May 2006

Improving Societal Welfare through Institutional Change in the Energy Industry: Capitalism's Creative and Destructive Capacity

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IMPROVING SOCIETAL WELFARE THROUGH INSTIUTITONAL CHANGE IN THE ENERGY INDUSTRY

CAPITALISM'S CREATIVE AND DESTRUCTIVE CAPACITY

AN HONORS THESIS
PRESENTED BY
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TO
THE DEPARTMENT OF ECONOMICS
IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR
HONORS IN THE MAJOR FIELD

CONNECTICUT COLLEGE
NEW LONDON, CONNECTICUT
APRIL 28, 2006

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By

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May we someday find a balance that allows us to live in harmony with the world around us.

Acknowledgments

My inspiration is indebted to a number of people whom I've had the utmost pleasure of working with at Connecticut College, a liberal arts institution that has enabled me to study a wide variety of topics and given me the skills necessary to relate them all in this thesis. For my love of new institutional economics I must thank Professor John Tian for introducing me to the subject. Crucial ideas and theories in this paper are the product of many classes and discussions we have had over the past few years. My appreciation for environmental welfare and sustainability comes from Dr. Norman Richards who conveyed the idea of a "systems approach", which has allowed me to bring ambition to reality through pragmatic action. Keeping my feet on the ground while my head wandered into the clouds, I thank my thesis advisor Professor Gerald Visgilio for assisting me in arriving at a reasonable conclusion that fit the theoretical model. Finally, I must thank my family for all of their support. My dad, who always told me not to follow the suits and find something that I was truly passionate about; my mom, who has always provided encouragement and moral support; and my two sisters, for whom I wish to make the world a better place.

Motivation

My motivation for writing such a unique paper that combines academic theories in economics, government, and sociology is not simple to explain, as it comes from many years of growth and exposure to so many different people and ideas. In my research I have found that grass roots environmental activism, although necessary, is a lot of work for little guaranteed return because the environmentally friendly solutions proposed are often more expensive than the current policy. There is also a dilemma between the present and future urgency surrounding issues that involve global public goods, particularly about the idea of climate change. I invite the reader to explore my thought process, which has ultimately driven me to research and write about a pragmatic way to find solutions for environmentalists and non-environmentalists with regard to energy.

Harnessing energy and using it efficiently is the key to the growth of economies, which promotes improvements of general welfare and quality of life. Human beings ever increasing stock of knowledge that enables improvements in general welfare is correlated with our initial ability and thereafter increasing efficiencies of harnessing energy. Most of the energy generated and harnessed to produce goods in modern society is provided by the burning of fossil fuels. Whether it is wood, coal, oil, or natural gas, these fossil fuels are dirty, meaning they release harmful emissions into the atmosphere when burned, such as nitrous oxide (NO), carbon dioxide (CO_2), and sulfur dioxide (SO_2), etc. These energy carrying resources are attractive because they are readily available commodities and have become the standard raw materials for energy production in many developed countries. Not only do these resources pollute our atmosphere and come with many hidden transaction costs, they are also finite, or 'scarce' in economic terms. There will come a day when we will run out of the juice that makes our modern

industrial society flow. With mounting costs of purchasing these scarce, increasingly demanded resources and an unknown date of when they will no longer be cheaply available for our use, developed societies are beginning to face pressures to find alternative forms and resources for energy production (See Appendixes).

Many renewable, non-fossil fuel based energy technologies have encountered troubles entering the mass market against fossil fuel based technologies and will continue to face high entry barriers due to an uneven playing field. The commercialization of these technologies has been gaining much popularity as of late. The popularity is largely due to recent spikes in the price of oil and natural gas, caused by a rapid increase in demand by developing behemoths China and India, volatile distribution networks recently exposed by natural disasters, and the prospect of terrorists disrupting pipelines, power plants, and refineries. Not only has the immediate price per barrel of oil risen dramatically in recent years, the indirect costs of obtaining, securing, shipping, and burning fossil fuels are also increasing. For example, going to war to secure oil fields costs billions of dollars, the cost of shipping millions of fossil fuels is rising, and old, inefficient centralized power-plants are costly to maintain past their peak. The current energy creation and distribution network is an extremely risky, inefficient, and non-diversified way to power industrialized nations. New technologies that have the potential to satisfy an increasing demand for energy and ultimately replace centralized energy must become competitively priced on the mass market before we find ourselves in an economic growth inhibiting energy crunch. I refrain from solely discussing the negative risks, externalities, and consequences about current energy systems in developed nations, as this would not be a pragmatic way to convince the world to stop utilizing highly centralized energy and fossil fuels. Instead I provide a model that explains how clean, decentralized alternatives that seem costly could be economically viable if producer's marginal costs accurately reflected total costs endured

by society as a result of externalities. In light of the potential probability of these dire negative consequences—such as global energy shortages, drastically rising energy costs, super-storms and flooding caused by global warming—there is promising evidence for a brighter future.

The wheels of capitalism are slowly turning in the early and inevitable stages of creative destruction. Green energy technologies are rising up against many market barriers created by outdated energy institutions, taking significant steps in the beginning of the transition to a decentralized and renewable energy-based economy. However, larger steps may be necessary to foster economic sustainability and growth through the transition process. Ultimately, when a vital resource, such as oil, becomes so scarce that the cost of using it is too high (the choke price) substitute resources will begin to be more readily used and, if economical, may replace the scarce resource. If this transition to the new resource is smoothly completed, economies will not suffer much during transition and will potentially benefit after equilibrium has ultimately been reached. Scarce fossil fuel utilization *should* inevitably be replaced by alternative renewable forms of energy due to market induced forces when the price of fossil fuels increases past the choke price. The *smooth* transition is the key to global economic sustainability and growth. Once the choke price is met a free capitalist market will clear by itself. Current market distortions such as taxes and subsidies that restrict free markets threaten the future of our society with market failure. These constrictions are the government's attempts to correct for poorly defined property rights for public goods. Poorly defined property rights are the inherent flaw in the markets themselves that consequently give capitalism incentives to negatively exploit natural capital. The irresponsibly inefficient misuse of natural capital is threatening future economic sustainability.

The questions this thesis ultimately tackles are: What is wrong with the incentive structure laid out by government allowing capitalism to threaten future economic sustainability? Does the capitalist mechanism have what it takes for a smooth transition to decentralized

renewable technologies, or are market distortions too strong to allow this change to happen within a reasonable time frame, or at all? What should be done to fix this problem that is threatening future economic sustainability? The answers to these questions are as much economic as they are political. Meeting the energy consumption demands of tomorrow presents us with questions about where best to change policy today. These policies must provide economic incentives that will foster increased energy creation and distribution efficiency in the United States. This must happen before economic growth is hindered by a possible energy crunch (See Appendixes). This debate is between what the government's current stance on energy is and what should be their stance based on the model outline in this thesis. The current stance perpetuates dirty and inefficient centralized energy creation and distribution through subsidies and poorly defined property rights that allow for irresponsible natural capital exploitation. Alternatively, the creation of market incentive schemes that promote clean, efficient, decentralized (distributed) energy distribution would address the collective action problem surrounding property rights for public goods at a legislative level and encourage economic growth. The model outlined in this thesis suggests that the latter would improve societal welfare by enabling larger and more sustainable growth for developed economies.

Motivated by my inner passion for the widespread use and promotion of clean, efficient energy production for the sheer environmental benefit, I assess rising energy costs due to supply capacity being outpaced by demand and analyze political barriers that are distorting the energy market. I apply this analysis through a theoretical model that supports a change in policy by re-defining of property rights for public goods to correct inherent flaws in the market, creating the incentives necessary for more efficient decentralized energy production to supersede inefficient centralized energy production.

A transition from a centralized fossil fuel based global economy to a decentralized and *renewable* energy based economy presents the world with perhaps the most difficult task ever faced within human control. It is undoubtedly, in my opinion, up to the larger, more developed states to manage this transition and assure its ease, as they are the major culprits in the misuse of resources and energy. Perhaps it is up to the state with the biggest demand for fossil fuels to take the lead, using its economic hegemonic abilities to steer the rest of the world through these difficult evolutionary times. The United States, being the world's largest consumer of fossil fuels, in my opinion, should take the wheel as early as possible making certain steps to see that the transition is done as quickly and painlessly as possible. For this reason, this thesis will focus on the energy institutions in the United States. It has become increasingly apparent, however, that due to the political shortsighted nature of democratic governance that create market distortions, current inefficient energy institutions are perpetuating beyond where free market forces say they should. Shortsighted political figures speak for layman citizens who aren't overly concerned with issues such as global warming, urban smog, acid rain, and clean air and water scarcity because the effects of these negative externalities are long term and difficult to accurately quantify. Meanwhile the costs of these environmental problems are being incurred by the unwise citizen who does not have the luxury of voting for the green candidate who doesn't promise job growth in his or her campaign. These costs also affect future parties, who are unable to vote, because they will bear the cost of long term problems. This vicious cycle may ultimately cause markets to fail, placing economies in dire risk of collapse.

Douglas North notes that,

> This human environment is divided by social scientists into discrete disciplines-economic, political science, sociology-but the constructions of the human mind that we require to make sense out of the human environment do not coincide with these artificial categories. Our analytical frameworks must integrate insights derived from these artificially separate disciplines if we are to understand the process of change. (North, 2005)

Therefore, as believer in free market capitalism while maintaining awareness for the environment and sustainability, I believe that the most pragmatic way to achieve what many environmental activists hope to achieve is to explore some of the things that publicly elected political figures can grasp and promote on the campaign trail. These include economic growth, job creation, and sustainability. In short, this thesis is not limited to economics because the world we live in is both political and economic. Therefore, this paper on the political economy of energy takes a unique look through the lens of new institutional economics on how capitalism, based around poor incentive structures, is limited in the United States, possibly allowing for markets not to clear at the choke price for centralized energy. I conclude with thoughts on the role government should play in resolving this potential problem in order to allow for change in the way of job creation, economic growth, and future sustainability.

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Preface

We use energy in every facet of our lives. Energy enables the bonds that hold us together and is the force that can break those same bonds apart. Energy allows human beings to do work and we work to improve our individual and societal quality of life. Therefore, facilitating more efficient means of producing and consuming energy will improve societal welfare and quality of life by encouraging economic growth and improving the condition of our surrounding environment. Modern economies function around institutions which generate and supply energy. These institutions can enable economic growth and can also consequently constrict growth. *The centralized energy institution in the United States has become a distributional coalition, due to the government's attempts to create stability through stiff regulation based on ill-defined property rights, and is hindering the capitalist market from destroying the old inefficient energy institution in order to create newer, more efficient decentralized energy institutions.* As stated in the title, this thesis attempts to show how institutional change in the energy industry can improve societal welfare through democratic free market capitalist mechanisms.

More specifically, this thesis will explore capitalism's limited ability to destroy inefficient distributional coalitions and create new, more efficient institutions in the energy market. The legal incentive structures created for organizations to exploit in the energy industry will be examined through the lens of new institutionalist and collective action theories. These incentive structures are derived from ill-defined property rights, which have allowed for polities to erect poor incentive matrices, thus allowing for centralized energy to become and remain the predominant energy provider in the United States. I've chosen to use new institutional economics as the underlying theory for economic change because of the recognition it gives to,

what Oliver Williamson refers to as, limited cognitive competence or bounded rationality.[1] A primary argument of this thesis, as will become more apparent in following chapters, is that institutions are man made constructs that are often created based on imperfect information due to our limited cognitive competence about property rights. As North indicates,

> The key to understanding the process of economic change is the intentionality of the players enacting institutional change and their comprehension of the issues. Throughout history and in the present world economic growth has been episodic because either the players' intentions have not been societal well-being or the players' comprehension of the issues has been so imperfect that the consequences have deviated radically from intention. (North 2005)

Due to human beings' limited cognitive competence or miscomprehension of the issues, intentions of human actors may have put us on an unsustainable growth track. Many of the public goods throughout our society, such as clean air, clean water, and biological diversity, haven't been properly protected against infringement, and thus, firms have been able to exploit these goods belonging to the people to produce energy by inefficiently utilizing dirty fossil fuels. The negative externalities caused by this unsustainable system are costing society an innumerable sum of money, threatening societal welfare. These issues are becoming commonly accepted knowledge but in order for societal welfare to improve, polities must address the issue of property rights of public goods at the legislative level.

In Part I, beginning with Chapter One, I provide a basic framework for institutions and include some insight on institutional change, utilizing theories by North, Williamson, and Olson. Progressing into Chapter Two, I focus on the growth of economies because its importance to societal wellbeing underlies the major analysis of this thesis. The focus of these first two chapters emphasizes the importance that institutional change has on growth in the United States. However, this same theory may be applied to other developed economies as well.

[1] Among the three primary scholars in the new institutionalism economics field – Oliver Williamson, Ronald Coase, and Douglas North – North's theory for institutions and institutional change is the most structurally outlined and will therefore serve as the primary theory for this thesis.

Part II begins with Chapter Three, where I will take the theoretical framework laid out in Chapter One and use it to analyze the formal and informal constraints, benefits, problems, and limitations of centralized electricity institutions. It is in this chapter where I argue that centralized energy has become a distributional coalition, a term that is explained in Chapter One. In Chapter Four I take a similar approach as the preceding chapter, discussing the emerging types of decentralized energy technologies, the institution of decentralized energy, benefits, problems, limitations, and barriers to market entry. I conclude Chapter Four by comparing and contrasting centralized energy with potential decentralized energy institutions that may arise as a result of change.

In Part III, beginning with Chapter Five, I examine institutional change in the energy industry in terms of the theory discussed in Chapter Two. I initially explore the limitations of free market capitalism, answering the question about its creative and destructive abilities by discussing issues about the uneven playing field and implications for fixing it. Despite high market entry barriers there are areas where capitalism is helping decentralized energy technologies to stay in the game but more help is necessary for a smooth transition. Following this, I detail and explain how promoting institutional change from centralized to decentralized energy could potentially allow for large-scale growth in the US and the world economy without much threat of instability. Concluding the paper with Chapter Six, I provide thoughts on policy options that would allow for institutional change. I will revisit the issue of the "un-free" market, questioning the government's role in maintaining stability and enforcing redefined property rights, as well as its effort to rid the economy of stagnation. Based on the conclusion I have drawn from the theoretical model, I suggest that the rules of the game need to be restructured in order to improve societal wellbeing. Specifically, I propose an amendment to the United State's Constitution that would give recognition and assign title to public goods such as clean air and

water. The amendment would call for the creation of a government backed organization to represent and defend the citizen's right to these properties in a court of law, thus solving the collective action problem surrounding public goods. Lastly, I acknowledge some of the limits to the model and suggest more realistic solutions to the problems at hand that also meet the criteria that the model calls for.

PART I

THEORY

Introduction

Over the past twenty or so years, one of the more controversial topics in economics has been the emergence of new institutional economics, or a "developing sociological view of institutions."[i] Simply put, "institutions reduce uncertainty by providing a structure to everyday life."[ii] It is through the lens of new institutional economics theory that centralized and decentralized energy institutions are analyzed in subsequent chapters. However, before this analysis can be conducted the reader should understand a theory of institutions and institutional change. Institutional economist Douglass C. North provides an outline for a theory of institutions and their effects on the performance of economies. This particular theory of the new institutional economics gives recognition to human beings' limited cognitive competence[iii], which because of ill-defined property rights has led to the creation of inefficient and harmful institutions through poor policy incentive structures, making it an optimal base theory for this study. In order to make North's theory more substantial, I turn to the theory of Mancur Olson to fill in some holes in the underlying theory. His theory on the collective action of rent seeking organizations is important to this study because it provides detailed explanations and implications for distributional coalitions that arise in older, more developed societies, which cause an overall decline in societal welfare. Chapter One outlines the Institutional Framework, Degree of Competition and Incentive Structures for Beneficial Institutional Evolution, and explains the Existence of 'Distributional Coalitions' in the Economy.

The subject of Chapter Two, The Growth of Economies, is vital to increasing the overall welfare of humanity. Although economic growth is essential in all societies for the betterment of mankind, it should be clarified that this chapter will reflect on the growth of *already* developed capitalist economies. Developing economies are different, in terms of governance and growth

potential, because their respective property rights structure is often not as established as in many developed economies. Therefore, the formal constraints distinctive to each country may not be mature enough to sustain long-term economic growth, thus limiting our ability to broadly generalize and discuss all developing economies. Chapter Two asks 'what is capitalism?' identifying the mechanism that is alleged to weed out inefficiencies in the market. This leads into the next section on The Free and Not So Free Market, which discusses the property rights and free flowing aspects that markets require to foster a healthy capitalist society. The next sections introduce the types of technologies responsible for large-scale and incremental economic growth and the adaptive efficiency of institutions that allow for these types of growth to occur. Finally this chapter concludes with a section on Stability, which raises the issue of how governments should not give priority to short term stability over long term sustainability because it may risk an ultimate decline in overall societal welfare.

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[i] New Institutionalism, http://en.wikipedia.org/wiki/New_institutionalism (04/10/06)
[ii] North, Douglas C. Institutions, Institutional Change and Economic Performance. Cambridge, United Kingdom: Cambridge UP, 1990. P 3
[iii] Williamson, Oliver E. "The New Institutional Economics: Taking Stock, Looking Ahead." Journal of Economic Literature Vol XXXVIII (September 2000): 595-613.

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Institutional Theory

> *The evolution of institutions that create an hospitable environment for cooperative solutions to complex exchange provides for economic growth. (Douglas C. North, Institutions, Institutional Change and Economic Growth)*

The reader might ask if the primary focus of this essay is to discuss economic growth potentials, what significance does institutional theory have? North would answer this question best, indicating that, "institutions affect the performance of the economy by their effect on the cost of exchange and production. Together with the technology employed, they determine the transaction and transformation (production) costs that make up total costs."[iv] Without institutions, transaction and production costs would be too high for the economy to function. Although institutions are diverse in different places, the evolution of these institutions allows for the total cost of transactions to decrease on the condition that the environment promotes cooperative solutions to exchanges, thereby allowing stable economic growth.

The natural tendency of human beings is to maintain control and stability – this provides a basis for why institutions arise. North indicates that the, "major role of institutions in a society is to reduce uncertainty by establishing a stable (but not necessarily efficient) structure to human interaction."[v] It is important to note what North is saying in this last statement—that stability is the primary objective over efficiency signifies that existing institutions may not be healthy for their society in the long run, but their stability allows them to perpetuate for the sake of their continual and reliable existence. Based on their perceptions of the world, human's construct institutional frameworks made up of formal and informal constraints. Organizations arise within these constraints, acting as either players or officials of the game. The players interact with each

other and with the officials, and the degree of their interaction is based on the incentives to engage in contractual relationships. Through monitoring systems, officials ensure the game is played fairly by punishing agents for breaking the rules, whether they encroach on property rights and / or break contracts. Institutional change can be good for the economy because surrounding environments are forever changing. Therefore, it is in the interest of the economy for its institutions to adapt in order to increase efficiencies. Institutions change both incrementally and drastically, the latter occurring less often. The ability of an economy to exhibit prolonged sustainability is based on the level of competition and incentive structures for beneficial evolution. However, stagnant economies are often the victim of distributional coalitions, which inhibit institutional change. The following sections explore these ideas in further detail.

Institutional Framework

North begins his theory by indicating that institutions are human constructs created to reduce uncertainty and that institutions differ from society to society. The simplest definition he provides is, "institutions include any form of constraints that human beings devise to shape human interaction."[vi] The constraints he refers to are either formal, such as rules and laws, or informal, such as social norms, taboos, and even technologies.

Formal constraints "include political (and judicial) rules, economic rules, and contracts."[vii] This particular type of constraint derives from a society's need to enforce property rights.

> The rules descend from polities to property rights to individual contracts. Contracts will reflect the incentive-disincentive structure imbedded in the property rights structure (and the enforcement characteristics); thus the opportunity set of the players and the forms of organization they devise in specific contracts will be derived from the property rights structure.[viii]

The structure of formal constraints is what allows a society to establish itself and grow within a virtual structure, while at the same time confining it from acting in divergence with the rules, by allowing specific kinds of interaction and exchange. This tells us that supposed free societies, such as the United States, are not entirely free… in fact they are very restrictive of freedom in its literal sense. The ability to act within a system of formal constraints is often called freedom, despite the literal meaning of the word.

As indicated earlier, North repeats that "…it is important to stress that there is nothing in [this] argument so far about rules that implies efficiency… rules are, at least in good part, devised in the interests of private wellbeing rather than social well-being."[ix] Societies that allow for the due process of reform to their structure of formal rules should be considered more efficient, performing more towards the interest of societal wellbeing.

Informal constraints are equally as important as formal constraints but are much more difficult to describe. Quoting Robert Sugden, North answers his question about the emergence of such constraints. "A pervasive but relatively simple to explain form of such constraints is conventions that solve coordination problems: 'These are rules that have never been consciously designed and that is in everyone's interest to keep' (Sugden, 1986, p. 54)."[x] North explains that it is much easier to describe and be precise about formal rules than to describe and be precise about the structure of human interaction within a particular society. Although they originate from cultural traditions and taboos, informal constraints are very prevalent in the decision making process of individuals, making their presence ubiquitous throughout modern economies. After all, traditions are responsible for shaping the tastes and preferences of the consumer, which determine the opportunity sets in an economy. The ultimate choice sets are a reaction to the way the mind processes information—its limited cognitive competence.

> The way by which the mind processes information not only is the basis for the existence of institutions, but is a key to understanding the way informal

> constraints play an important role in the makeup of the choice set both in the short-run and in the long-run evolution of societies.[xi]

The short and long-run evolution of institutions, North alludes, is determined in large part by the opportunity sets derived by the mental processes involved in shaping a society's informal constraints.[2]

Informal constraints both subtly and visibly exist all throughout our societies. With three encompassing thoughts, North says,

> [e]ven the most casual introspection suggests the pervasiveness of informal constraints. Arising to coordinate repeated human interaction, they are (1) extensions, elaborations, and modifications of formal rules, (2) socially sanctioned norms of behavior, and (3) internally enforced standards of conduct.[xii]

Cognizant, we are, that informal constraints often originate from cultural traditions we should keep in mind that they will not drastically change over night. Instead they will evolve with time. As North explains,

> …we do know that cultural traits have tenacious survival ability and that the most cultural changes are incremental… Equally important is the fact that the informal constraints that are culturally derived will not change immediately in reaction to changes in the formal rules. As a result the tension between altered formal rules and the persisting informal constraints produces outcomes that have important implications for the way economies change…[xiii]

If, however, an informal constraint were to be technologically derived as opposed to culturally derived, the constraint may be more easily alterable if a more efficient alternative were to displace the outdated constraint. This would also have important implications for the way the economy changed and will be explained further in forthcoming chapters.

Within institutions there exists a *framework of organizations*. Organizations "…are groups of individuals bound by some common purpose to achieve objectives."[xiv] These "organizations" are entities that function as either players or officials. There are various different types of

[2] Although this paper does not discuss the cognitive processes involved in human decision making, it would be most prudent for the reader to read North's more recent book, Understanding the Process of Economic Change.

organizations that emerge within different institutional structures because not all groups of individuals will have the same common objectives.

> A crucial distinction… is made between institutions and organizations… Conceptually, what must be clearly differentiated are the rules from the players. The purpose of the rules is to define the way the game is played. But the objective of the team within that set of rules is to win the game…[xv]

Depending on what "game" an organization is playing, there will be different rules as well as objectives. The varied objectives of organizations range from the maintaining of stability and promotion of societal growth, as governments often do, to earn a profit, as companies often do, or to maximize utility, as consumer often do. It should be noted that the officials (the government) are the ones who write the rules to the game, but it is only "in rare cases [that] the government designs and enforces a set of rules of the game that encourage productive activity."[xvi] Due to the fact that the officials write the rules while the players play the game, "the government has strong incentives to behave opportunistically to maximize the rents of those with access to the government decision-making process… the government will [thus] cartelize economic activity in favor of politically influential parties."[xvii] The reader should note this for the coming section about distributional coalitions.

The players and officials within organizations coexist and grow together sometimes changing the institutional structure, depending on the overall *level of interaction*. North notes that "both what organizations come into existence and how they evolve are fundamentally influenced by the institutional framework. In turn they influence how the institutional framework evolves."[xviii] Here we have a lead into how institutions change. Following this, he comments on how economies are influenced by institutions. Institutions have the ability to affect the performance of the economy because they determine the costs of exchange and production. As uncertainty is reduced through the structure of constraints, production and transaction costs are both reduced, improving the efficiency of the economy. North rhetorically ponders that "the

central puzzle to human history is to account for the widely divergent paths of historical change. How have societies diverged? What accounts for their widely disparate performance characteristics?"[xix] Societies have diverged and have boasted different performance characteristics because of the different levels of interaction between organizations and institutions.

Institutions have *punishments* for violations of their society's respective formal and informal constraints. North indicates that "an essential part of the functioning of institutions is the costliness of ascertaining violations and the severity of punishments."[xx] Once violations can be easily ascertained, the society's effectiveness of *monitoring* the playing field for future violations is a good gauge of how well the institution is functioning. As noted in North's book, most economic theories take enforcement as a given, however, enforcement should not be taken as a given. As can be imagined, however, gauging enforcement is difficult from society to society. What one must observe is the performance of contracts between patrons, which will indicate the level of transaction costs. The spectrum of performance ranges from inefficient to efficient. The transaction costs correlate directly from the former being most costly to the latter being least costly. The most efficient contracts are self-enforcing. "Contracts are self-enforcing when it pays the parties to live up to them—that is, in terms of the costliness of measuring and enforcing agreements, the benefits of living up to contracts will exceed the costs."[xxi] A primary goal of economies is to achieve self-enforcing contracts.

Degree of Competition and Incentive Structures for Beneficial Institutional Evolution

North goes on to state that institutional change is very complicated in nature, therefore it is difficult to explain. Institutional change can come about from a variety of different reasons,

such as a change in formal rules, informal constraints, or in kinds of effective enforcement, but changes are rarely large and most typically occur at the margin. Change generally occurs incrementally because bureaucracies act as preventative forces for the rapid change of formal constraints. Even if formal constraints are changed, it is even more difficult and timely to change the informal constraints of a society because they are most often rooted in cultural traditions and societal norms. Although change is often slow, it does in fact occur. The direction which the change takes place, for better or worse, depends on the type of interaction the organizations share with the institution. The level of efficiency, if efficiency means that the common goal is overall societal benefit, determines the direction of change. If institutional change improves societal welfare via a reduction in total costs and better products, then the institution itself is efficient.

North questions, "what accounts for societies experiencing long-run stagnation or an absolute decline in economic well-being?"[xxii] Inefficient institutions are the cause, crippling the abilities of societies to become more efficient. The more pertinent question is why do they persist? He says that "…it is possible to explain the existence of inefficient institutions..." but it is difficult in explaining why the competitive pressures will not "lead to their elimination."[xxiii] In attempting to explain the situation North writes that,

> The answer hinges on the difference between institutions and organizations and the interaction between them that shapes the direction of institutional change. Institutions, together with the standard constraints of economic theory, determine the opportunities in a society. Organizations are created to take advantage of those opportunities, and, as the organizations evolve, they alter the institutions.[xxiv]

Therefore, the level of efficiency depends on the level of competition amongst the organizations and the incentive structure for beneficial evolution, which is laid out by the institutional framework. North then describes two assumptions by which the direction of change is shaped:

> The resultant path of institutional change is shaped by (1) the lock-in that comes from the symbiotic relationship between institutions and the organizations that have evolved as a consequence of the incentive structure provided by those institutions and (2) the feedback process by which human beings perceive and react to changes in the opportunity set.[xxv]

The symbiotic relationship referred to in the first assumption are the constraints that inhibit change, while the opportunity set referred to in the second assumption is the "entrepreneurs" perception of the idea of a less costly means for interaction versus the current system. This 'perception' is again what Williamson refers to as the limited cognitive competence, or bounded rationality. In North's words, "[incremental] change comes from the perceptions of the entrepreneurs in political and economic organizations that they could do better by altering the existing institutional framework at some margin."[xxvi] Finally, North explains that once an institution becomes inefficient, it is difficult to realize alternative opportunity sets because actors must base decisions on incomplete information that stems from the inefficient institution. Not only do the players have this limited cognitive competence but it also limits the referees of the game who define the rules. Therefore, the rationality behind the definition of property rights remains bound by individuals' perception of what they should be, not necessarily what they really are.

Existence of 'Distributional Coalitions' in the Economy

North's difficulty in explaining institutional change leads us to question why inefficient institutions exist and harm the overall welfare of society. Mancur Olson explains that in developed societies, as organizations and institutions evolve together, the organizations will grow large enough to steer institutional change for the purpose of perpetuating their own existence.

> The organizations for collective action within societies that we are considering are therefore overwhelmingly oriented to struggles over the distribution of income and wealth rather than to the production of additional output—they are 'distributional coalitions' (or organizations that engage in what, in one valuable line of literature, is called 'rent seeking').[xxvii]

These distributional coalitions are harmful to society and,

> …have the incentive and often also the power to prevent changes that would deprive them of their enlarged share of the social output. To borrow an evocative phrase from Marx, there is an "internal contradiction" in the development of stable societies. This is not the contradiction that Marx claimed to have found, but rather an inherent conflict between the colossal economic and political advantages of peace and stability and the longer-term losses that come from the accumulating networks of distributional coalitions that can survive only in stable environments.[xxviii]

The question then arises, why, if distributional coalitions are so harmful, are they allowed in developed societies to exist and inhibit other institutions from developing? North might answer this question by reminding us of his explanation that stability is the primary objective over efficiency. Olson would agree about the importance of societal stability. While distributional coalitions are harmful, so is instability.

> The dense network of distributional coalitions that eventually emerges in stable societies is harmful to economic efficiency and growth, but so is instability. There is no inconsistency in this; just as special-interest groups lead to misallocations of resources and divert attention from production to distributional struggle, so instability diverts resources that would otherwise have gone into productive long-term investments into forms of wealth that are more easily protected, or even into capital flights to more stable environments. On the whole, stable countries are more prosperous than unstable ones and this is no surprise. But, other things being equal, the most rapid growth will occur in societies that have lately experienced upheaval but are expected nonetheless to be stable for the foreseeable future.[xxix]

In his analysis of more developed societies, Olson outlines nine implications for distributional coalitions. Here, only implications that pertain to this institutional outline are listed[3]:

[3] It would be advantageous for the reader to investigate chapter 3 of Olson's book The Rise and Decline of Nations; Economic Growth, Stagflation, and Social Rigidities for a more thorough understanding of collective action theory.

4. On balance, special interest organizations and collusions reduce efficiency and aggregate income in the societies in which they operate and make political life more divisive.
5. Encompassing organizations have some incentive to make the society in which they operate more prosperous, and an incentive to redistribute income to their members with as little excess burden as possible, and to cease such redistributions unless the amount redistributed is substantial in relation to the social cost of the redistribution.
6. Distributional coalitions make decisions more slowly than the individuals and firms of which they are comprised, tend to have crowded agendas and bargaining tables, and more often fix prices than quantities.
7. Distributional coalitions slow down a society's capacity to adopt new technologies and to reallocate resources in response to changing conditions, and thereby reduce the rate of economic growth.
9. The accumulation of distributional coalitions increases the complexity of regulation, the role of government, and the complexity of understanding, and changes the direction of social evolution. [xxx]

Implication four indicates that the presence of special interest organizations reduces the total income of the society in which they reside because they are not concerned with societal welfare. Their existence complicates the role of government because governments favor the short term stability that the distributional coalitions provide. The problem is that political figures are not accountable for long term sustainability, so by favoring short term stability they may be risking a reduction of societal welfare over time. Implication five indicates that if organizations are large enough relative to the society, encompassing as Olson puts it, incentives favor them to act for the benefit of society because the health of the organization and society are highly correlated. Implication six reflects on the distributional coalition's inability to make quick decisions to the relatively nimble decision-making abilities of individuals and smaller firms. Implication seven indicates that the presence of distributional coalitions in a society impedes technological change and hence growth. Implication nine signifies the difficulty of the government's role in regulating distributional coalitions, for they bring stability as well as stagnation, consequently changing the direction of social evolution.

Conclusions

By fusing together North, Williamson, and Olson's works on institutions and collective action I present a list of theoretical criteria that I will use in my analysis of energy institutions in the United States.

- The major formal and informal constraints.
- The framework of organizations within the institution.
- Level of interaction between organizations.
- Punishments and monitoring systems.
- Degree of competition and incentive structure for beneficial institutional evolution.
- Existence of 'distributional coalitions' in the economy.

Before I can analyze energy institutions, the reader must understand what role institutions play in the grand scheme of economies. The next chapter will do just that, exploring the importance that institutional change has on growth in developed, capitalist economies.

Chapter Notes

[iv] North (1990) 5-6
[v] *Ibid.* 6
[vi] *Ibid.* 4
[vii] *Ibid.* 47
[viii] *Ibid.* 52
[ix] *Ibid.* 48
[x] *Ibid.* 41
[xi] *Ibid.* 42
[xii] *Ibid.* 40
[xiii] *Ibid.* 44-45
[xiv] *Ibid.* 5
[xv] *Ibid.* 4-5
[xvi] North, Douglas C. Understanding the Process of Economic Change. Princeton University Press, Princeton, NJ. 2005. 67
[xvii] *Ibid.* 67
[xviii] North (1990) 5
[xix] *Ibid.* 6
[xx] *Ibid.* 4
[xxi] *Ibid.* 55
[xxii] *Ibid.* 7
[xxiii] *Ibid.* 7
[xxiv] *Ibid.* 7
[xxv] *Ibid.* 7
[xxvi] *Ibid.* 8
[xxvii] Olson, Mancur. The Rise and Decline of Nations; Economic Growth, Stagflation, and Social Rigidities. Yale University Press. New Haven, London. 1982. P 45
[xxviii] *Ibid.* 144-145
[xxix] *Ibid.* 165
[xxx] *Ibid.* 74

2

The Growth of Economies

> *Western history is replete with examples of the rise and fall of nations and empires, in both absolute and relative terms. The declines are particularly important, because they have been propelled by institutional and organizational failures.*
> *(Elhanan Helpman, The Mystery of Economic Growth)*

To what can we attribute economic growth in developed capitalist societies? The answer to this question is not precise. For, if there were a formula that governments could implement to yield economic growth, all certainly would. Unfortunately, no such formula exists. Because inter-workings of individual economies are unique and are subject to different tastes, demands, supplies, resources, and labor, the job of central bankers and law-makers around the world also are unique. Law-makers especially because they are the ones responsible for defining and enforcing property rights, which are a product of the bounded rationality[xxxi] rooted in the informal constraints of each respective society. There is, however, a generalization that I would offer for all developed economies—stability and institutional change are vital to their perpetual existence and growth. This chapter focuses on the importance of both stability and institutional change in developed capitalist economies and why the latter is necessary for economic growth.

What is Capitalism?

When Joseph Schumpeter published *Capitalism, Socialism and Democracy* he did not believe that capitalism could survive; yet, it has thrived more than he expected. Schumpeter takes a pessimistic stance while describing some key factors about capitalism that many other theorists

interpret in a more positive light. As a general description, "capitalism… is by nature a form or method of economic change and not only never is but never can be stationary."[xxxii]

Capitalism often gets demonized by its potential negatives, such as environmental degradation and exploitation of the poor. Capitalism, however, is only the continual process of organizations exploiting market incentives created by polities. Although Schumpeter may not agree with this statement, institutionalists might agree that the purpose and reason for capitalism is to enable personal freedoms and allow for the naturally equilibrated allocation of capital throughout a society. "Once property rights have been defined and their enforcement assured, the government steps aside. Resources are allocated to their highest value as the marvel of the market works its wonders."[xxxiii] By allowing individuals to exploit ever-changing consumer demands, efficiencies are continually promoted throughout the system by means of innovation and reductions in production and transaction costs. If organizations are allowed to harm the general wellbeing of society without punishment, it is most likely the fault of the ill-defined property rights that are delineated by polities. Organizations harming the general wellbeing of society can also be the result of the costliness of ascertaining violations. Where self enforcing contracts will be less costly to enforce, non-self enforcing contracts are very costly to enforce therefore making it difficult to monitor and punish wrong-doers.

The world is not static, it is forever changing. The capitalist economic system reflects this continual change: "The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates."[xxxiv] "Creation" cannot, however, come without destruction.

> The opening up of new markets, foreign or domestic, and the organizational development from the craft shop and factory… illustrate the same process of

> industrial mutation… that incessantly revolutionizes[4] the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in.[xxxv]

Creation and destruction are the two primary pillars of capitalism. These pillars do not put capitalist societies on a path toward socialism, as Schumpeter indicates, but instead puts them on a path toward obtaining the ultimate objective of freedom. Capitalist societies strive for personal freedoms but their efforts are often hindered by corruption. There are many confounding and corrupting factors that play into real-life capitalist systems. A primary corrupting factor that derails capitalist societies from their track to freedom is the constriction of free markets.

The Free, and Not So Free, Market

Government-induced constrictions of free markets are reminiscent of socialist ideologies, where a government will attempt to centrally plan a society using capitalist mechanisms. Milton Friedman says that "there is an intimate connection between economics and politics, that only certain combinations of political and economic arrangements are possible, and that in particular, a society which is socialist cannot also be democratic, in the sense of guaranteeing individual freedom."[xxxvi] The ultimate goal of a capitalist society, as Friedman would say, is freedom, with the individual being the ultimate entity. Although Friedman is not an institutionalist, the principles he outlines about the free market are recognized by institutionalists as very important to societal health. Individual and economic freedoms foster healthy democracies. "The kind of economic organization that provides economic freedom directly, namely, competitive capitalism, also promotes political freedom because it separates economic

[4] Schumpeter notes here, "Those revolutions are not strictly incessant; they occur in discrete rushes which are separated from each other by spans of comparative quiet. The process as a whole works incessantly however, in the sense that there always is either revolution or absorption of the results of revolution, both together forming what are known as business cycles."

power from political power and in this way enables the one to offset the other."[xxxvii] Friedman might agree that societies which restrict free markets are not truly democratic because competitive capitalism requires free markets. Government-induced constrictions of the free market abuse the capitalist mechanism, limiting its capacity to function properly.

The title of this paper refers to capitalism's creative and destructive capacity. Why should one care about its creative and destructive capacity? Why should one care about anything that does not work properly? Without free markets, capitalism's ability to destroy old, inefficient institutions and create new ones is severely limited, placing the society at hand in dire risk of stagnation and an absolute decline in overall welfare. The free markets must, however, function within a system where property rights are clearly defined and enforced. Take clean air and water for example, these public goods are the property of the people and should be protected against encroachment without compensation. If these rights are not clearly defined or enforced, capitalisms driving force may also steer society toward a decline in welfare, as it has in many cases of environmental degradation.

The United States likes to boast about itself as being a democratic and free market capitalist society. However, as explained in the previous paragraph, this can hardly be the case because the representative government often restricts free markets. As noted in Chapter One, the 'free' in free society does not actually imply total personal and economic freedom. It means that there are freedoms within a structural matrix of formal and informal constraints (political, economic, contractual, and social rules of the game) that allow for a society to grow. If a market is built upon constraints, what is a free market, and can it truly exist in a society? A free market can indeed exist, but only in a true and healthy democracy where individual freedoms are not stifled. The matrix of constraints creates the market, but transactions must be allowed to flow freely. Free-flowing means that there is a level playing field for all rule abiding competitors.

Market restrictions should only serve to enforce property rights, thereby restricting negative externalities potentially caused by business operations. These types of restrictions would provide incentives for efficient market outcomes while at the same time protecting individual rights and freedoms that would otherwise be encroached upon. The constraints within the matrix are not dissimilar from friction. Without friction, things would not be able to move or grow. Too much friction, however, limits movement and growth. A structural matrix of constraints, which evolves over time, accumulates laws, taxes and subsidies that are often too specific in regard to technological outcomes, thus creating too much friction. The consequence of formal constraint specificity will ultimately cause market failure. When the market does not clear at its natural equilibrium, where marginal social cost equals marginal social benefit and producers pay the total cost of production, disastrous impediments to sustainability arise.

Take for example this biological metaphor. In order for a heart to function properly there must be valves that provide a steady flow of blood for life to sustain itself. These valves are not dissimilar from the structural matrix of constraints that create a market which provides the production and transaction channels for the economy to be sustainable. If the valves become clogged, slowing the blood flow, the heart rate will slow down as well. If the valves become so clogged that the heart cannot get enough blood to function properly the heart will consequently stop beating. This too will happen if the structural matrix becomes cluttered with excessively specific constraints. Although institutional matrices are more complex than a heart, the principles of constraints and sustainable life are very similar.

Governments often create policies that make more friction within a system in attempts to foster rapid growth. They may, for example, subsidize a specific type of technology for the purpose of sculpting a particular technological outcome that planners believe to be superior. This market is not free because it involves a mix of central planning. Nor is it sustainable. When

a government sponsors a specific type of technology to promote rapid growth over natural growth, the direction of institutional change will be altered and future stability threatened. As North stated, the opportunities in a society are determined by institutional constraints because organizations will be created to take advantage of those opportunities. The evolution of these organizations will then alter the institutional structure, often times forming distributional coalitions that bring about a decline in economic wellbeing. This decline causes nations to become stagnant and limits their ability to adapt to an ever-changing world. By promoting continuous change through creation and destruction, institutional and organizational failures are avoided because growth is achieved naturally and sustainability through a market process. From my perspective, this is why we should be interested in capitalism's creative and destructive capacity.

Two Types of Growth

What is the cause of economic growth? The answer, again, is not precise. However, new institutionalist economic theory explains the importance of institutional change for economic growth. In the simplest language, a society has resources and inputs. Essentially, growth can be observed as a society's increasing ability to adapt and efficiently utilize its resources and inputs. Elhanan Helpman, in his book *The Mystery of Economic Growth*, states that "… economists use the concept of *total factor productivity* (*TFP)* to measure the joint effectiveness of all inputs combined in producing output."[xxxviii] The input-to-output ratio is not the same among economies and their rate of output growth does not equal the contribution of inputs. As Helpman points out:

> In a typical data set the growth of output exceeds the contribution of inputs. The difference between the rate of growth of output and the contribution of input growth represents the rate of growth of total factor productivity. That is, it represents the aggregate effect of the various forms of technological change.[xxxix]

The crucial point to take from this quote is the involvement that technological change has on the efficiency of utilizing inputs and its positive influence on economic growth. Economic growth is positively correlated with total factor productivity, of which an important determinant is technological change that encourages a more efficient use of inputs. Helpman, cites Simon Kuznets as stating: "'since the second half of the nineteenth century, the major source of economic growth in the developed countries has been science-based technology-in the electrical, internal combustion, electronic, nuclear, and biological fields, among others.'"[xl] These types of technologies, as well as others, have been the primary cause for substantial economic growth since the industrial revolution.

There are two types of growth that, for the purpose of this thesis, are important to understand: incremental growth and large-scale growth. It is important to note that both types of growth can occur in all societies and that most of the time a society will experience incremental growth, if it is growing at all. A timeline of economic growth can be broken down by milestones, where a milestone represents a drastic technological shift. Clayton M. Christensen first coined the type of technology that causes these shifts as 'disruptive technologies' in his book *The Innovator's Dilemma*. A disruptive technology is described as follows:

> a new technological innovation, product, or service that eventually overturns the existing dominant technology in the market, despite the fact that the disruptive technology is both radically different from the leading technology and that it often initially performs worse than the leading technology according to existing measures of performance.[xli]

The term "disruptive" is explanatory of the reaction to existing technologies that become obsolete. This term is not intended to indicate a negative disruption to the society or its economy. In fact, after its implementation, the society should experience relatively larger economic growth because of more efficient utilization of inputs which, as a result, reduced production and transaction costs that come with the new technology.

If a capitalist society is to continually gain new efficiencies and reduce transaction costs, then the growth curve of that society will be upward sloping. The slope of a society's economic growth curve over time should presumably get steeper with each disruptive technology because of the decrease in total cost it causes. Large-scale growth is spurred by disruptive technologies. Technologies such as the steam engine, electricity, internal combustion engine, automobile, personal computer, and information technology are prime examples of disruptive technologies that have enabled enormous levels of economic growth:

> Each one of these inventions was drastic rather than incremental; each had the potential for pervasive use in a wide range of applications, each triggered the development of many complimentary inputs, and each launched a prolonged process of adjustment that included the reorganization of the workplace.[xlii]

Disruptive technologies should be encouraged through incentive schemes that allow the market to decide what is appropriate in democratic, free market, capitalist societies. Their creation and implementation is vital to the growth of economies that are seeking reductions in total costs.

Incremental growth occurs during the process of gaining efficiencies after a disruptive technology is invented and the spread of these efficiencies throughout the economy. These efficiencies are achieved by means of 'sustaining technologies'[xliii] that improve the performance of the once-disruptive technology. The improvement of efficiency through the innovation of sustaining technologies plays a large role in determining a society's total factor productivity, enabling a society to more efficiently utilize its inputs. In striving for total efficiency, disruptive technologies must be allowed to develop. Sustaining technologies will than incrementally allow for marginal increases in output, until yet another disruptive technology is invented and commercialized.

Institutional Change

Human beings interact through institutional structures. Often times, institutions are structured around a specific type of technology. The institutional network of roads and highways, for example, are the result of the automobile, which was a disruptive technology. Highway and road systems serve as both sustaining technologies as well as institutions with formal and informal constraints. Cars are only permitted to drive on the right side of the road when traffic is traveling in both directions (a formal constraint), and drivers should not exhibit any action with their vehicles that is in a retaliatory manor to another driver (an informal constraint). As explained in the previous section, people are constantly seeking to reduce costs. The innovation of sustaining technologies reduces costs without necessitating the creation of an entirely new institutional structure. However, when there is a disruptive technological innovation the latest technology may require new institutions to be constructed. The evolution of technology has proven this to be true with most disruptions. Institutional change plays an important role in economic growth. If institutional change did not occur, there would be economic stagnation and an ultimate decline in welfare because of the society's inability to adapt to change.

Institutional change is a requisite for long-term growth, but where does it come from? North says that "organizations and their entrepreneurs engage in purposive activity and in that role are the agents of, and shape the direction of, institutional change."[xliv] These organizations are formed in response to the institutional framework, or a game. There would be no players without a game, to use North's sports analogy. How can it be assured that institutional change induced by organizations will be beneficial to their respective society? The level of "adaptive efficiency" permitted by the institutional framework plays an important role in determining this outcome.

> Adaptive efficiency… is concerned with the kinds of rules that shape the way an economy evolves through time. It is also concerned with the willingness of a society to acquire knowledge and learning, to induce innovation, to undertake risk and creative activity of all sorts, as well as to resolve problems and bottlenecks of the society through time.[xlv]

A society that has developed distributional coalitions may not be as willing to acquire the knowledge to induce innovation that spurs disruptive technologies. Distributional coalitions are more concerned with preserving the current technologies for the purpose of generating more returns. Without a properly functioning capitalist mechanism, there are no incentives for organizations to resolve problems and bottlenecks—as long as there are incentives to generate and redistribute wealth within the organization.

Adaptive efficiency is sculpted by the institutional framework, which is created by the government. According to North:

> …different institutional rules will produce different incentives for tacit knowledge. That is, the particular institution will not only determine the kinds of economic activity that will be profitable and viable, but also shape the adaptive efficiency of the internal structure of firms and other organizations by, for example, regulating entry, governance structures, and the flexibility of organizations.[xlvi]

Tacit knowledge is knowledge that "is acquired in part by practice and can be only partially communicated...."[xlvii] If a particular institution fosters the growth of distributional coalitions and is not conducive to the markets adaptive efficiency, the structure of rent seeking organizations will grow around outdated technologies. It is up to the government to structure the institutional matrix, or game, as such so that the players respond to market forces as opposed to corrupting incentives, such as subsidies.

> The incentives embedded in the institutional framework direct the process of learning by doing and the development of tacit knowledge that will lead individuals in decision-making process to evolve systems gradually that are different from the ones that they had to begin with…[xlviii]

Natural evolution of the economy, which often occurs gradually, ensures sustainable growth. Large-scale growth should be allowed to take place due to natural market forces as opposed to rapid growth caused by specific government-induced incentives. North indirectly indicates why government should not attempt to specifically induce rapid change:

> In a world of uncertainty, no one knows the correct answer to the problems we confront and no one therefore can, in effect, maximize profits. The society that permits the maximum generation of trials will be most likely to solve problems through time (a familiar argument of Hayek, 1960). Adaptive efficiency, therefore, provides the incentives to encourage the development of decentralized decision-making processes that will allow societies to maximize the efforts required to explore alternative ways of solving problems. We must also learn from failures, so that change will consist of the generation of organizational trials and the elimination of organizational errors. There is nothing simple about this process, because organizational errors may be not only probabilistic, but also systematic, due to ideologies that may give people preferences for the kinds of solutions that are not oriented to adaptive efficiency.[xlix]

Therefore, the best governmental policy is one that fosters adaptive efficiency through the enforcement of clearly and well defined property rights, which presumably restrict negative externalities.

Stability

The real world is not as simple as some of these implications make it seem, making the job of governments extremely difficult. Democratic governments are faced with the task of appeasing the immediate demands and needs of the people while positioning themselves for long-term sustainability. While ensuring the economy's ability to adapt and change with the times, there is often too heavy of an emphasis on the government's role in maintaining short-term stability. Helpman cites Samuel Huntington's views on stability:

> Huntington (1968) emphasized the role of stability in the survival of regimes. But change per se does not appear to be harmful to regimes. Rather, change that results from economic growth is good for the survival of both democratic and

> autocratic regimes, while contraction of income per capita is detrimental to the survival of both.[1]

Huntington points out that although stability is vital to the survival of regimes, lack of change that results in a contraction of income per capita is injurious to a nation's survival. Despite this warning, nations often tend to favor the creation of interest groups that ensure stability. Helpman brings the discussion back to Mancur Olson's idea of the distributional coalition that reduces efficiency and threatens the long-term welfare of a nation.

> …Olson suggested that the formation of interest groups does not further economic efficiency. Moreover, stable societies tend to accumulate more groups that promote their own interests. The activities of these groups then reduce efficiency and foster political divisiveness. Despite the fact that large organizations weigh the loss of aggregate efficiency against their own distributional gains, significant excess burden emerges in societies with such organized groups. They slow down the social process of decision making, erect entry barriers, produce complex legal and regulatory frameworks, and complicate the role of government. As a result they damage a society's capacity to adopt new technologies and to reorganize in response to technological change. Thus they slow growth. In short, in stable societies the number of groups that seek redistributive gains grows over time and the rate of growth of income per capita declines.[li]

This quote summarizes a point that is fundamental to this chapter. Self-interest groups accumulate in stable societies, such as the United States. These groups reduce efficiency and will corrupt law-making politicians, creating excess societal burden. The society's ability to change is slowed because of specific constrictions implemented into the institutional framework which favor the distributional coalition. Therefore, in a country such as the United States, capitalism's creative and destructive capacity to adopt new technologies and smoothly change institutions is hindered. This hindrance slows growth and induces a decline in per capita income, which is more detrimental to a society in the long-run than the attempts at maintaining stability by government.

Conclusions

This chapter about the growth of economies coupled with the previous chapter about institutional theory lays the ground work for my analysis of energy institutions in the United States. The important points to remember from this chapter, while reading the forthcoming chapters, are as follows:

- Capitalism is a creative and destructive method of economic change and is never stationary. It can enable personal freedoms and allows naturally equilibrated allocation of capital throughout a society, thus reducing production and transaction costs.
- In order for the capitalist mechanism to function properly, markets must be free flowing, with restrictions that enforce well-defined property rights, thereby restricting negative externalities produced by businesses and consumers.
- Capitalism fosters large-scale growth, enabled by the innovation of disruptive technologies, and incremental growth, enabled by the innovation of sustaining technologies which make the once-disruptive technology more efficient.
- The ability of a society to quickly adapt with the times, adaptive efficiency, is a crucial element for institutional change and therefore long-term growth.
- Stability is crucial to a society's long-term sustainability, but governments should not attempt to foster stability in fear of institutional change because distributional coalitions will subsequently arise, potentially leading to a decline in overall societal welfare.

These five points will be referenced in the upcoming chapters as theories outlined in Chapters One and Two are applied to energy institutions in the United States.

Chapter Notes

[xxxi] Williamson, Oliver E. "The New Institutional Economics: Taking Stock, Looking Ahead." Journal of Economic Literature Vol XXXVIII (September 2000): 595-613.
[xxxii] Schumpeter, Joseph A. Capitalism, Socialism, and Democracy. Harper Perennial. New York, NY. 1942. P 82
[xxxiii] Williamson 598
[xxxiv] Schumpeter 83
[xxxv] *Ibid.* 83
[xxxvi] Friedman, Milton and Rose. Free to Choose; A Personal Statement. Harcourt Inc. San Diego, New York, London. 1980. P 8
[xxxvii] *Ibid.* 9
[xxxviii] Helpman, Elhanan. The Mystery of Economic Growth. The Belkhap Press of Harvard University Press. Cambridge, Mass., London, England. 2004. P 20
[xxxix] *Ibid.* 22
[xl] *Ibid. 34-35*
[xli] Disruptive Technology, http://en.wikipedia.org/wiki/Disruptive_technology (04/10/06)
[xlii] Helpman 51
[xliii] Disruptive Technology, http://en.wikipedia.org/wiki/Disruptive_technology (04/10/06)
[xliv] North (1990) 73
[xlv] *Ibid.* 80
[xlvi] *Ibid.* 81
[xlvii] *Ibid.* 74
[xlviii] *Ibid.* 81
[xlix] *Ibid.* 81
[l] Helpman 132-133
[li] *Ibid.* 136-137

PART II

ENERGY INSTITUTIONS

Introduction

In Part I I provided the theoretical discussion necessary to analyze the institutions that surround one of the primary sources of economic growth: energy. In this next section I will use the new institutionalist theory outlined in Chapter One to analyze centralized and decentralized energy institutions. In Chapter Three I define centralized energy and identify its various forms. Through comprehensive analysis I explain why centralized electricity institutions in the United States have become distributional coalitions. Following this claim, I will explore the benefits, problems, and limitations of centralized electricity production and distribution. In Chapter Four I define and examine decentralized energy, identifying its various forms. Through more comprehensive analysis, I will determine that decentralized energy institutions have not yet, and likely will not after their adoption, become distributional coalitions. Thereafter I explain the benefits, problems, and limitations of these technologies and the future institutions that could develop around them. Concluding Chapter Four, I cross-examine centralized and decentralized energy potentials, exploring the question of why centralized energy has prevailed as the dominant institution, and explore the rise of decentralized energy against entry barriers.

3

Centralized Energy

> *Until recently, governments the world over have felt that [energy] was too "strategic" to be left to the vagaries of the market. In many ways, they have ensured that oil, gas, and electricity operated outside proper market principles. Decades of mismanagement, inefficiency, unnecessary pollution, and excessively high costs have been the result.*
> *(Vijay V. Vaitheeswaran, Power to the People)*

The principal foundation of modern economies, energy, is often taken for granted and yet it is critical for society to function. The institution of 'centralized energy' refers to the idea that electricity is a strategic resource that is provided in a supply driven, top → down system and cannot be adequately be supplied if left to the free market. The players that make up the organizational structure produce large quantities of energy in facilities far away from the end user, who is connected through a transmission grid. The two primary forms of centralized energy production in the United States and around the world are in the form of fossil fuel based electricity and oil. Although centralized oil is equally as important to economies around the globe as electricity, in this thesis I will focus solely on the analysis of centralized electricity institutions in the United States.

Types of Centralized Energy

Fossil fuel based electricity is primarily produced in large power plants across the country, producing roughly 800,000 mega-watts of electricity from nearly 5,000 plants[lii]. Power is transmitted and sold through the nation's grid of electric wires, which are connected to factories, businesses, homes, and learning institutions. Electricity is most often utilized after it is sent

through the buildings in which we live and conduct business, creating the illusion that the walls are filled with limitless power. Although energy seems to flow effortlessly through homes and places of work, seldom does the average American see how their power is actually produced and almost desensitized people are to the transmission of that electricity. After power is produced in a coal-fired, natural gas-burning, nuclear, or hydroelectric facility (although hydroelectric and nuclear are not fossil-fuel based), electricity is transmitted through over 250,000 miles[liii] of high and low tension power cables that line streets, highways, and sometimes open plains. Transformer stations allow for the high voltage electricity to be converted into low voltage electricity. This system works and has enabled huge success for developed countries over the past hundred years (although this approach has failed most of the developing world)[liv].

Oil, although often synonymous with energy, is not actually a type of energy. Oil is a practical type of energy carrier like coal or natural gas that, among many other applications aside from ones energy related, allows for yet another primary foundation of modern economies: transportation. The network of oil, from ground pump to gas pump, is so conveniently hidden from most consumers that if it were not for dramatic price fluctuations caused by increases in demand and shocks to supply chains, it too could be as hidden as electricity generation networks. Oil is pumped from the ground and piped through distribution networks. From these networks it can be sent via cargo ship to a gasoline refinery, where it is than trucked to local gas stations, readily available to be purchased by automobile owners. It can also be trucked directly to homes where it is pumped into a tank for storage, readily available for heat generation during cold winter months. The production and transmission of drilled coal and natural gas are very similar to their liquid energy carrying counterpart, however their contribution to transportation does not compare to that of oil's. Their respective applications vary, but the consumers are all

the same. Like fossil fuel based centralized electricity production, these systems also work and are irrefutable successes.

Despite the success of these heavily concentrated, or "centralized hub-and-spoke systems"[lv], they are highly inefficient and come with hidden monetary costs. The hidden costs, as referred to in the Preface, include maintaining outdated power plants, grids, and shipping lines, as well as militarily securing oil fields and pipelines, and protecting nuclear power plants from terrorist attacks—not to mention the costs of cleaning up environmental disasters caused by nuclear accidents, oil spills, and the negative externality costs of pollution endured by society. The latter is an impossible number to accurately quantify because, aside from the positive correlation with increased emissions and an increase in human ailments such as respiratory illnesses, the inconclusive possibility of human induced global warming may be causing insurmountable and irreversible costs to the entire world. Vijay Vaitheeswaran, in his book *Power to the People*, indicates that the economies of scale promised by bigger power plants is what has enticed governments to support them and turn a blind eye toward their extremely low efficiency and high environmental costs.

> Many of America's giant coal plants, for example, are well over thirty years old and barely manage an efficiency rate of 30 to 40 percent; in comparison, the best combined-heat-and-electricity micropower plants can achieve double that efficiency. The power industry has also ignored the losses dissipated as heat incurred in transporting power over wires to distant consumers, which typically amounts to more than a quarter of the cost of delivered electricity in developed countries.[lvi]

In light of the previous chapter's discussion about inefficiencies being weeded out of the market, the big question is why have inefficiencies in centralized energy institutions perpetuated? The answer: organizations that comprise centralized energy institutions in the United States constitute self-interested distributional coalitions that have been supported by government for much of the 20th century, whose inefficiencies are hindering economic growth and threatening

future sustainability. This next section reviews a history of centralized electricity production in the United States and then interprets the system through North, Williamson, and Olson's theory from Chapter One.

Centralized Electricity History

Centralized electricity is by and large an institution. Within this overarching institution are smaller institutions that are made up of electricity producing organizations. Both overarching and smaller institutions share and have unique formal and informal organizational constraints. In order to be officially referred to as an institution, 'centralized energy' must be analyzed through the criteria outlined in Chapter One. Before this, the reader should have an understanding of the history behind how centralized electricity came to be in the United States. The US Energy Information Administration's most recent update on *The Changing Structure of the Electric Power Industry 2000* provides a detailed history of legislation and governmental regulations. Vaitheeswaran also conveniently explains this detailed history of centralized electricity production in *Power to the People*. This summarized history can be attributed to these sources.

Electricity can be produced as direct current (DC) or alternating current (AC). During the emergence of electricity in the 19th century, there was an ugly struggle between Thomas Edison's promotion of DC, which is produced in smaller quantities for local generation, and Nikola Tesla's promotion of AC, which has the capability of being transmitted over long distances. Both forms have their benefits and disadvantages, but ultimately AC won the battle hands down in the late 19th century because centralized energy generators could produce large quantities of energy at low costs. Tesla and Edison's rival companies rushed to bring electricity to the masses through miles of transmission grids, beginning the reign of top → down power generation and transmission.

The consumer quickly shifted from local to centralized energy production, as new technologies like the electric motor demanded more and cheaper electricity. Samuel Insull, Edison's aide, came to control Edison's company and exploited the weak legal system's anti-trust regulations, attempting to dominate the entire electricity supply system in the U.S. by consolidating the industry. He believed the electric industry was a "natural monopoly" and should not contain any competition because the one supplier would supposedly supply the cheapest power at the lowest unit cost. Legal representatives feared an episode similar to the railroad monopolies and instituted the first wave of regulation to electric utilities in the early 1900s. This first wave, however, did not do very much regulating on the industry but rather gave the utilities the right to seize property as the government can in cases of eminent domain, making their existence almost legitimate.

Word of regulation led Wall Street to believe that these electric utilities were less risky, which allowed the utilities access to more funding at cheaper interest rates, thus allowing the industry to expand. What little regulation there was on the utilities was often evaded because individual states could not regulate interstate holdings. At this point, individual states were responsible for most of the regulations. By the end of the 1920s, there were a total of eight giant holding companies controlling roughly 75% of the electricity supply in the United States. Finally, under Franklin D. Roosevelt, the depression era laws were passed at the federal level as a part of the New Deal, totally constricting any type of market freedom in the industry. Most popular was the Public Utility Holding Company Act (PUHCA) in 1935, which restricted holding companies with regards to mergers, financing, and ownership, placing them under the Securities Exchange Commission's (SEC) regulation. Utilities were forced to serve all customers in their local areas without competition on pricing, quality, or service. Prices were set by public utility boards, not at the market price, but at the alleged "right" price based on the costs incurred by the utilities.

Despite the toll that the depression took on the economy, the electric power industry proved resilient to downward economic forces.

Congress, wanting to increase employment and secure the domestic food supply, passed the Rural Electrification Act (REA) in 1936. Subsidies under this piece of legislation brought electricity to American farmers previously too far away from the transmission grids. New Deal legislation also led to the construction of federally funded dams throughout the country to create jobs, also solidifying the government's position with centralized power. Centralized supply outpaced demand through to the 1960s, with increasing capacity and decreasing costs.

Beginning in the 1960s, with a surge in population amongst the middle class, demand for electricity quickly outpaced supply as well as capacity growth. Lack of R&D in the electric power industry, a result of restrictions on competition, ruled out any hope for market based industry reform. Wide spread centralization of electricity was set in stone as the standard because of governmental restrictions on competition (the most notorious being the construction of nuclear power plants during the 1970s). Lack of competition induced R&D resulted in "decades of mismanagement, inefficiency, unnecessary pollution, and excessively high costs have been the result."[lvii]

A series of four major events from the mid '60s to the late '70s led to increasing doubt over state regulation: The Northeast blackout in 1965, the Clean Air Act in 1970 and amendments in 1977, the oil embargo from 1973-74, and the nuclear regulatory delays caused by the accident at Three Mile Island. Deregulation of the industry began with the passage of Public Utilities Regulatory Policies Act (PURPA) in 1978. PURPA is known as the "catalyst for competition" in the electric power industry. Liberalization of energy markets continued in the '90s with the passage of the Energy Policy Act of 1992, allowing for the expansion of non-utility markets. PUHCA was repealed with the 2005 Comprehensive Energy Bill, allowing holding

companies to once again own utilities and removing SEC regulation. However, the reemergence of monopolistic energy utilities is an unlikely scenario. What is more likely is a decentralization of the players, creating a competitive market place where new alternative forms of energy technologies in non-utility markets are allowed to enter the arena, most likely increasing efficiencies through market based competition.

Centralized Electricity Institution

Now that the reader is familiar with the development of government backed centralized electricity production in the United States, the analysis of the institutions will be much better understood. The first criterion to identify is the structure of formal and informal constraints that comprise the centralized electricity institution. The *formal constraint structure* consists of the written rules that create the incentive and disincentive structure within which institutions are allowed to grow. There are three types of written rules that comprise formal constraints: political, economic, and contractual. Written rules are often created in the interest of private, as opposed to social well-being. As noted in the previous section, PUHCA, REA, PURPA (under the National Energy Act of 1978), EPACT, and the 2005 Comprehensive Energy Bill comprise the major political rules. The incentive structures put forth by these legislations have created specific opportunity sets and fostered the growth of centralized electricity organizations. Where initial regulation constricted competition, inefficiencies were allowed to perpetuate for decades. The outcome of this regulation was a lack of change from the 1920s until reform began in the 1980s.

> The government and local monopolies that have long controlled the generation, transmission, and retail distribution of power never had much incentive to encourage innovation or invest in new approaches to power delivery. Since market forces were suppressed, the gross inefficiency of energy utilities did not seem to matter terribly much.[lviii]

This statement indicates that the formal constraints have not, until recently, allowed for competition. The *degree of competition and incentive structure for beneficial evolution* has been absent from this industry until the past two decades. The institutions that remain, even after deregulation has begun, are outdated, and new institutions have yet to emerge because of the lack of R&D spent on new technologies.

The *informal constraints* of centralized energy have been created by the tradition of readily available electricity that flows through the walls of buildings, homes, and factories. People make choices based on this informal constraint and it is embedded into our every day decision making mental constructs. The average person's complacency about electricity supply denotes its very existence as an informal constraint. Electricity has become something people use every day without having to think about, just as traditions shape the way people greet each other or taboos restrict people from diverging from cultural norms. *Readily available electricity, the product of its suppliers' exploitation of formal rules, has become a socially sanctioned norm in every day life and a standard medium for power, making its existence both subtle and highly visible throughout modern society.* Oliver Williamson says informal constraints "are 'adopted' and thereafter display a great deal of inertia—some because they are functional (as with conventions)" and "are pervasively linked with complementary institutions (formal and informal), etc."[lix] People would demand electricity if it were gone tomorrow because of its pervasiveness throughout our society. Therefore, the utility of the informal constraint could not be changed over night. Electricity itself is an informal constraint because it has created a "…lasting grip on the way society conducts itself."[lx] If anything were to be changed about the consumption of electricity, it would have to be the rate of efficiency in consumption or in generation and transmission from producer to consumer. These changes, however, would not disrupt the utility of the informal structure.

The *framework of organizations* within the centralized electricity institution is not difficult to see. As mentioned earlier there are different types of centralized energy producing players in the game, comprised of coal-fired, natural gas-burning, nuclear, and hydroelectric power companies. By law, players are either utilities or non-utilities. The Energy Information Administration defines utilities as "either privately owned companies or public agencies engaged in generation, transmission, and / or distribution of electric power for public use."[lxi] Utilities are primarily centralized energy producers because of the long history of government backed centralization. "Non-utilities are privately owned entities that generate power for their own use and / or for sale to utilities and others."[lxii] Non-utilities are comprised of both centralized and non centralized energy producers because they emerged with the passage of PURPA. These two types of producers have two common objectives: the generation of power and the desire to earn a profit. The government is an organization that serves as an official to these players (the government is also a player in some cases, owning and operating a portion of total capacity). Its role is to ensure the game of producing and delivering energy is played by certain rules, so that the lights stay on and the producers do not take advantage of the consumer.

Since the passage of PUHCA, the *level of interaction* that the centralized energy producing players have had with the officiating organization was very close in that the official saw to it that the game was played in a specific and static way. The lack of evolution of ideas from the norm in the centralized energy industry from the early to the late 20th century exemplifies this constricting relationship. Industry players have continued to invest in capital intensive centralized projects that aim to generate more megawatts from one source. Since the 1980s, however, the constrictions have been slowly relieved, allowing the game to be played with increasing levels of competition.

The *punishment and monitoring system* in the centralized energy institution has evolved over time. As indicated in Chapter One, the costliness of ascertaining violations is important for the functioning of institutions. The reason why PUHCA and other regulatory laws were established was to prevent privately owned "natural monopolies" from exploiting the consumer, and to provide incentives for the electrification of the entire country. This was, at the time, the only way for the government to supply the country with a "strategic resource" and keep the suppliers from harming consumers with high prices. Otherwise, the costliness of enforcement would be too high because of technological limitations. With a premature legal system based around a limited cognitive competence for public goods, the only perceived way to avoid consumer deficits was to ensure that the contracts between supplier and consumer were "fair", which would help to make them self enforcing. Public utility boards arrived at a "fair" price based on costs endured by the utility. Unfortunately, the immediate benefit to the consumer may not have been worth the cost in terms of lost efficiencies and pollution caused by a lack of competition induced change in technologies over time. In quest for the self-enforcing contract, the state attempted to assure that the consumer was provided electricity because it is of strategic importance to growth and security, and that the consumer would pay the bills because it is more beneficial to pay than to be without power.

Since these forms of centralized energy were allowed to perpetuate without change for so many years, their institutions have become distributional coalitions that are harming societal welfare by reducing total income based on the theoretical model outlined in Chapter One. The underlying cause being that stability has been the government's primary objective over efficiency. Centralized energy producers are rent seeking organizations that, as a collective, have become large enough to steer institutional change. Their existence complicates the role of government because stability is viewed as more important than long-term societal welfare. They

are large enough to have their contribution benefit society to some degree so that a symbiotic relationship is formed. Their presence has impeded technological change and they have an inability to make quick decisions like smaller organizations have. Government has had a difficult time regulating them because they bring about stability *and* stagnation, changing the direction of social evolution.

Benefits

Admittedly, centralized energy has enabled many benefits to developed societies across the world. In countries where large sums of startup capital are available for big projects, power has been provided to the masses through top → down systems that function with high levels of reliability. Jobs have been created in the private companies that comprise the overarching institution and industry, contributing to economic growth. Jobs have also been created in desperate times of need, like during the Great Depression when the REA mandated the building of massive dams and establishment of cooperatives to bring power to the American farmer. The government has, at least for almost an entire century, fostered stability and facilitated economic growth, which are top priorities.

Problems & Limitations

Despite the obvious economic benefits of centralized energy production during the majority of the 20th century, there are many problems and limitations that present decision makers with some interesting challenges for the future of energy. These problems are the result of what Williamson calls humans "bounded rationality" about the negative externalities of centralized fossil fuel based energy. Pollution, caused by the emissions from the combustion of

fossil fuels is poisoning the earth. "Among the gases emitted during the burning of fossil fuels are sulfur dioxide (SO_2), nitrogen oxides (NO), and carbon dioxide (CO_2)."[lxiii] The centralized energy approach has also failed most of the developing world, "…where more than a billion and a half people still lack access to grid electricity."[lxiv] Inefficiencies in centralized generation speak for themselves, relative to decentralized generation. Coal fired plants, which accounts for over 50% of total electricity generation, overall reach a maximum of roughly 40% efficiency.[lxv] Waste energy in the form of heat and steam are often not utilized, making roughly 50% of the nation's electricity generation half as efficient as it could be if it were generated by micropower.

Pollution and inefficiencies are issues plaguing the developed world, while much of the developing world remains in the dark (not to mention being burdened by the developed world's emissions). Although these factors play a huge role in sustainability, they are not paramount to the central theme of this study, economic growth. According to the very first page of the National Energy Policy, signed in May of 2001 by Vice President Dick Cheney, consumer energy demand will dramatically outpace domestic energy production at current capacity growth rates over a projected twenty year period.[lxvi] Essentially, centralized supply cannot keep pace with projected increasing demand, limiting economic growth. Centralized energy was a creative endeavor that emerged in response to the problem of power scarcity and has been a large success. However, the perpetuation of its existence to satisfy future demand in light of obvious system inefficiencies is not creative and productive. Increasing demand that outpaces supply capacity should cause prices to increase, thereby making alternative forms of energy more economically attractive. But at what cost will this occur and will there be stagnation in the transition process? North indicates that "sometimes the way experiences have interacted with consciousness has led to institutions that resulted in stagnation with resultant human frustration in the context of more dynamic societies."[lxvii] In order to prevent stagnation, the dynamic United

States should recognize its experience with the inefficiencies of centralized energy and respond to the future energy demand by looking to alternative means of energy before prices are driven up. Policy makers who believe that future demand should be satisfied by more capital intensive centralized projects should expand their bounded rationality and understand that decentralized technologies must be allowed to enter the market more quickly in order to facilitate a smooth transition.

Chapter Notes

[lii] National Energy Policy Development Group. National Energy Policy. Washington: GPO, May 2001.
[liii] *Ibid.*
[liv] Vaitheeswaran, Vijay V. Power to the People. Farrar, Straus and Giroux. New York, NY. 2003. P 27
[lv] *Ibid.* 27
[lvi] *Ibid.* 27
[lvii] *Ibid.* 46-47
[lviii] *Ibid.* 27-28
[lix] Williamson, Oliver E. "The New Institutional Economics: Taking Stock, Looking Ahead." Journal of Economic Literature Vol. XXXVIII (September 2000): 597.
[lx] *Ibid.* 597
[lxi] Energy Information Administration – U.S. Department of Energy. The Changing Structure of the Electric Power Industry 2000: An Update. Washington, October 2000. P 16
[lxii] *Ibid.* P 21
[lxiii] *Ibid.* P 11
[lxiv] Vaitheeswaran 27
[lxv] Energy Information Administration – U.S. Department of Energy. The Changing Structure of the Electric Power Industry 2000: An Update. Washington, October 2000. P 10
[lxvi] National Energy Policy Development Group. National Energy Policy. Washington: GPO, May 2001. P viii
[lxvii] North (2005) P 44

4

Decentralized Energy

> *Imagine a world in which power flows not from on high, but from the masses. In such as world, important decisions would be dictated not by the whims of grandees, but by the needs and wants of ordinary people. The price of meeting these desires would be set not by bureaucrats, but by the robust interplay of supply and demand. In politics, such principles are the cornerstones of democracy. In economics, they are the foundation of capitalism.*
> *(Vijay V. Vaitheeswaran, Power to the People)*

The alternative to centralized energy is decentralized energy. The institution of 'decentralized energy' refers to the idea that electricity is produced relatively close to the end-user, wherever the end-user requires it, in a demand driven, bottom → up system. There is a wide array of renewable, decentralized energy options that can supply the energy demands of virtually any consumer in any location. The National Renewable Energy Laboratory (NREL) has identified solar, wind, geothermal, bio-mass, and hydrogen fuel cells, as major R&D areas that have great energy producing potential. NREL leaves out microturbines as a major R&D area but they too have great potential. These particular forms of decentralized energy are notable because they have the ability to be renewable energy producers, meaning they don't rely on finite resources to continue producing power. Most of these forms of energy also have the ability to be emissions-free or discharge much less harmful emissions into the environment as byproducts relative to centralized fossil fuel based energy producers. Coupling renewable and non-emitting aspects makes these forms of energy sustainable for long-term societal and economic development. The advantages of decentralized over centralized include improved system efficiencies, reduced pollution, and consumer choice.

The institutions that surround these types of energy production do not constitute distributional coalitions. This is in part because they are still in the developmental growth phase and haven't yet reached a percentage of total energy capacity comparable to centralized energy in order to allow them pricing power. However, the primary reason is because the decentralized institutional structure is a bottom → up system as opposed to top → down system. Users that utilize decentralized energy choose where their energy is produced and do not rely on centralized energy producers in their region, which may not have every individual user's interests in mind. Users of decentralized energy are exemplars of true freedom because of the choice that they are able to make with their dollar. While centralized energy achieves cost reducing economies of scale by producing vast amounts of energy, decentralized energy will become competitively priced by taking advantage of the economies of scale associated with producing a large quantity of power generating units such as fuel cells. The construction of this market for decentralized energy is demand driven as opposed to supply driven. The consumer in this market is given the freedom to choose which type of energy best suits them. This freedom of choice is the truest principle of democracy and capitalism.

This chapter will follow a similar format as the previous chapter. First I will discuss various types of decentralized energy and then analyze the overarching institutional structure for these technologies. In the next section I review the benefits of these technologies and the institution for society as a whole. Following this section I analyze the problems, limitations and barriers to market entry for these technologies. Concluding the chapter I will explain why centralized energy has evolved as the dominant institution.

Types of Decentralized Energy

Before I discuss different type of decentralized energy a point of clarification should be made. Thus far, this study has referred to energy and electricity. People demand energy in many forms, electricity being one of those forms. Often times, people use different types of energy to create different products to satisfy demands such as the heating and cooling of water and interior climate. When someone wants to heat their home they can simply turn up the thermostat. The same goes for cooling where someone might either turn on a fan or lower the thermostat. These examples use electricity to supply the consumer's demand. A large percentage of the electricity demanded in the United States is for heating and cooling. Some forms of decentralized energy bypass the need for electricity in supplying this demand, subsequently decreasing the total demand for electricity and increasing system efficiency. When efficiencies are improved at both the supply and demand ends, there is less waste; hence greater system efficiency because the consumer is getting the same amount of utility by using fewer resources. Therefore, many of the following forms of decentralized energy are referred to as 'energy' as opposed to decentralized 'electricity' because they supply energy needs other than those electricity related.

Most forms of energy used today are technically a form of solar energy. Fossilized plants and animals from some point in history used the sun's energy, in processes such as photosynthesis, and their remnants are stored in the form of fossil fuels (i.e. coal, oil, gas, etc.). However, the forms of solar energy referred to here are renewable direct and indirect solar energy used to generate electricity and heat. Currently the most widely known form of direct solar generated electricity uses crystalline silicon semiconductors to make photovoltaic cells (PV cells). This type of direct solar power utilizes PV cells to capture the suns rays and generate electricity on site by allowing photons emitted by the sun to knock an electron off of the

semiconductive material of the panel to create a current. PV cells like these are not yet competitively priced on a per kilowatt hour (kwh) scale, costing between 20 and 25 cents per kwh versus typical grid electricity in the United States that costs between 3 and 5 cents per kwh.[lxviii] Solar power is being realized in niche markets today where grid electricity is unavailable or unreliable, such as in very rural homes and road maintenance signs. Improvements in solar technology have increased efficiency to convert 15% of the suns light into electricity, a great improvement from cells built in the 1950s, which only achieved a maximum of 4% efficiency.

New entrepreneurs are rethinking traditional solar energy technology, which for the past thirty years has been focused around crystalline silicon semiconductors, for a number of reasons. One reason being the silicon wafer market is experiencing shortages caused by increasing demand and driving production costs up. Aside from material shortages, the technology has a poor efficiency to cost ratio versus traditional energy technologies, therefore entrepreneurs are seeking new ways to harness the sun's energy. Some companies are investing in transparent thin film technology for building integrated PV windows that use "thin layers of copper, indium and gallium selenide pioneered at America's [NREL]."[lxix] Others are researching technologies that utilize mirrors to concentrate the suns power to heat a stored substance in order to create mechanical energy from its expansion and contraction. Organic substances and nano-technologies are newer stage ideas and may play a large role in reducing costs and materials in existing technologies. Indirect solar energy is harnessed for use in applications such as heating pools, bathing and drinking water, as well as interior climates by means of fluid circuits. Indirect solar technologies have the potential to drastically reduce total electricity demand because they bypass the need for electricity in some heating applications.

People have been harnessing the wind for thousands of years to generate mechanical energy and for sailing boats. Today, turbines that capture the winds energy are capable of generating the least costly form of renewable, decentralized electricity. Windmills come in varying sizes. A turbine less than one meter in diameter and a few meters high can generate a few hundred watts (a typical incandescent light bulb requires 60 watts). Whereas currently the largest turbine in the world, which is 63 meters in diameter and 123 meters high, residing off the coast of Denmark, generates on average enough power to provide for 5,000 homes, roughly 5 megawatts. Wind turbines have the potential to be a very decentralized energy provider, or, in the case of Denmark's 5 megawatt turbine, a less decentralized energy provider. However, it is still a renewable energy source, relieving dependence on finite resources. When the wind is blowing, turbines have the potential to generate electricity at comparable prices to coal and natural gas fired plants, around 5 cents per kWh, and less than centralized nuclear energy, which costs roughly 6 cents per kwh.[lxx]

Geothermal energy can be used for generating electricity or for heating and cooling applications. Regarding electricity generation, geothermal energy accounts for roughly 2,800 megawatts of capacity in the United States and costs from 4-6 cents in steam plants and 5-8 cents in binary plants.[lxxi] Electricity generation in geothermal plants are often smaller scale than coal fired and natural gas plants, releasing only small amounts of gaseous emissions in steam plants and zero emissions from binary plants. The other form of geothermal energy, used for air and water heating and cooling, is much more decentralized than electricity generating geothermal technology. A home, for example, with a geothermal system requires nothing more than good insulation for internal climate control. Ground source heat pumps use a liquid, such as water, as the energy carrier in order to transmit the constant temperature beneath the earth's surface into the desired application: water heating or temperature heating and cooling. Utilizing a system,

such as this one, decreases electricity demands that may be used for water heating and climate control.

Biomass is biological material, such as ethanol, biogas, or biodiesel, which can be easily substituted for conventional energy carrying materials like oil and gas.[lxxii] Biomass has the potential to be centralized or decentralized because there are so many options for use. Farmers, for example, that may not have access to cheap centralized energy could capture the biogas emitted by rotting plant or livestock waste and use it to fire microturbines for electricity. A microturbine is an extremely efficient rotary engine that uses the same principle as wind turbines to produce electricity, the difference being the fuels. Farmers also have the opportunity to centrally provide energy instead of food, inexpensively producing fuels, like ethanol from corn or switchgrass for use in today's vehicles.

Hydrogen fuel cells are the holy grail of decentralized energy. By means of a chemical reaction between stored hydrogen and ambient oxygen, fuel cells produce electricity.

> A fuel cell is made up of a negatively charged anode on one side, a positively charged cathode on the other, and an electrolyte in the middle that is made up of an alkaline or watery acidic solution or a plastic membrane, allowing the electrically charged hydrogen atoms to travel from the anode to the cathode. Commercial fuel cells are composed of many individual cells stacked atop one another. Hydrogen is fed into the anode side of the cell, where a chemical reaction splits the hydrogen atom into a proton and an electron. Freed electrons exit through the external electrical circuit in the form of direct current electricity.[lxxiii]

Emitting nothing but water vapor and heat, these silent marvels of modern technology have the potential to completely reorganize the way energy is distributed. The concept of the fuel cell dates back over one hundred years, but the technology has yet to become commercially viable on a scale comparable to the internal combustion engine. However in the future, the fuel cell could play an enormous role in meeting the demands of increasing energy consumption. Jeremy

Rifkin talks about hydrogen fuel cells revolutionizing the way energy is generated and distributed in *The Hydrogen Economy*, forming a network of "hydrogen energy webs," or HEW's.

> Today, hydrogen and the new fuel-cell distributed-generation technology are beginning to fuse with the computer and telecommunications revolution to create a wholly new economic era. The individual fuel cells that make up the growing distributed-generation revolution are just now being connected to one another with the help of sophisticated computer software, smart digital technologies, and internet access to form the beginnings of a distributed-energy web. Soon, end-users will not only produce their own electricity but be able to share it with others, posing a fundamental challenge to the current top-down, uni-directional energy regime currently in place around the world.[lxxiv]

In order for this to happen, fuel cell companies must reduce the cost of their product to compete with centralized power generation; and, hydrogen producers must find less costly and more efficient ways to produce, store, and distribute hydrogen. HEW's have the potential to rapidly change the energy market much like the internet did the information and media markets, which lead to the largest and longest uninterrupted period of economic growth in American history during the 1990s.

Decentralized Energy Institution

Do decentralized energy institutions exist yet? Not comparable to that of centralized energy, but yes an overarching decentralized energy institution does exist and is growing. The primary difference is the direction of integration. The top → down system generates, transmits, and supplies energy from the centralized producer down to the consumer. The bottom → up system involves the generation and direct consumption or resale of energy from the decentralized producer to consumer. A top → down system is supply driven, meaning that peoples energy demands are supplied on the terms of the centralized producer, baring the consumer from choice. The bottom → up, decentralized, system is demand driven, which takes into account the individual's energy demands and allows for choice in the process.

Although there are many small individual institutions comprising the overarching decentralized energy institution, they all share theses similarities, or *informal constraints*: bottom → up systems, choice power to the consumer, the potential to be environmentally friendly when produced by renewable sources, improved system efficiencies over centralized power generation, and finally electricity is considered a publicly traded commodity as opposed to a centrally supplied resource. This last informal constraint is important to understand because when people begin to change their view of electricity as a centrally supplied resource to a traded commodity, micro-markets will begin to trade electricity openly, providing incentives for producers to find cheaper means to produce and trade it. Electricity cannot be stored without some type of power-sacrificing battery—it must be produced and then consumed. For this reason, the centralized approach does not allow for it to be considered a commodity because the resale is always less valuable than the original product, making consumption the only option. If electricity were to be produced from the bottom → up, consumers could also be producers who trade power on micro-levels as if it were a publicly traded commodity. The ability to trade energy at the micro-level is an incentive for smaller producers to find cheap ways of generating power. In order for these markets to emerge, investment and development needs to happen with energy information technology that could handle the millions of transactions that would take place. The *formal constraints*, or rules, of this type of institution would have to enforce property rights and enforce the contracts of these micro-markets. In order for this type of system to be sustainable, better and more clearly defined property rights for public goods would have to be established so that smaller producers would be prohibited from creating pollution.

The *framework of organizations* within the decentralized energy institution is different than that of the centralized energy institution because of its demand driven nature. Decentralized organizations consist of producers of energy technologies, consumers of those technologies,

producers of electricity, and consumers of that electricity. After the technology is produced and sold, the consumer may become both a producer and consumer of electricity. The players in this game are organized very differently. Where under the centralized institution the producers are the sole provider of power to the consumer, this decentralized institution contains producers of power who are also the consumer, who can also provide power to other consumers. The government still plays an officiating role in this institution, acting as a body to enforce contracts and property rights, as well as a producer of its own distributed energy. Although transaction costs may be higher in punishment and enforcement of micro-market contracts, developments in smart information technology that hold digital transaction history records will be necessary preventatives against violations of contract infringement.

The players within this demand driven market create lots of competition amongst themselves and will thus benefit the economy. The competitive *level of interaction between organizations* in this bottom → up institution has the potential to be much more complex than the top → down system because of the incentives to create new markets for trading micro-energy. Smart energy technologies will use real-time production and consumption sensors to allow for peer-to-peer energy, via a grid that is conceptually similar to the internet, enabling micro-producers to trade energy from producer to user in a limitless number of micro-markets all over the country. The high rate of efficiency at which these micro-markets could demonstrate will allow for cost savings on the exchange and production of energy. The competitive nature of this institution, caused by the interaction between organizations, will be brought on by increased efficiencies, smart technologies, and reduced negative externalities, having a beneficial impact on the overall economy's performance. An essential part of the functioning of this type of institution, however, is the costliness of ascertaining violations of property rights and contract breeching. A nationwide distributed energy infrastructure may be more difficult for the

government, in terms of *monitoring and punishment*, because there are so many more players in the game. Although an advantage of this high-tech system is that digital recording of energy transactions can be required by law to make cheating the system very difficult. The incentive not to cheat makes contracts self-enforcing, causing the occurrence of violations to decline, and yet again making the system more efficient.

Two factors contributing to the rise of decentralized energy against the centralized energy distributional coalition are product diversity and competition. There are many different ways to generate electricity and other forms of energy. Therefore, there are many players competing to develop, market, and distribute the least expensive technology. The high *degree of competition* in the decentralized energy business is providing incentives for organizations to cut costs, which benefits the consumer and the evolution of the institution. The efficiency level of the decentralized energy institution is high because of this high level of competition. There are two primary reasons why people are now demanding these products more than in the past. First, the general knowledge about the negative externalities caused by centralized energy is expanding people's limited cognitive competence. In other words, people's sense of rationality is improving and they are more intelligent because of it, causing them to be more democratic with the dollars they spend. Second, as already noted, alternatives are becoming price competitive in some niche markets.

The very nature of decentralized energy production emphasizes smaller is better. Distributional coalitions are organizations that will grow large enough to steer institutional change for the purpose of perpetuating their own existence. With many individual players in the bottom → up micro-energy-generating and -trading game, it is difficult to imagine one individual agent growing large enough to steer institutional change. The producers of the technologies that generate energy could potentially grow large enough to steer institutional change, however, those

producers are currently in a position to steer institutional change for societal benefit. Energy trading organizations, similar to Enron, could potentially become large enough to steer institutional change. Under a nationwide decentralized energy network, however, it seems more probable that these types of organizations could not profit unless the size of the energy traded were very substantial, like the energy produced from centralized sources. Decentralized energy technology producers are in direct competition with centralized energy producers and therefore have an incentive to cut costs and prices to work their products into the market, benefiting the consumer. If a decentralized energy distributional coalition were to arise it would occur after centralized energy became the higher priced alternative. When this occurs, centralized energy companies will be forced to restructure their business model to respect the consumer demand for more efficient, decentralized energy technologies.

Benefits

There are many benefits that may come from a widespread implementation of decentralized energy. The paramount benefit being sustainable economic growth, achieved through: an ability to supply the country's ever increasing energy demand, reduced costs from the economies of scale in mass production of energy-generating units, job creation, reduced emission and externalities, increased system efficiencies, and increased reliability. There is also the likely possibility of spillover benefits to developing countries from the improved technology R&D in energy generation.

According to the National Energy Policy, US energy consumption will increase 32 percent by 2020. "Our nation's most pressing long-term electricity challenge is to build enough new generation and transmission capacity to meet projected growth in demand."[lxxv] Proponents of centralized energy are advocating the construction of new power plants, however, "even with

adequate generating capacity, we do not have the infrastructure to ensure reliable supply of electricity."[lxxvi] At current generation capacity growth, there will be an energy shortfall to the equivalent of 1300 to 1900 new power plants by 2020 (See Appendix C). Decentralized energy utilization provides the potential to bypass the need for new generating and transmission capacity by providing for the consumer at the source of demand. Due to the very large demand of distributed generating units, economies of scale will be achieved not by producing large amounts of power but by manufacturing large amounts of units. Employment may also increase due to a rise in demand for generating units. Centralized energy will co-exist with decentralized energy until the capacity of decentralized producers outpaces demand for power.

Retail centralized energy prices do not reflect the real costs that society pays for in the production process. The negative externality costs that society indirectly pays for in a centralized fossil fuel based system are drastically reduced in a decentralized system, and eliminating them in many cases. The reduction and potential elimination of emissions consequent of decentralized energy could lead to an increase in monetary liquidity and disposable income for consumers and businesses. Increased disposable income for consumers, who represent 2/3 of the economy, will increase marginal spending. Reduced energy costs for businesses will allow more money to be put towards new plant and equipment or R&D. Reduced energy costs are very advantageous for sustainable economic growth over the long run. Growth will also come from the efficiencies found in micro-energy-generation and -trading markets as system efficiencies will increase reliability, reducing costs endured by the victims of blackouts.

Problems, Limitations, and Barriers to Market Entry

During the 20th century, when centralized energy reigned as the only option for consumers, there was little need for R&D supporting alternative energy technologies.

Governmental R&D budgets for energy started to decline beginning in the 1980s as markets were opened to foster private investment.[lxxvii] Decentralized energy technology investment began to increase at this time, however, most of these technologies haven't been able to gain major market share. The cost per kilowatt for many of the previously mentioned distributed energy technologies is still too high for many primary applications relative to centralized energy and they therefore have only been able to tap small markets.

The centralized energy distributional coalition is presently the standard medium for mass power generation, preventing distributed energies from breeching the primary energy market. Solar generated electricity, with a current maximum efficiency of just 15% and at best costing four times as much as most centralized generation, is not commercially viable without long term financing schemes. Wind power has the most potential growth against centralized power because it can be competitively priced, but has its problems as well. Demand does not decline when the wind stops, but no wind consequently means no power generation. When there is no power, reliance is left on centralized plants which are not easy to quickly switch on and off. Sudden wind, creating lots of power, could also potentially cause gluts in the existing grid. Geothermal energy requires drilling and a potentially high initial capital cost that can be overcome by grants and long-term financing, but the payback period is known to be very lengthy. Biomass is promising, however, decentralized biomass electricity applications with the use of microturbines are only available in niche markets like farming. Hydrogen fuel cells, like PV paneling, are not competitively priced with centralized generation. Supply capacity is also limited because these technologies are still in developmental phases. These are some of the problems associated with the previously cited distributed energy technologies. Diversification of energy sources is a good solution to these problems in the transition process.

Energy policy expert Howard Gellar cites nine particular barriers to market entry for what he cites as energy efficiency and renewable energy technologies: limited supply infrastructure, quality problems, insufficient information and training, misplaced incentives, lack of money or financing, purchasing procedures, pricing and tax barriers, regulatory and utility barriers, and political obstacles.[lxxviii] These nine barriers can also be used to describe barriers for the decentralized energy technologies market because of their potential to be renewable energy sources with higher system efficiencies relative to centralized fossil fuel based generation.

Due to the lack of demand for decentralized energies until the late 20th century, "energy-efficient technologies are not produced or readily available… creating a vicious cycle where, because demand is low, suppliers do not make products or services available, and demand remains low due to limited availability."[lxxix] This problem of *limited supply infrastructure* has been especially the case for photovoltaic cells and hydrogen fuel cells. Demand is low and there is also no central market for the demand, so market entry for suppliers is difficult due to high sales, marketing and transaction costs. The growing industry needs more market information to reduce these costs.

Wind turbines and photovoltaic cells occasionally do not achieve their maximum efficiency rating because of installations that aren't well thought out. This issue of poor installation *quality* and energy potential is related to *insufficient information and training* for installing these types of technologies. Another issue related to insufficient information is awareness. If consumers aren't aware of decentralized energy options or how these technologies could help reduce long-term costs than they will stick to what the standard is, centralized energy. Lack of a standard in the renewable decentralized energy industry opens the door to poor service and repair capacity.

The market for energy provides *misplaced incentive* structures that often favor centralized energy because "the financial interests of those responsible for purchasing energy efficiency measures may not be aligned with those who would benefit from the purchase." The upfront costs of implementing efficient decentralized energy systems are often more expensive than having centralized energy provide the power. The *purchasing procedures* of newly built or renovated buildings focus on the "least first cost, not the least life-cycle cost"[lxxx] of the structure. *Financing* incentives that have the potential to change the market place to favor more efficient decentralized energy products are currently not offered on a large enough scale to make a significant impact on the broader energy market.

Exclusionary *pricing and taxes* are also preventing more efficient decentralized energy technologies from entering the market place. Subsidies of over $140 billion to the nuclear power industry from 1947 to 1999 have enabled the industry to now contribute 20% of the United States' electricity generation, excluding decentralized energy technologies from these markets.[lxxxi] As referred to in previous sections, centralized fossil fuel based energy prices do not reflect the total cost to society, in terms of negative externality costs, leading to "excessive consumption, relative to what would be socially desirable."[lxxxii] Not only do prices not reflect total societal costs, they also do not provide financial incentives for efficient usage because consumers pay the average price instead of the marginal price for power. If it costs a utility less to produce power on off-peak hours, the price for these hours should be less, encouraging consumers to use more power during off-peak hours. Smart metering systems are not widely used, however, so consumers don't have any incentive to use less during peak and more during off-peak hours. Tax policies also discourage efficient decentralized energy technologies that are capital intensive. Businesses, for example, are allowed to deduct most energy costs from their flow of revenue before determining their income taxes. Consumers, for example, do not pay a sales tax on fuel

and electricity, but do have to pay sales tax on energy efficient technologies. These taxes are huge barriers against capital intensive decentralized technologies from entering the market.

Although deregulation and privatization are helping move markets in the right direction, they also have the potential to exclude efficient decentralized energy. The *regulatory and utility barriers* that deregulation is designed to break are in some cases promoting top → down systems, which discourages the utilities from putting money or management activities towards demand side efficiencies. The separation of generation, transmission, and distribution into private entities places incentives on the sale of more electricity, not efficient usage. This also inhibits on site cogeneration systems because utilities do not have the incentive to buy back power at a reasonable rate. The utilities may also charge hefty interconnection fees, or high disconnection fees from the centralized grid.

Finally, the *political barriers* are one of the best examples of how distributional coalitions are attempting to perpetuate their own existence by altering the institutional structure. The centralized fossil fuel based energy industry has huge lobbies that oppose the adoption of restrictive measures such as carbon dioxide emissions taxes.

> These business interests have a great deal of political clout and are highly motivated to block the adoption of policies that are perceived to be harmful… The fossil fuel industries contribute heavily to political campaigns, and their political influence has blocked the adoption of higher energy taxes or taxes on carbon dioxide emissions.[lxxxiii]

Geller references legislation proposed by President Bill Clinton in 1993 for the adoption of a small energy tax based on the British thermal unit (Btu). The bill called for a tax of 26 cents per million Btu's when using coal, natural gas, or nuclear, and 61 cents per million Btu's when using petroleum. This green tax would create tax free Btu's when consumers used renewable wind, solar, and geothermal sources. The fossil fuel industry lobbied congress and squashed this legislation, exemplifying how the centralized energy distributional coalition's political clout

allows them to alter the institutional structure for their own benefit, not in line with societal benefit.

Geller believes that it is possible to overcome many of these barriers through policies which, "eliminate price subsidies, make energy efficiency and renewable energy technologies readily available, improve the performance of these technologies, educate and train consumers, require certain levels of efficiency of renewable energy use, or provide convenient financing."[lxxxiv] The barriers he notes that will be harder to overcome are those which give priority to low upfront energy costs versus low life cycle energy costs of a building. These policies are crucial political measures to reduce many of the barriers to market entry for decentralized energy technologies. The most crucial policy change that Geller does not discuss, however, is the redefining of property rights for public goods: clean air and water. Individuals that have the right to life, liberty, and the pursuit of happiness should also have the right to clean air and water.

Centralized vs. Decentralized Energy

If it is true that a shift from centralized to decentralized energy would in fact foster economic growth and sustainability, the question arises: Why has centralized energy prevailed over decentralized energy? The answer takes us back to what North and Williamson call human's limited cognitive competence, where human's perception of property rights at the time of defining them were incomplete. What does this mean? The property rights structure for the clean air and water public goods was not fully understood at the time energy institutions came into existence. So when electric utilities began to belch various types of emissions into the air, it was not considered an illegal infringement on individual property rights until people began to understand costs related to the externalities. Although Alfred Pigou wrote about *The Economics of Welfare* in 1920, followed by Ronald Coase's work on "The Problem of Social Cost" in 1960, the

issues they discussed with regard to the socially optimal outcome of agents harming other agents were not addressed at the legislative level for the environment until clean air legislation was introduced to congress during the 1970s. Major issues about externality costs, social welfare, and property rights for clean air and water became commonly understood knowledge with the passage of the Clean Air Act (CAA) in 1970, the Federal Water Pollution Control Act Amendments (FWPCAA) in 1972, and the Clean Water Act (CWA) amendments in 1977. By this time, however, modern society had grown to revolve around the production of cheap, centralized electricity, presenting law-makers with the dilemma of maintaining the balance between stability and sustainable growth. More specifically, the dilemma was how to provide electricity for the masses, while ensuring the electricity providers that have enabled growth would not hinder future sustainability through debilitating negative externalities. The government took the route that, at the time, was the most rational option. Electricity is a strategic resource thought unlikely to be provided adequately by unregulated markets. However, this was the government's bounded rationality, prohibiting them from seeing better policy options such as liberalizing markets, capping emissions, and auctioning tradable permits that allow the free market to find efficiencies. Perhaps at the time, technological limitations that created the government's bounded rationality were not close to being adequate enough to allow for a decentralized energy infrastructure to enable the growth that the United States has seen under a centralized energy infrastructure. Hence, the quandary between which is more important: rapid growth or sustainable growth.

The reader should certainly not understand these statements to imply that all government intervention in the free market is bad for the economy because this is not the case. Politics play a huge role in the determination of economic activity because of the inseparable relationship that it shares with institutions. "Together they determine the ability of countries to

accumulate, to innovate, to adopt new technologies, and to reorganize in the face of technological change. And they shape the economic policies that either promote or hinder growth."[lxxxv] It is the government's role to establish clearly, well-defined property rights so that the institutions and markets that form will follow incentives for beneficial societal evolution towards natural equilibrium. Policies that do otherwise are potentially harmful to the free market economy because they hinder the market's ability to find its natural equilibrium. Natural equilibrium being where marginal social cost is as close as possible to private costs so that there are minimal externalities, and that these costs equal marginal social benefit. It is government that spurs the development of the institutions which,

> …affect the incentives to innovate and to develop new technologies, the incentives to reorganize production and distribution in order to exploit new opportunities, and the incentives to accumulate physical and human capital. For these reasons institutions are more fundamental determinants of economic growth than R&D or capital accumulation, human or physical.[lxxxvi]

Government intervention was needed in the case of electric utility holding company mergers in the early 1900s because it is likely that monopolies may have taken advantage of consumers. Government, because of its bounded rationality, supported a specific type of technology (centralized energy). Had other measures been taken, such as restrictions on emissions and inefficiencies, micropower may have prevailed as the popular institution or at least encouraged more R&D in decentralized energy technologies. Other measures that created incentives to reorganize production and distribution from centralized to decentralized may have sparked electricity's transition from being a top → down supply driven strategic resource to a bottom → up demand driven commodity.

Chapter Notes

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[lxix] *Ibid.* 18-20
[lxx] Parfit, Michael. "Powering the Future". National Geographic, Aug. 2005: 2-31.
[lxxi] National Renewable Energy Laboratory - http://www.nrel.gov/geothermal/geoelectricity.html
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[lxxv] National Energy Policy Development Group. National Energy Policy. Washington: GPO, May 2001. P 19
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[lxxix] *Ibid.* 34
[lxxx] *Ibid.* 36
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[lxxxii] *Ibid.* 38
[lxxxiii] *Ibid.* 40
[lxxxiv] *Ibid.* 45
[lxxxv] Helpman 113
[lxxxvi] *Ibid.* 139

PART III

IMPLICATIONS FOR THE FUTURE

Introduction

As Oliver Williamson noted in his article "The New Institutional Economics: Taking Stock and Looking Ahead", "[an] attribute of human actors warrants remark, and that is the capacity for conscious foresight."[lxxxvii] Institutional change in the energy industry would be beneficial for job creation, economic growth, and sustainability. Re-defined property rights are necessary for this to be achieved to create the incentive structures for capital to flow towards new and developing technologies. Allowing further perpetuation of centralized energy distributional coalitions will prove to be detrimental to society. Williamson quotes Richard Dawkins on the future of societal change in lieu of limited cognitive competence, saying that it is the "capacity to simulate the future in imagination… [that saves] us from the worst consequences of the blind replicators."[lxxxviii] Hopefully, through insights brought to light in this paper, the reader's conscious foresight and capacity to simulate the future through the imagination might help save us from the worst consequences of allowing existing centralized energy distributional coalitions to live on without competition from decentralized energy. Future policies should alternatively promote change in the industry to a distributed energy generation based system by the incentives of redefined property rights for public goods. In Chapter Five I will explore what institutional change in the energy industry would entail by first discussing the flaw in the incentive structure allowing for centralized energy to exist, then explaining how capitalism is still working in favor of decentralized energy despite market barriers. Then, referencing theory in Chapter Two, I will explain how the transition to decentralized energy will cause large-scale economic growth and institutional change without sacrificing short term stability. In Chapter Six I conclude this thesis with my policy prescriptions based on the theoretical model for reshaping the entire market by redefining property rights for public goods

and creating a government backed organization to solve the collective action problem that prohibits the people from adequately representing themselves in defending their right to clean air, water, and naturally occurring climate in a court of law. Following, I discuss how this conclusion may not be feasible and what other policy prescriptions fit the model as well as have a chance for success in the real world.

[lxxxvii] Williamson 601
[lxxxviii] *Ibid.* 601

5

Institutional Change in the Energy Industry

> *Rare windows of opportunity to effect broad reform are thereby opened. Such "defining moments" are nevertheless the exception rather than the rule. At least partly because of our primitive understanding, the response to such opportunities is often one of "failure". Absent such a window, major changes in the rules of the game occur on the order of decades or centuries.*
> *(Oliver E. Williamson, The New Institutional Economics: Taking Stock, and Looking Ahead)*

Despite high market entry barriers, decentralized and renewable energy popularity is gaining momentum amongst many businesses and governments for reasons related to market opportunity and environmental responsibility. Big oil firms BP and Shell are spending billions of dollars on developing businesses to take advantage of future alternative energy markets such as solar, wind, and hydrogen. Energy conglomerate GE has independently taken steps to cut its CO_2 emissions, as well as launch it's "Ecomagination" theme, implying clean energy is commercially viable. Governments in the US, Asia, Canada, and the EU are making efforts to support renewable energy projects that will aid in the world's growing demand for electricity and to address the controversial topic of human induced climate change. Whether it is environmentalism or capitalism that is driving this popularity, the players are beginning to realize that the game is changing. Electricity demand in the United States, in particular, is expected to continue increasing at a steady pace through the foreseeable future, where at current capacity and price, there will be a significant shortfall of supply, consequently constricting economic growth. Through 2020, it is projected that in order to meet the growing demand for electricity, the United States will need anywhere between 1,300 and 1,900 new power plants, or approximately one new power plant per week (See Appendix D). These capital intensive plants

often take years to build, making centralized energy an inadequate solution to this inevitable problem. Economic growth will decline and stability will be threatened unless energy institutions begin to change. This chapter will discuss the limitations of "free" market capitalism's creative and destructive capacity over the centralized energy distributional coalition. