980s, yet a solution has never been found. Missing from contemporary biogas markets, are the 'rules and procedures' and overall capacity of markets to detect and make overflows and controversies visible, make them debatable, and eventually ensure they can be reframed and solved. Compare the situation with markets for automobiles. If the car suddenly breaks down, there are warranties stipulating rights and responsibilities, garages to repair it. In the tragic event you hurt and injure an innocent pedestrian, there are courts of law and insurance companies and policies to reframe such unfortunate overflows. And so on. In the case of biogas markets, none of these exists. Many of these must first be framed and organized. Lunde's account of how he had to institute multiple regulatory changes before he could legally incinerate the overflow of dry fiber fraction is a vibrant example. In terms of obtaining a building permit for a new biogas plant, the transaction is more liable to fail midway because there is no standardized well-framed way by which to obtain it.

Exactly why the powers to be have failed to look beyond the mere combination of technological innovation and policy as the main ingredients to implementing national energy and environmental policy, I do not know. However, this project has clearly demonstrated that a central explanation to the troublesome journey of biogas plant technology in Denmark is a complete failure to focus on framing and organizing markets, without which biogas plants are invaluable as economic goods and transactions are impossible to complete. As I have proved by keeping an inventory over overflows and controversies, they simply do not vanish. They linger around. And as long as they do we end up with ill-framed markets that are unable to perform the most elementary of tasks. I suspect, many people still see markets as some universal force in line with Dosi, Tidd and Utterback that automatically deploys the black-boxed 'free will' of market forces that pick the optimal, cost-effective solution between supply and demand. However, this project is testament to the fact that markets, much like everything else in human society, are temporary outcomes of complex processes; processes that can be unfolded and described. Unlike Utterback's argument, that the conditions for technological development can only be explained ex post, the frameworks deployed here shows that by the force of research, analysis, and argument they can be unlocked, described and understood in concrete terms. Markets are not some benevolent force like gravity. They can be molded, framed, and organized by combining human and material actors to form a durable assemblage. And just as easily can they be made to disappear. The question remaining to be answered is how, then are well-framed markets are created?

4.2 From Ill-framed to Well-framed Markets

What this project suggests, above everything else, is a markedly different perspective on implementing environmental and energy policy when biogas is sought enlisted as a valuable solution. A perspective focused on constructing well-framed markets, rather than the narrowed perspective on creating a supply of innovative biogas plants and demand stimulated by national policy that has characterized the past four decades of the life of biogas. Time and again, we witnessed how official targets of biogas proliferation were never realized because overflows and controversies remained unsolved, hence why biogas markets achieve little more than conveying good intentions rather than constructing biogas plants. To realize the good intentions of biogas in Denmark what is required are well-framed markets that are adequately framed and organized to 'tackle' whatever overflow and controversy will emerge.

The good news is that markets are human constructs and can therefore be tailored to accommodate society the way we see fit. At least in theory. We have already witnessed how for instance policy can be applied to fund technological development, set regional or national targets for their use, set prices, etc. Furthermore, to place the responsibility of implementing national policy on the shoulders of frame-makers such as Preben Andersen and Alan Lunde seems imprudent. The bad news (for some at least) is that although markets are human-material constructs, they are beyond the control of any single agency. Even the limited populations of biogas markets enroll too many different actors for any single agency in a democratic society to maintain control and coordinate the framing activities of market making. Not even the government will be able ensure a successful marketization. And apparently, neither is our current governance structure in the form of local democracy capable of solving local controversies over biogas. No policy can predict or prevent the fragile and controversial process of technological development and marketization. And nor should they. As such, we should not begin to entertain the idea of superimposing some kind overarching market organization agency with the power to control all aspects of marketization. That only works in theory.

Meanwhile, we would be making the erroneous assumption that there is consensus on what the overflow and controversy consists of, when in fact, the analyses of this project strongly indicate that is rarely the case. Simply think of Brædstrup. Keep in mind overflows occur all the time, without them being identified as overflows. The fact that several overflows remained unframed and controversies remain hot is a clear indication of what is, perhaps needed more than technology and policy is what David Stark calls an organization of dissonance. Only by organizing ‘clashes’ between different and opposing actors with competing valuation practices, is it possible to make overflows and controversies detectable, measurable, and visible which is vital before they can be reframed and resolved thus creating well-framed markets.

