Strategic Policy Approaches to Technological Development for Sustainability: The Role of Consensus Building and Experimentation

by

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University of California at Irvine, 1997

Submitted to the Department of Urban Studies and Planning
in partial fulfillment of the requirements for the degree of

Master in City Planning

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2000

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Abstract

This thesis explores how technological transitions can be better implemented in society, to help achieve sustainability goals. The focus is specifically on technologies that may imply a paradigm shift, which is a change in existing practices or norms. To overcome potential barriers to market and societal penetration, government has traditionally initiated regulations and economic incentives to help diffuse the technology. However, a major impediment to technological shifts is the lack of effective interaction among the relevant institutions and other stakeholders. Through case study examples, it is argued that effective interaction for technological transitions can best be achieved through the use of consensus building strategies which can help promote legitimacy, development of institutional relationships, and learning. In recognition of this, an additional strategy is proposed for government – creating a forum for effective interaction to test or experiment with new sustainable technologies.

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Acknowledgments

When I reflect back on my two years at MIT, I can only smile. Yes, it has been mentally challenging and rigorous, but it has also been personally rewarding both from an academic/career oriented view and from a personal point of view. Academically, I have been fortunate enough to work with an outstanding faculty and thesis advisor, David Laws. Through his guidance and support he has helped me to greatly enhance my professional development at the Department of Urban Studies and Planning. Other faculty members, in particular, Larry Susskind and his stimulating class on negotiation and consensus building has also helped to broaden my knowledge base. And John Devillars, as past New England EPA administrator,has also been extremely valuable in providing practical suggestions for my thesis. My research group members, and our Wednesday group meetings also provoked a lot of intellectually stimulating thoughts on the role of technology and consensus building. Our team included: Vandana Sareen, Ginette Chapman, and Jaisel Vadgama.

And of course, I want to thank my parents and sisters for all of their support, not just while I was slaving away at MIT, but for the twenty four years of my life. On a more personal note, my experiences at MIT have also been personally rewarding. At MIT, I have made many great friendships. But, in particular I want to thank Vandana for all of her support and friendship, especially when we worked in Olongapo, Philippines together. And also, Sotiris for always lending an ear when I would stress out at MIT. But, above all, I want to thank John Tolsma for all of his love and support.

Contents

Chapter 1

The Link Between Sustainability and Technology

1.1 Introduction

The objective of this thesis is to contribute to our understanding of the role government can play in technological transitions. It is increasingly recognized that such transitions are important for meeting societal goals, such as sustainability. Pollution prevention technologies can span from approaches which may require a paradigm shift to approaches which improve upon the existing process, known as end-of-the-pipe technologies.

Pollution prevention technologies that imply a paradigm shift, or a new way of looking at the world, may imply a change in existing practices or norms. These changes may span in the production process and organizational management. End-of-the-pipe technologies only require small or incremental steps, and do not challenge existing practices or beliefs. The focus of this research is on the later, the role of technologies that may imply a technological shift.

The research is grounded on the premise that when a new technology is introduced into society, it is likely to confront a host of challenges (regulatory, economic, structural, etc.). These challenges will be greater for technologies that challenge the existing practices or norms. Through an analysis on technological development and implementation, I identify a major barrier to technological transitions that is not associated with the mechanics of the technology, but with the pattern of social interaction generated by the development effort.

Many institutional actors are involved in the introduction of a new technology. Manufacturers, engineers, consumers, and regulators all play roles and influence each other. Because of the complex set of actors involved, and the multiple overlapping linkages between them, it is rare that one actor or one action alone, will determine the success of a new technology. Instead, the pattern of interaction among these different institutional actors will often determine the success of a technological transition. Current government initiatives focus primarily on regulations, incentives, and support research, and so fail to adequately address the need for effective interaction and coordination among the different institutional actors. The thesis suggests that government expand upon their existing portfolio of actions by creating a forum for effective interaction that brings together the different stakeholders, so that there can be shared knowledge and problem solving.

This leads to the question – what is effective interaction? Through different case studies on technology and implementation, three important effects of effective interaction have been identified. These set criteria for effective interaction are: legitimacy, promotion of institutional relationships, and learning. Consensus building is identified as a practical oriented theory that can help to promote these important criteria in technological transition. This thesis proposes that consensus building strategies be used to provide the procedureal framework for interactive experiements with new technologies.

1.2 The potential of technology

Although technology is often considered responsible for many of today's environmental problems, technological advancements can also provide solutions for many of these problems. The availability of technology to help meet societal goals and its role in helping to achieve sustainability goals can be illustrated in the Dutch 81 Options.

This document analyzes eighty-one different environmentally relevant technologies in sectors that under the proper conditions may help the Dutch meet economic and environmental objectives over the next 15 to 20 years.[1] The study found that many of the new technologies would make a positive contribution to environmental goals. Despite the ready supply of new technologies, relatively few have been introduced into broad use. The unrealized potential is not a technological problem, but the difficulty is a social and organizational issue. New technologies may imply a shift in existing practices or norms. These may be required at the level of manufacturing process, management, or consumer preferences. Change can be especially difficult, when organizational systems are dynamically conservative. For instance, it is technically possible to switch from non-renewable energy sources to renewable sources, however it may not be so easy to convince industry and all of the other relevant institutional actors to make the necessary structural changes [i.e. process changes].

Technologies, which may require large shifts in existing practices, as opposed to technologies that only demand, small or incremental changes, are the focus of this research. These types of technologies, which emphasize a transition to a new process, or a "paradigm shift" rather than trying to make existing systems more efficient with "end-of-the-pipe" solutions, are confronted by greater structural and cultural challenges.[2] These challenges may include economic, cultural, regulatory, or existing technological barriers.

1.3 The electric vehicle in California

The introduction of the electric vehicle in California suggests the societal challenges that may impede the introduction of a new technology. Policy commitments in California have pushed for the replacement of the traditional gas-guzzling cars with cleaner

[1] The Ministry of Environment, Housing, and Spatial Planning (VROM) of the Netherlands examined the technological opportunities in the five major areas of energy systems, new raw materials, production, information and communication, and transport systems [9].

[2] "End of the pipe solutions" focus pollution control from key point sources. This add-on type of technology, such as using filter screens for high smoke stacks, focuses on making existing pollution sources less polluting, rather than shifting or changing to an entirely new technology.

running, zero emissions electric vehicles. This transition from internal combustion to electric vehicles is an example of a large technological shift I will focus on.

With ambitions of curbing environmental problems associated with emissions from internal combustion engines,the State of California, mandated that 2% of all vehicles manufactured by car companies, be zero-emissions by 1998.[3] Two percent of the cars would have to abandon the use of fossil fuels and operate by solar energy or by electricity. Despite this strong regulatory push and the availability of zero emissions vehicles, electric cars are not in wide use.

The deficit between policy and practice suggest that there is more at play than incentives, in particular, coordination issues among the different institutional actors seems critical [4]. The infrastructure to support electric vehicles such as battery recharge stations is not in place. This deficit can be both a cause and effect of the limited demand for electric vehicles. On the supply side, car manufacturers may be reluctant to introduce the technology because of unstable and uncertain demand. Production and consumer costs must also be reasonable for car manufacturers to produce, and for the consumer to purchase in volume. Yet volume is often required to achieve reasonable prices. Moreover, it also depends on what alternatives are readily available for the consumer, such as the existing gasoline guzzling vehicles, which are cheaper for ownership.

These highlight the significance of interaction among stakeholders and coordination among institutional actors in technological shifts. Implementation can be understood to be a series of interrelated decisions involving a loosely coupled network of actors, none of whom has the power to affect change through unilateral action. Successful implementation must respond to this interdependence and recognize the demands of both its end user and the intermediary actors involved at various stages. It is their combined actions, and interactions that shape the success or failure of a technology. The need for an appropriate forum for interaction is apparent in other institutional actors' attempts to introduce a technological shift in society. The case study presented below describes an environmental advocacy organization's attempt

[3]California Air Resources Board, Report.

to introduce photovoltaic cell technology.

1.4 The Solaris Project

In 1998, Greenpeace International, an environmental advocacy organization set a point. Much of the discussion on photovoltaic cell technology at that time cited the need to solve the next generation of technical problems before moving the technology into social use. Greenpeace wanted to demonstrate that the technology was more ready than was acknowledged and that what was needed was a different kind of push. Their strategy had three major components: [4] 1)interest and a contract with individual consumers; 2) contract with companies with expertise in solar energy and coordinate to production; and 3) make the technology available in a form that would be attractive to Dutch households. To interest potential consumers, Greenpeace initiated a campaign to publicize the benefits of solar energy use. They then, gathered contracts from 5,000 Dutch households interested in purchasing solar panels. These signed contracts were used to convince industry and government to take steps in solar panel technology.

Greenpeace's effort brought together Shell Corporation which had manufacturing capacity and expertise with organizations with smaller firms like ECOFYS, a consultant organization that provided price calculations and helped to enlist other companies, such as RAUBANK a prominent German bank. These organizations coordinated to manufacture a final product and distribute it. The do-it-yourself kit allowed people to generate their own solar energy, while being connected to the traditional power grid. This type of compatible system allowed the user to switch-off between traditional electricity and the energy generated by photovoltaic cells.

The pricing of the solar panels were at a high of 2000 Guilders (about $1000USD). Greenpeace guessed that the price was too high that it discouraged consumers from purchasing it. To help lower the manufacturing costs, Greenpeace worked to convince

[4]The information contained here is based on an informational interview with Greenpeace International campaigner, Sander van Egmond, Amsterdam, The Netherlands, February 2000 and an informational handout on the Solaris Project provided by Greenpeace International.

the Dutch economic ministry to shift existing subsidies to its program. After proving to the government that there was was substantial consumer interest in photovoltaic cell technology, Greenpeace was able to successfully acquire a subsidy from the Ministry of Economic Affairs (NOVEM) to support the effort of this project. The subsidy lowered the cost of the panels to 1000 Guilders (about $500 USD) bringing the price of the panels into a range that was affordable to the average consumer. At the conclusion of the project, 5000 customers purchased a total of 15,000 panels. Consumers were generally pleased with the solar panels. However, some were critical of the fact that they were unable to actually see that the panels were generating energy. Similar to how it is possible to monitor how much electricity is being consumed with a traditional electricity meter, users wanted to monitor the amount of energy that was being generated by the panels.

1.5 Case analysis

The Solaris Project raises many significant issues about the potential role of government in the development of technology. First, it raises the issue that some technologies may be ready to be taken off the shelf or used in alternative ways in society, that can help to meet societal goals. In this case, photovoltaic cell technology was endorsed as one method to meet sustainability goals of reducing greenhouse gas emissions. Photovoltaic cell technology can be considered to be a technological paradigm shift due to the challenge it poses to the existing and widely used electricity grid system.

This case is similar to the electric vehicle as it also raises important interaction and coordination issues. The alliances and partnerships that Greenpeace formed with Shell and the other companies to promote solar panel usage in Dutch homes illustrates the numerous institutional actors, and coordination amongst them that may be necessary in order for a new technology to be widely used in society. Lastly, the case study raises important questions concerning the role government can play in helping to ease technological transitions to help meet societal goals. In Solaris, the purchase and distribution of solar panels was made possible only after a subsidy was provided by NOVEM to lower costs. This exemplifies the fact that existing regulations, and/or economic or social conditions may make explicit or implicit references to the development of new technologies. Government can potentially play a key role in shaping the necessary conditions that may be necessary for a technology to be introduced into society.

Chapter 2

Government's role

This chapter explores government's current role and their potential to help ease technological shifts. The three major strategies that government commonly employs to promote innovation are research and development, regulation, and market incentives. [1] Although, research and development is necessary, as the Solaris story illustrates, energy spent on improving the knowledge base can undercut the drive to act and diffuse the technology in society. This was evident in the Solaris Project, as it was Greenpeace, and not Government that finally took action to test the potential of solar panels in society.

"Command and control" regulations such as standard setting can promote changes by forcing industry to adopt innovative technologies. For example, in the California electric vehicle case, the state mandated that 2% of all vehicles manufactured must be zero emissions by 1998. This regulatory requirement essentially forced car manufacturers to chose from a limited amount of technological options to meet this requirement – either electric cars or solar cars. The problem with technological forcing is that government alone may not be fully capable of identifying realistic requirements for the different institutional actors to make. Setting unattainable or unrealistic requirements can possibly lead to resistance, as indicated by car manufacturers lobbying for more time to extend the deadline. Additionally, when the cars were finally out to market,

[1] Other strategies include information programs and voluntary programs [5].

demand for the electric car was low. And even today the demand for electric cars in California is still relatively low. This exemplifies the fact that mandating "technology forcing" standards, without fully understanding the possible constraints of industry and the other institutional actors that may be involved [directly or indirectly] may result in the technological shift failing.

Another strategy is creating market incentive programs. Market based instruments generally rely on the principles of economics, such as providing economic incentives for environmental compliance and economic disincentives for non- compliance. Tax credits, penalty fees, and emission trading schemes are a few examples. Although, incentive systems are generally favored over regulation by industry, government may not be fully aware of the different incentive systems that need to be created to encourage shifts in technological use.

The strategies of research and development, regulation, and market incentive programs can be effective only if there is sufficient knowledge of the appropriateness, and effectiveness of the different strategic policy approaches. However, it may be difficult for any one institution, such as government, acting alone or with limited information, to understand the "right" portfolio of actions to administer. Due to the variety of conditions that are necessary for a technological transition, "...public actors, if acting alone, are unlikely to have complete knowledge or resources to orchestrate a process of technological development. They may lack the practical experience with organizational, technical, and economic issues needed to convey their interests." [7] This points to the major weakness of these existing policies and programs; they do not foster the kind of interaction that may be important for technological transitions.

2.1 The role of government in coordinating interaction

The importance of interaction and coordination among the different institutions is broadly acknowledged in policy making. The experiences in the Solaris Project and the California electric vehicle case both suggest that technological shifts are often dependent on the interaction and coordination among the many different institutional actors such as industry, consumers, and regulatory agencies. Although, government agencies frequently spend time and resources organizing public hearings, citizen advisory panels, and other types of participatory approaches for many public issues, interaction processes in technological development has received less explicit attention. This chapter seeks to highlight the existing approach of government in promoting interaction in technological development and propose recommendations on improving the effectiveness of interaction.

An example, of an interactive approach to technological development is the Sustainable Technological Development Program (STD), in the Netherlands. In this program, major stakeholders are involved to articulate a vision on a desired sustainable future and then a method to achieve the vision is engineered.[2] This method called "backcasting," articulates long term goals to help direct the path of technological development so that it contributes to the realization of the long term vision.[3] The program methodology is divided into three phases: development of a long-term vision; articulation of immediate steps; and action on those steps. This approach assumes consensus in the long range vision will minimize conflicts of interest in the intermediate phase, and the progression between steps will unfold naturally without the need to rethink or reevaluate the process. This faith in the long term vision is tested by the conflicting interests of the stakeholders, the complexity, and the poten-

[2] The STD Program was an interdepartmental program (1997-1999) to research how the Dutch can become twenty times more environmentally efficient with sustainable technology in meeting social needs for the next forty years. Despite some of the procedural drawbacks with the STD approach, the program has added great value to the Dutch Government. The STD program has been instrumental in helping to generate concern and action for the development and research of new sustainable technologies. For instance, the program has helped launch research initiatives such as the Novel Protein Foods Program which investigates possibilities of developing a protein product that can play the same dietary role as meat, but without all of the environmental problems associated with the production of meat. Strains on the environment generated from raising livestock include excessive amount of manure, emissions from manure, pesticides, and the excessive use of space, energy, and raw materials.

[3] "Backcasting" is a term first articulated by Peter Steen of Sweden and then further developed by Professor Leo Jansen of The Netherlands. Interview with Jansen, The Netherlands, February 2000.

tially controversial nature of technology. The experiences in the Solaris Project and the California electric vehicle case both suggest that technological paradigm shifts require effective interaction to coordinate the actions of diverse institutional actors such as industry, consumers, and regulatory agencies.

What is needed in helping to improve technological transitions is an improved methodology for interaction that takes into account the characteristics of technological change, such as the complexity, uncertainty, and interdependence. To identify what demands an effective process of interaction, case studies have been reviewed on technological decision-making and experimentation. The cases illustrate how important interaction contributes to outcomes of policy making that are important for promoting the use of new technologies. Important interaction elements in the interaction process have been identified as legitimacy, development of institutional/political relationships, and learning.

2.2 Legitimacy: A democratic, fair, and equitable process

2.2.1 Case: High technology waste disposal site in Germany

Public participation in this experiment was reactionary by local citizens who were against the siting of the waste disposal site in their community. They directly opposed the scientific and technical decision making in choosing their city to have the high-tech waste disposal site [3]. The initial public opposition was overcome by an "open planning" process. Technical experts worked jointly with the local citizens to mitigate their risk perceptions by addressing them in both the technical design and management of the high-tech waste disposal site. The process included public hearings, discussions, and public dissemination of information through the media. The experiment was designed to test out new technical equipment to reduce any possibility of health hazards that may be related to the waste disposal site. The citizens also recognized that even with the proper technological equipment, there still could be human related errors such as the operating crew misidentifying certain types of waste. The concerned citizens wanted to practice precautionary principles by being able to "reverse" potential harm. A new technological solution was designed to "reverse" any damage by identification of clearly marked waste containers that could easily be retrieved if needed. Also, it was agreed that the plant be able to be shut off at any time in case of an emergency. The citizens were now satisfied.

Implications

This case demonstrates the importance of a fair and equitable process. The local citizens stopped the protests and accepted the waste disposal site, only after an "open- planning" process was instituted. Open planning implies that different participants have input and influence on the decision-making processes and outcome. For instance, the local citizens were able to have direct influence on the development of the technological capability of being able to easily retrieve discarded waste if needed. Due to the potentially controversial nature of technology, and the changes it may imply for different stakeholding groups, involvement of those directly and indirectly affected by the technology may greatly improve the likelihood of the technology being accepted in society. A process that is considered to be legitimate, is of course dependent on the particular situation in hand, however, an important element is including a wide range of stakeholders in a transparent and open planning process early on. Legitimacy can be an integral part of technological implementation.

2.3 Development of Institutional/Political Relationships: The promotion of collaboration or partnering with other institutions

2.3.1 Case: The Greenfreeze refrigerator

International treaties mandated the phase-out of CFCs in refrigerators, which led to the use HFC 134a, which was still detrimental to the environment. Two medical doctors invented a new hydrocarbon cooling substance for refrigerators that had fewer adverse environmental impacts than the traditional use of HFC 134a [8]. By partnering with Greenpeace and a German refrigerator manufacturer called DKK Scharfenstein, they were able to revolutionize the German refrigerator market. Within two years of partnership all German-made refrigerators used hydrocarbons. Greenpeace, was interested in the partnership because it was consistent with the organization's objective of promoting a more sustainable society. They contributed to this effort by launching a successful publicity campaign on the environmental benefits of the hydrocarbon refrigerators. The refrigerator manufacturer, DKK Scharfenstein, former monopolist refrigerator manufacturer of East Germany was interested in revitalizing his failing refrigerator manufacturing business. The company helped by developing prototypes of the environmentally friendly refrigerator. Within two years, the remaining refrigerator manufacturers in Germany abandoned the use of HFC 134a and adopted the use of hydrocarbons. The technology was successfully implemented in society, resulting in a more sustainable environment.

Implications

Partnering with other institutional actors can allow for greater possibilities of information sharing and general capacity building. In this case study, the two medical doctors had the scientific know-how; Greenpeace had the environmental legitimacy; and DKK Scharfenstein had knowledge of the refrigerator market. It was their combined actions and interaction, which led to the abandoned use of HCF 134a and the technological shift of using hydrocarbons in refrigerators. If Greenpeace acted alone, such as in an informational campaign banning HCF 134a, their action could have just led to greater consumer awareness, as opposed to a technological transition. The importance of creating an alliance and working together was also apparent in the Solaris Project, as Greenpeace coordinated with Shell, and other organizations to reach a common goal of distributing the solar panels. Creating alliances to coordinate action as opposed to working autonomously may also greatly increase the gains of each individual actor. For example, in the Greenfreeze refrigerator case, the two doctors were able to use and distribute their new technology; DKK Scharfenstein was able to revitalize his refrigerator business; and Greenpeace was able to promote environmental sustainability. Understanding how to create successful partnerships, including the necessary mix of government regulation (in this case, "technological forcing" of international mandate to phase out CFCs) may help to facilitate a good learning environment to experiment with the feasibility of a technology.

2.4 Learning: To improve the knowledge base

2.4.1 Case: Danish telecommunication centers

The Danish Government sponsored 16 experiments on establishing a broadband network for small urban areas and rural communities. The experiments involved the testing of different information and telecommunication technology applications. The one highlighted by Cronberg, are the telecommunication centers [1]. At these centers, people experimented with the state of the art telecommunication devices. Through the hands on learning experience, participants that largely included farmers were able to learn and assess how technology could better aid them. These centers offered specific courses, such as the use of information technology on farming, or word processing or accounting for local enterprises. Over 50,000 people participated, and evaluated whether or not they could use information technology, and for what specific purposes. The experiments revealed that word processing and book keeping applications were popular uses among participants. Secondly, more advanced applications were developed and found useful, such as picture transmission, which allowed farmers to seek assistance from veterinarians or crop specialists for their animals or crops.

Implications

The users of the technology were able to actively participate and evaluate the usefulness of the technology. The users gained more knowledge about technology, while simultaneously influencing the shape of technological applications in farming communities. The testing of new technology can have an important influence in the outcome of how a technology will be later used in society. The shaping of a technology through interaction was also evident in the high technology waste disposal site in Germany as citizens were working with technical experts to directly articulate and assess the needed technology in the waste disposal site to mitigate their concerns. The citizens and experts engaged in mutual learning, as opposed to leaving the problem solving to experts alone. This may imply that the involvement of all relevant stakeholders in a coordinated interaction process can greatly enhance the venue for learning.

2.5 Summary

These case study examples provide informative suggestions on how to improve the interaction process so that new technologies have a greater chance of making a technological transition. In the waste disposal case, the initial public resistance was overcome after having an open-planning process that involved the concerned stakeholders. Involving stakeholding interests early on created legitimacy. The case also shows that it was possible to engage in a mutual learning process with experts and the concerned public. In this process, experts can still remain important to the process, but the public should also play an important role in expressing their concerns and engaging in the decision making process. The Green-freeze refrigerator case suggests that technological shifts may be more successful when institutions partner or coordinate with other institutions so that resources and information can be shared. The two doctors, Greenpeace, and DKK Scharfenstein shared information and worked cooperatively, to succeed in bringing about a radical change in the refrigerator market. The Danish telecommunication case demonstrates that experiments can be a good venue for learning. Learning-by-doing can be an important process that helps to evaluate the technology to ensure that it meets the needs of the stakeholders. It is a beneficial process, allowing users to become more comfortable with the technology, while providing constructive feedback, to influence the shape of the technological application. These case studies have identified the contribution interaction can make to the legitimacy of the policy making effort, the development of institutional relationships, and the capacity for learning. As important as interaction is, many efforts to promote the use of new technology fail to give it explicit attention. What is needed is a theory of practice that could guide the organization and management of interactive processes to maximize the potential for action, political legitimacy and social acceptance, institutional development, and learning. One area where there is a codified body of experience with interactive processes in the public sphere is consensus building.

Chapter 3

Using consensus building to facilitate technological transitions

As the different case studies illustrated, technological transitions require institutional coordination and interaction among the different stakeholders. Interaction that promotes legitimacy, building of institutional relationships, and learning are important elements in technological transitions. Consensus building is an organized approach that can incorporate these important elements. A consensus is a general agreement or accord among a diverse group of parties. Consensus building is defined as a process that draws out the collective knowledge of a diverse group of people to reach a common goal. Knowledge refers to information, resources, and skills. This democratic process serves to involve all of the relevant actors to reach a desirable and optimal outcome. It is grounded on a "mutual gains approach" in which actors without compromising their own interests consider other actors' interests, to suggest mutually beneficial options. Consensus-building strategies are generally understood to promote the following:

Consensus building helps to promote an engaged public with the capacity and will to contribute. Consensus building promotes broad based inquiry by not limiting the problem solving to one group, but involving all stakeholding interests. For example, limiting participation to technical experts alone, may result in a narrow problem definition, and "technifying" the issue to the extent that social, political, and economic issues are simply "quantified" to an "objective analysis." This can be problematic especially when other actors may view the problem not in quantitative terms, but may have qualitative concerns such as values, which may be better resolved through constructive dialogue. Different stakeholders may have different positions and ways of defining a problem to seek an acceptable solution. Limiting the involvement of a few actors to define problems or seek solutions, such as scientific experts alone, may not lead to a satisfactory solution, especially when there are many institutional actors affected [directly and indirectly] by the technology. Consensus building strategies promote broad based inquiry, which may be important in technical problem solving, because of the complexity and sometimes controversial nature of technology. With consensus building strategies, the stakeholders help to frame the issue to ensure that everyone's needs are articulated in the process. This engaged public is also one that has the capacity to actively contribute. In this interaction process, participation is not limited by one's scientific or technical knowledge because each participant is viewed equally important in the process.

Consensus building creates an open and legitimate process. Consensus building promotes quality assurance by creating an atmosphere for open dialogue, in which the process is clear and legitimate to everyone involved, because it is the participants themselves who organize the process, with the help of a neutral facilitator. All participating stakeholders participate in the process from the beginning to the end of the process. As the high technology waste disposal exemplified, an "open-planning" process helped to mitigate controversy and improved the legitimacy of the decisions of the city administration. In fact with consensus building strategies, decision making may not be viewed as legitimate if not all participants are present. The involvement of all concerned stakeholders at each phase of the process helps to create greater legitimacy. With consensus building, all stakeholders participate in determining the format, structure, and decision making process of the discussions. Issues such as types, levels, and distribution of risks are some of the topics that stakeholders might find important to discuss. This style of decision making can be considered to be more fair and equitable than standard processes such as *Roberts Rules of Order*, especially when not everyone is familiar with the "rules of the game."[1] Consensus building strategies are structured to facilitate an interaction process that everyone can understand and participate in.

Consensus building creates an opportunity for learning and reflection. Consensus building promotes constructive interaction that may enhance learning opportunities. For example, agreed upon guidelines are set to help stakeholders avoid fruitless debate on vested interest. Deliberations are pursued constructively, such as engaging in active listening, disagreeing without being disagreeable, and striving for the greatest degree of transparency possible. This type of interaction may help to create conditions conducive to information sharing and learning. Furthermore, the involvement of different stakeholders helps to create a more broad based inquiry, so that the information learned is representative of the different stakeholders' interests. As the high technology waste disposal case study showed, learning can greatly aid in technological transitions by resulting in technological improvements and greater societal acceptance of the technology. Furthermore, consensus building is a flexible approach, allowing for changes in the process or strategy, if new information is learned. The ability to provide ongoing feedback can be especially important when testing new technologies, as new information is often learned in the trial stages of the technologies. For example, in the Solaris Project, Greenpeace might have been able to sell more solar panels, if there was a learning process set in place that allowed for the technology to be evaluated prior to being sold to the consumers. After the majority of solar panels were distributed, Greenpeace later learned that consumers wanted a device that could precisely quantify the amount of energy being produced by the solar panels. Unfortunately, this information was learned too late in the process, to make any immediate manufacturing changes. Consensus building strategies, which

[1]The rules written in 1870, known as *Robert's Rules of Order*, are based on the parliamentary procedures of Congress, with the presumption that making motions, tabling topics, and ruling by majority would ensure that everyone's interest are being met. But, how effective are the "rules" when not everyone is familiar with them? Susskind points out that not everyone's viewpoints are included when they don't know the rules or are intimidated by them. People are not able to fully participate, especially those who are least able to articulate their views. Secondly, making a decision base on "majority-rule" – an all or nothing ultimatum may leave many groups feeling dissatisfied with the outcome [6].

promote feedback, continual evaluation, and reflection, can be an important strategy to promote learning.

Consensus building creates opportunity to improve institutional capacity. Involving all relevant stakeholders in the process, in which information is shared, and new knowledge is gained, can result in the formation of inter-organizational networks and institutional relationships to take collective action. As the technological case studies pointed out, collective action as opposed to unilateral actions can greatly improve the effectiveness of any one institution. The importance of institutional coordination was evident in the Solaris Project, as solar panels were distributed to Dutch households, only after Greenpeace coordinated and partnered with other institutions. Consensus building promotes an interactive environment that promotes constructive dialogue and an opportunity for learning and reflection so that it may be possible to understand and make the necessary institutional adjustments. Consensus building strategies might have greatly aided in the promotion of electric vehicles in California. Perhaps, if there was a forum for effective interaction, alliances could have been built between the different institutional actors, which might of allowed for a more organized and successful technological transition.

Consensus building creates opportunity for appropriate policy responses. Consensus building creates an effective forum for interaction that helps to clearly identify the most appropriate policy responses and action steps to take. An engaged public, open planning process, conducive learning environment, and institutional capacity building, all culminate to help make a more informed decision on the most appropriate actions or policy responses to make. The decision making process, does not imply abandoning interests or values, instead stakeholders are encouraged to think about their best alternative to a negotiated agreement (BATNA). This may involve considering what will happen if no agreement is reached, improving some of the existing options; and selecting from it the alternative that seems best [2]. The consensus approach promotes an interactive forum for making practical plans for taking actions which is informed by the understanding of the different institutional actors and interests involved.

Chapter 4

The role of consensus building and experimentation

Consensus building strategies can offer a method of organizing public interaction that contributes to legitimacy, the development of institutional relationships and learning. Meeting these criteria can be especially important to help make technological transitions. Additionally important to helping technologies make transitions, may be the need for a temporary space, in which the technology can be tested or experimented in a semi- controlled environment. Professor Johan Schot at Delft Technical University in the Netherlands states that it is sometimes necessary to develop and test the technology in a protected space, where "technological niche" development can occur.[1] "A niche can be seen as a specific domain for application in which producers and users – sometimes third parties such as governments – form an alliance to protect new technologies against harsh market selection." These protected spaces, or rather, experimental conditions, can provide an interactive learning environment so that institutions and other relevant stakeholders will be able to learn about the possibilities as well as any adverse consequences of the technology. Schot describes this as "strategic niche management."

"Strategic nice management is defined as the creation, development and con-

[1] Professor Johan Schot, Centre for Studies of Science, Technology, and Society, University of Twente, The Netherlands, Interview, February 2000.

trolled break-down of test-beds (experiments, demonstration projects) for promising new technologies and concepts with the aim of learning about the desirability (for example in terms of sustainability) and enhancing the rate of diffusion of the new technology."[4] It allows the different stakeholders to better identify the conditions [social, cultural, economic, and political] in which a set of technological options will prevail, and encourages the exploration of the different actions in a safe "test" environment.[2]

It may be possible for government to take on the role of creating a forum for interaction that brings together the different institutional actors indirectly or directly affected by the technology. In this forum for interaction consensus building strategies can be adapted to test technology. The technology can be tested in a town or in a city with all relevant stakeholders participating. This type of experimentation is different from the confines of a laboratory, which may not be as externally valid as it excludes the technology from more "real-life" conditions. Although, the experimentation process in a town or city is likely to be in a semi-controlled environment, since real-life market conditions may not prevail for instance, this experimental condition can provide a valuable learning opportunity with a wider range of research questions to address. This experimentation process can be considered to be a good learning opportunity for government, and other stakeholders to jointly better understand the technology, and what changes may have to be made (i.e. structural), if any, for the technology to be implemented in society.

[2] As part of the European Science and Technical Observatory Program in the European Union, 16 transportation related experiments were evaluated to identify important lessons for managing large scale experiments. In the analysis of the different case studies, Schot points out different suggestions such as the need to communicate the project with a wider public and importance of identifying complementary policies needed to help with the experiment. However, the great limitation with niche experiments is the fact that it falls short of identifying a process that fosters fairness, interrelationships, and a continual process of learning.

4.1 Integrating consensus building in experimentation

The experimentation process can be called "integrative experiments" in which more than one goal can be achieved. An integrative experiment can be defined as experiments with one or more technologies to help meet specific policy goal(s), such as sustainability goals. For instance, to reach $C0_2$ reduction targets, the government can experiment with one or more available technologies, which may include: wind energy, solar-panel, and biomass fuel. Unlike the other types of experimentation processes described above, participation from all stakeholders is encouraged at each phase of the process: from the beginning to the end. The level of public participation that is endorsed in integrated experiments is stakeholders having direct input on the design of the experiment; management; and evaluation of the experiment. An important strategy in "integrative experiments" is consensus building. The consensus building strategy can be understood in four major phases which includes: 1) Convening; 2) Management; 3) Implementation; and 4) Evaluation, with evaluation being a continual process.

Convening describes the initial meeting and planning process, such as the framing of the problem, agenda setting, etc. A neutral facilitator will lead in the convening stages. Management describes the pre-planning and procedural stages for experimentation, such as determining how the experiment will be designed and conducted. Although, all stakeholders will participate in making management related decisions, the leadership of a few major actors can facilitate the process. For example, the central administrative body that sponsors these experiments can play an important role in helping to set the general protocol; the selected scientific experts can prepare a suggested design format for the experiment; and the facilitator can take the lead role in incorporating the stakeholders questions and concerns in the experiment. Implementation describes the process when the experiment is actually being carried out. Evaluation is a continual process in the experiment, with possibility for readjustment of parameters, as new knowledge is gained. At the conclusion of the experiment, benchmarking will be used to help evaluate the experiment, and identify next steps of action.

4.2 Key elements in the experiment

Throughout the design, management, implementation, and evaluation of the experiment, consensus building strategies techniques will be used to help build the commitment, legitimacy, development of institutional relationships, and learning.

4.3 A framework for integrated experiments using consensus building

This section provides a framework for what the experimental process may look like with consensus building strategies.[3]

A. CONVENING

1. DECIDE IF AN INTEGRATED EXPERIMENT ON SUSTAINABLE TECHNOLOGY NEEDS TO BE CONDUCTED

Decide which environmental issues are "ripe" for discussion and experimentation. The environmental issue can relate to a domestic or international environmental policy goal.

Criteria that might be considered to determine if an integrated experiment is needed:

1. Does the issue generate a sense of importance/urgency?

2. Does the issue generate real enthusiasm and interest from the government and public?

[3]The format of this consensus building process for experimentation has been inspired by the fundamental techniques practiced by Larry Susskind and the Consensus Building Institute (CBI) in Cambridge, Massachusetts.

3. Does the issue have significant social, environmental, and economic implications if unresolved?

4. Can we perform an experiment that will yield useful data and insight?

5. Are there funds available to conduct the social experiment on this environmental issue?

1.1 Decide which existing sustainable technologies should be used to help meet the environmental goal(s):

A technology or a group of technologies can be tested to meet environmental goal(s). For example, to reduce CO2 emissions a portfolio of technological options can be tested, such as the use of photovoltaic cells to generate energy and the use of electric vehicles. The large-scale experiment does not have to be limited to test one technology, it can include the testing of multiple technologies. The government can decide on the most "ripe" sustainable technologies to test based on national priorities and interests.

1.2 Assess the technologies chosen

First assess the existing status of the technology proposed for the experiment. This initial review could cover the extent of technological progress in this field, the state of the environment, and the existing social, political, and economic conditions under which the technology may operate.

1.3 Analyze technologically related concerns

Identify direct or indirect issues of concern that can either influence the development of the technology or wide-spread acceptability of it.

2. ORGANIZE A CONSTRUCTIVE DIALOGUE PROCESS

2.1 Frame the policy problem

Frame the policy problem to articulate the current situation and what is at stake:

1. The problem definition must not only interest stakeholders, but also encourage them to become actively involved in addressing the problem.

2. It must be tangible that it can lead to the design of concrete action steps.

3. It should sufficiently open to permit, or even invite, participants to reframe the problem. Through framing, participants 'make the problem their own' and generate an internal commitment to the experiment. The beliefs and proposals that emerge from the process then draw legitimacy from the broad and thoughtful public participation in the process.

2.2 Enlist a neutral facilitator to help organize the process

A neutral facilitator is an unbiased party that manages the process.

2.3 Identify advocates for collaboration

The convener and the assessor should identify appropriate representatives that represent the full range of organizational actors needed to conduct the social experiment, robustly and legitimately, including institutions or groups that may be potentially adversely affected. The necessary people involved may include:

- Technology designers – scientists and engineers
- Institutions or organizations – relevant unions, advocacy organizations
- Potential users – people who may use the technology
- Indirect beneficiaries – organizations or people that may be positively influenced by the use of the technology
- Others effected – organizations or people that may be negatively influenced by the introduction of the technology
- Decision makers– key people essential in the decision making process
- Government – relevant agencies

2.4 Assign responsibility for preparing the technology assessment

Responsibility for preparing a written assessment should be assigned to a neutral party. This task is usually the responsibility of the neutral facilitator.

2.5 Conduct a preliminary assessment

A preliminary assessment is a process that aims to assess the interests of stakeholders, including issues of agreement, and points of departure. The assessment should encompass issues regarding how the social experiment is conducted, including the technological/societal implications if the technology is implemented.

1. Interview the advocates for collaboration.
2. Ask these first group of interviewees to help identify a second group of participants who might be able to contribute to the consensus building effort. Also remember to include participants, that without their involvement the process may be viewed as illegitimate.
3. Interview the second group in the same manner as the first.

2.6 Prepare a draft assessment

The neutral facilitator should prepare a draft assessment that describes the issues of concern, including areas of agreement, and possible disagreement. The assessment should be written so that it does not indicate who said what written statement. By not having ideas or statements attributed to particular people, participants will be more open to make comments and provide feedback. The draft should be distributed to the participants for comment and editing.

2.7 Prepare a final assessment

The final draft should include the necessary changes as recommended by the participants.

2.8 Locate funding

Acquire the necessary funding to support the experiment. Funding of the experiment should only be contributed by institutions, which do not have a specific stake in the outcome of the process. Or alternatively, funding should be acquired from what the general public perceives to be neutral and legitimate. Enough funding should be acquired so that all expenses of all participants are reasonable cared for.

2.9 Clarify responsibilities

The roles of the participants can not be predetermined but must be agreed upon collectively. The roles of the different types of participants need to be clearly defined so that there is no confusion on who is responsible for what, what the procedures are, etc. Below are suggested examples of what the roles can be:

2.10 Facilitator/mediator

The facilitator should be a non-partisan party hired professional. Facilitators manage the dialogue process including all logistical tasks, such as leading the group in collective decision making processes as well as managing interaction between the parties. Facilitators work at the consent of participants which adds to their legitimacy directly and explicitly, ot the ongoing consent of the parties involved.

2.11 Recorder

The recorder takes accurate record of major points discussed during the dialogue, including points of agreement and points of departure. The recorder may aid the facilitator in the dialogue process by creating visuals for all participants. Information discussed, including relevant visuals should be documented as a summary. Participants for accuracy should review the summary.

2.12 Role of scientific/technological experts

The role of the scientific expert is to provide accurate scientific information. In cases, in which a participant may be an expert, all participants should decide if the participant could unbiasedly serve dual roles. Due to the contentious nature of scientific information, the participants need to agree upon the scientific expert.

2.13 Observers

Generally, having sessions open to the interested public may afford a greater degree of openness and/or legitimacy. Parities who are not directly involved may participate as observers. In some cases, active participants may decide that observers should not be included in the process or observation may be limited. If observers may preclude any of the stakeholders from openly discussing issues, for any reason, it might be advisable to consider which discussion sessions are closed and which are open to the public. Lastly, observers should refrain from bringing any recording media device such as photograph equipment, videocameras, or tape recorders. Such media equipment may distract the active participants or discourage them from openly interacting.

2.14 Media

The group can decide if any of the progress or results of the large-scale experiment will be documented or made public by the media. In some instances, it may be advisable to assign the task of spokesperson for the group, after collectively agreeing upon what information is to be publicly disseminated. The spokesperson can be a neutral person, such as the facilitator.

2.15 Agree on the range of issues

Get agreement on agenda and the range of issues to be discussed. The range of issues to be discussed should include the design, the management, and the evaluation of the social experiment.

2.16 Pursue deliberation constructively

The deliberation procedures are intended to encourage constructive dialogue between stakeholder groups. They are not intended to encourage people to sacrifice their interests or beliefs. Instead, the guidelines are intended to help stakeholders communicate their differing viewpoints and in such a way that helps them to discover areas of common ground. The guidelines also serve to avoid fruitless debate based on vested interest. In other words, the agreed upon ground rules and the procedures practiced by the facilitator and the participants help to break down the possibility for gaming.

1. Express concerns in an unconditionally constructive manner
2. Never trade interests for relationships
3. Engage in active listening
4. Disagree without being disagreeable
5. Strive for the greatest degree of transparency possible

2.17 Formulate joint fact finding procedures

Joint fact finding procedures help to dispel any preconceived notions of unfairness, by bringing the different stakeholders together to collectively agree on what information will be sought by whom, and how. The heated controversies surrounding scientific issues and the appropriate technological responses such as the climate change debate demonstrate the need for a new approach to reach common ground. The obstacles to come to achieving consensus on the relevance and interpretation of scientific facts include the uncertain nature of scientific knowledge, situational factors, and cognitive limitations of different actors. The existence of these fundamental obstacles to the use of scientific information in a public process has been recognized for quite some time. Furthermore, issues of credibility often arise if one person or organization is responsible for selecting the scientific experts. Other actors may question the experts legitimacy and impartiality. Joint fact finding is a means of overcoming these obstacles. However it can also provide a means for participants to practice constructive deliberation on an issue that is narrower and more easily resolvable then the experiment as a whole.

B. MANAGEMENT

3. DECIDE HOW THE EXPERIMENT WILL BE CONDUCTED

3.1 Review existing practice

It might be advisable to review existing demonstrations, pilot studies, and/or experiments that have been conducted as they relate to this specific technology.

3.2 Agree on general principles and objectives

The objective of the experiment should be clear from the start. The goals of the experiment should encompass all of the stakeholding interests and concerns. Some goals of the experiment may include: learning about design elements of the technology, clarifying cost and market related issues, learning about the needed physical infrastructure elements, accessing the types of incentives and or government regulations needed, etc.

3.3 Plan and design experiment

Decide on how the experiment will be designed and conducted. The experiment should be robustly designed so that it is adaptable to unforeseen changes in conditions.

A sensitivity analysis may want to be performed to identify key experiments. Some other important issues may include:

- Will one or multiple experiments be conducted? If multiple, will they be parallel or in series? If in series, what will the order of experimentation be?
- How can the experiment be designed so that it is flexible enough to allow for learning and possible reframing of the issue?
- How will the experiment be managed?

3.4 Agree on preliminary experiment evaluation protocol

Although the experiment will be designed with flexibility so that there can be process changes, if deemed necessary, it is important that the experiment be grounded on some concrete parameters, that can be used as a basic foundation to help evaluate the progress.

C. IMPLEMENTATION

4. RUN THE EXPERIMENT

4.1 Monitor what happened

Data needs to be gathered, shared with the stakeholders, updating the collective knowledge base. With increased understanding of the situation, additional information may be desired and needed. The pre-selected scientific experts may be the ones chosen to be in charge of the data gathering and monitoring of the experiment. Although, all of the stakeholders may not be involved in the monitoring of the experiment, it is important to keep everyone informed of the progress, including any notable findings, or problems.

4.2 Link action with opportunity for joint reflection

The process should be flexible enough that it allows all participants to learn from the experiment. The experiment needs to be designed so that after new information is learned changing parameters or procedures is possible without having to run another experiment. Before any significant changes are made in the agreed upon experimental process it is important that decision making is made collectively, and not confined to the scientific experts. Update knowledge base, then (if necessary) update metrics and plan for remaining project duration.

4.3 Push for common interpretation through discussion

Because scientific findings can be interpreted in different ways, the pre-selected scientific experts may take the primary role in describing the results of the experiment. The results need to be communicated to the stakeholders, so that everyone understands the meaning and possible scientific implications of the results. Group discussion will help to interpret the findings, including determination of its significance and relevance to specific questions of concern.

D. EVALUATION

5. REFLECTION

5.1 Evaluate progress with benchmarking

As the experiment reaches its final stages the progress can be evaluated with benchmarking. Benchmarking can be done in a number of ways. The two primary methods are: 1) evaluating the results against a set of goals or criteria or 2) evaluating the goals against similar projects.

5.2 Identify new learned knowledge After the experimental phase it is important to collectively identify and agree upon the learned knowledge. In the most ideal situation, the questions posed in the beginning of the experiment are all answered. The information learned from the experiment may help to generate discussions on:

- What are the social, economic, and environmental costs associated with this technology? Are the benefits and costs equitably distributed among the stakeholders?

- What environmental problem(s) are being solved with this new technology? Are new ones being created? If so, how will trade-offs be measured?

- What structural, institutional, and/or cultural changes are necessary for the technology to be widely used?
- Do the stakeholders have the capacity or the will to make the necessary changes/adjustments to meet the sustainability goal?

5.3 Identify new relationships

The information learned from the experiment may point to the need to collaborate or form an alliance with some of the stakeholders.

5.4 Decide on course of action

Next steps should be identified.

5.5 Assign new socio-technical responsibilities

These next steps may involve a shift or a change in practice. It may require organizational changes within institutions.

5.6 Commit to abide by all agreements

Agreements can be voluntary or contractual.

Chapter 5

Conclusions

As the case studies illustrated, there are many institutional actors involved in the implementation of technology such as regulatory agencies, manufacturers, industry, technology designers, and consumers. The experience in the Solaris Project exemplifies the fact that technological shifts are greatly dependent on the interaction and coordination among the different institutional actors. Implementation can be understood as a series of interrelated decisions involving a loosely coupled network of actors, none of whom has the power to affect change, through unilateral action. Public actors, who act alone, may lack may lack the complete knowledge or resources to orchestrate the complicated process of technological transition. By analyzing different case studies on technological transition, important principles in effective interaction have been identified to include, at minimum: legitimacy, development of institutional relationships, and learning. The strategy that can help to promote all of these critical elements is consensus building. Consensus building is a codified theory of practice that can help guide the need for the organization and management of interactive processes. Itis a process that helps to draw out the collective knowledge of the institutional actors to help reach sustainability objectives. Current strategic policy approaches for technological development have often overlooked this need for coordinated and effective interaction among the numerous institutional actors. It is argued that government can augment their existing role in technological development, by creating a forum for effective interaction to test or experiment with new sustainable technologies with consensus building strategies. A framework for the interaction process is provided to suggest a role that consensus building can play in experimentation. In this experimentation process, stakeholders can learn about the implications of the technology, including any actions that may need to be taken to improve the transition of the technology. There are four phases of the experimentation process, convening, management, implementation, and evaluation. In each of these steps, legitimacy, the building of institutional capacity, and learning is promoted. The consensus building procedural framework that is proposed serves as a guideline as to what the integrated experimentation process may look like. Because there is limited research on the role of effective interaction in technological transitions, the evidence presented in this thesis can serve as compelling evidence for the importance of furthering research and development in this area.

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