An initial step could be to analyze just how well-framed are the markets that are supposed to implement the solutions needed to realize the good intentions? Markets or parts of markets may turn out not exists at all, in which case efforts must be dedicated to creating them. Even if markets exist temporarily, the question is how well are they framed and organized to render goods valuable and facilitate the transactions. Is the good pacified to favor organized action? Do agencies possess the qualculative capacities and ability to dominate whether the good is valuable or not? Are market encounters in place to allow agencies to perform valuations of the goods in question, and facilitate the transaction? In short, how easy is it so purchase, implement, and operate the good? Such an analysis will reveal the plethora of overflows and controversies, for which rules, procedures, solutions, and what not must be framed and integrated into the market to rectify them. In principle, overflows and controversies cannot be avoided, but neither can they be sidestepped and ignored. At the end of the day, it all comes down to ensuring a ‘smooth ride’. For instance, this project has demonstrated that the greatest problem currently facing biogas plants in Denmark is the lack of well-framed market encounters. But as markets are undergoing perpetual change there is a consistent need to monitor market making.

In the end, no market can rule out overflows and controversies from occurring. I do not wish to indicate that solving controversies and reframing overflows is easy. Biogas technology exists today because of the concerted and hard work by generations of scientists, government officials and governments, engineers, the biogas industry, and grassroots movements to address them. Some succeeded, many more failed. Nor do I wish to discredit the many biogas plants which are alive and financially stable today. However, as with all aspects of human progress uncertainty prevails in every aspect of marketizing goods which is why overflows and controversies were excellent entry points into markets in the first place. They reminded us of the fragility in all human constructs, but they also remind us that all human constructs are only temporary. As David Stark reminds us, there are no final settlements, no single optimal metric; there are only clashes through which new mutually knowledge and answers can emerge. Unless markets are organized to make overflows and controversies visible and measurable no new insight, gadgets, policy measures, ideas etc. can be produced to (re)frame the perpetual fragile and controversial nature of biogas market making. And if that is the case, what we end up with are more markets of good intentions.

5 Danish Summary

Forskningsprojektet undersøger markeder for biogasanlæg i Danmark, forkortet til *biogasmarkeder*, som en omskiftelig og kontroversiel organisatorisk proces, ved at analysere hvordan uventede hændelser og kontroverser påvirker, at markedet konstruerer biogasanlæg som et værdifuldt økonomisk produkt samt at udbygningen af biogasanlæg finder sted gennem markedstransaktioner. Uden velfungerende og velorganiserede markeder kan disse grundlæggende økonomiske funktioner ikke finde sted. Projektets overordnede pointe er, at for at kunne indfri skiftende tekniske, politiske, og socioøkonomiske intentioner med biogas skal det pågældende marked være konstrueret og organiseret på en sådan måde, at det kan imødekomme de uventede hændelser og kontroverser, som karakteriserer biogasmarkeder i Danmark. I modsat fald er der tale om 'de gode intentioners markeder'. Selvom disse ikke altid kan forudsiges, og det er de selvsamme dele i markeder som udgør robustheden såvel som kilden til dens uundgåeligt skrøbelige og kontroversielle natur, er det essentielt for konstruktionen af biogasanlæg som et økonomisk produkt og gennemførelsen af disses transaktioner, at uventende hændelser og kontroverser løbende integreres i markedskonstruktionen. Dette indebærer, at de gøres synlige og diskutable i forhold til de kalkulationer og andre elementer, der er grundlaget for biogasanlæggets påstående værdi, og som markedets aktører opererer ud fra.

Projektets teoretiske grundlag er markedsantropologien af Koray Caliskan og Michel Callon som bygger på antropologiens forståelse af 'værdi' samt den relationelle ontologi i aktør-netværks teori (ANT). Markedsantropologien giver anledning til at formulere markeder og transaktioner som midlertidige socio-tekniske resultater af en konstruktions- og organiseringsproces under konstant indflydelse af uventede hændelser og kontroverser. Det betyder, at et velfungerende og velorganiseret marked betragtes som et, der kan identificere og imødekomme uventede hændelser og lukke kontroverser, i hvert fald midlertidigt i modsætning til de uorganiserede 'gode intentioners marked'. For at analysere denne konstante re-konstruktion og re-organisering inddrages det analysestrategiske redskab, kendt som 'følg aktørerne', skabt af den franske sociolog og filosof Bruno Latour. Herigennem optrevles de associationer mellem humane og ikke-humane aktører, der udgør delene i markedets netværk. Det empiriske materiale består af interviews med centrale personer fra biogasmarkeder i Danmark samt et omfattende sekundært materiale. På baggrund af forskellige søgeord er der i perioden august 2006-juli 2009 indsamlet en lang række artefakter i form af avisartikler, rapporter fra statslige biogasforskningsprogrammer og andre dokumenter, der omhandler biogas i Danmark.

Afhandlingen består af fire sektioner. En introduktion, to analysekapitler efterfulgt af en konklusion. Det første analysekapitel har til formål at undersøge, hvordan markeder for biogasanlæg er blevet konstrueret i Danmark siden de først opstod i 1970'erne. Ved hjælp af Caliskan og Callon's markedsantropologi demonstreres det, at processen hvormed biogasmarkederne konstrueres er stærk influeret af uventede hændelser og kontroverser. Der etableres en sammenhæng mellem hvorvidt markeder er konstrueret og organiseret til at identificere, imødekomme, og løse uventede hændelser og kontroverser, og dermed hvorvidt markeder kan indfri skiftende gode intentioner med biogas. Når det ikke lykkedes markedet at konstruere biogas som et stabilt og værdifuldt produkt, er man startet forfra ved at koble biogas på et nyt sæt gode intentioner. Siden 1970'er, er der således ikke tale om ét universelt marked, men om ét marked for hvert forsøg på at konstruere og organisere biogasanlæg som et værdifuldt økonomisk produkt i relation til et skiftende energi-, miljø-, eller klimarelateret problemer i Danmark. Analysen viser, at siden midten af 1990'erne har biogasmarkederne ikke været tilstrækkelig organiseret til at kvalificere biogasanlæg som økonomiske produkter pga. en række uløste uventede hændelser og kontroverser. Som konsekvens heraf, har det været yderst problematisk at gennemføre transaktioner hvorigennem nye biogasanlæg bliver konstrueret.

Den første analyse giver således anledning til at undersøge, hvordan centrale agenter navigerer i et marked karakteriseret af uventede hændelser og kontroverser, for at bygge nye biogasanlæg ved at gennemføre markedstransaktioner. Ved hjælp af et nyt teoriapparat baseret på Callon's forståelse for markedsinstrumenter og David Stark's koncept om evalueringsprincipper, viser analysen, at den proces hvormed transaktioner gennemføres hele tiden støder på nye uventede hændelser og kontroverser over biogasanlæg. Der er i den grad tale om 'de gode intentioners marked'. For at transaktionen således kan gennemføres kræver det, at essentielle humane og ikke-humane aktører hele tiden identificeres og efterfølgende overtales til at blive integreret i transaktionen. I den forbindelse er centrale agenter afhængige af at konstruere forskellige markedsinstrumenter til at kvalificere biogasanlæggets værdi og integrere modstridende aktører i transaktionen på en sådan måde, at de ikke undermineres af de evalueringsprincipper andre agenter anvender til at fremsætte modstridende værdisætninger af biogas. Hvorvidt centrale agenter i markedet lykkedes med at bygge nye anlæg afhænger således af at imødekomme uventede hændelser og kontroverser i markeder, og dermed genoprette den manglende funktionalitet og organisation i markedet til selv at opnå dette.

Forskningsprojektet konkluderer således, at udfordringen i at realisere regeringens nuværende målsætning om 50 biogasanlæg inden 2020, ligger således ikke alene i at sikrer et teknisk og økonomisk værdifuldt produkt. At konstruere og organiserer markeder er et midlertidigt resultat af en kompleks proces, som hele tiden er under pres fra uventede hændelser og kontroverser. Det handler således om at konstruere og organisere markeder så markedet kan identificere, synliggøre, og løse de uventede hændelser og kontroverser, der uundgåeligt opstår som funktion af de markeder, hvorigennem biogasanlæg handles og implementeres. I modsat fald, skabes blot flere af de gode intentioners markeder.

6 English Summary

This research project examines markets for biogas plants in Denmark, referred to simply as *biogas markets*, as a fragile and controversial process of framing and organizing by analyzing how unexpected events, called ‘overflows’, and controversies influence how markets frame biogas plants as a valuable economic good and ensure biogas plants are implemented through market transactions. Without well-constructed and well-organized markets these fundamental economic functions cannot take place. The overarching argument of the project is that to realize changing technical, political, and socio-economic intentions of biogas the market must be framed and organized to reframe and solve overflows and controversies that characterize biogas markets in Denmark. Otherwise, what we end up with are ‘markets of good intentions’. Although they are rarely predicted and constitute the robustness as well as the source of the inevitable fragility and controversy of the market, it is essential to the framing of biogas plants as a valuable commodity and the completion of transactions, that overflows and controversies are addressed and internalized into the market assemblage. This involves identifying and rendering them debatable based on the calculations and other elements that underpin the alleged value of biogas and the actions of market actors.

The theoretical foundation is the anthropology of markets by Koray Caliskan and Michel Callon based on the anthropology of valuation and the relational ontology of actor-network theory (ANT). It provides an occasion to address markets and transactions as temporary socio-economic assemblages of framing- and organizing processes under the constant influence of overflows and controversies. Consequently, well-framed and organized markets are defined as those that are capable of identifying, addressing and solving overflows and controversies, at least temporarily, as opposed to ill-framed markets of good intentions. To analyze this constant reframing and reorganizing the projects deploys the analytical strategy of ‘following the actors’, created by French philosopher and sociologist, Bruno Latour. It is thereby possible to retrace the associations between human and non-human actors which constitute the assemblage of the market. The original research consists of interviews with key figures from biogas markets in Denmark along with an extensive set of secondary data. Using a variety of keywords, between august 2006 and July 2009 produced a plethora of artifacts represented by newspaper articles, reports from government biogas research programs, and other documents pertaining to biogas in Denmark.

The project is organized into four main sections; an introduction, two analytical chapters followed by a conclusion. The purpose of the first analytical chapter is to examine how markets for biogas plants have been constructed in Denmark since they first appeared in the 1970s. Using Caliskan's and Callon's anthropology of markets it is demonstrated that the process whereby biogas markets are constructed is strongly influenced by overflows and controversies over biogas. A fundamental correlation is established between whether markets are framed and organized to identify, address, and solve overflows and controversies and whether markets are capable of realizing the good intentions of biogas. When markets fail to frame biogas as a stable and valuable economic good, actors have restarted by framing biogas on the basis of a new set of good intentions. Since the 1970s, what has emerged is not one universal biogas market, but one market for each attempt to frame and organize biogas as a valuable economic good associated to changing problems with energy, the environment, or climate change in Denmark. The analysis demonstrates, that since the mid-1990s biogas markets have not been adequately framed and organized to qualify biogas plants as economic goods due to a range of unresolved overflows and controversies over biogas. As a result, it has been extremely problematic to complete market transactions whereby new plants are constructed.

The first analysis thereby prompts an examination of how central actors navigate markets characterized by overflows and controversies over biogas, to build new biogas plants by completing market transactions. Afforded by a new theoretical framework based on Callon's notion of market devices and David Stark's notion of evaluation principles, the analysis shows that the process whereby transactions are completed is consistently influenced by overflows and controversies over biogas. Indeed, they are markets of good intentions. To complete transactions in such a fragile and controversial environment it is necessary for vital human and non-human actors to be continuously identified and enlisted into the transaction. In this regard, central actors are dependent on framing a host of market devices to qualify the values of biogas plants and integrate opposing actors into the transaction in such a way, that they are not undermined by the evaluation principles other actors deploy to present competing valuations of biogas. Whether central actors in the market succeed with building new plants therefore depends on their ability to address overflows and controversies thus restoring the functionality and organization markets lack to accomplish this.

The research project therefore concludes, that the challenge of realizing the government's present intention of 50 new biogas plants by 2020 lies not only in constructing a technically and economically valuable product. To frame and organize markets is a temporary outcome of a complex process constantly subject to overflows and controversies. The central challenge consists of framing and organizing markets to constantly be able to identify, make visible, and solve overflows and controversies that inevitably emerge as a function of markets whereby new biogas plants are transacted and implemented. Otherwise, what we end up with are more markets of good intentions.

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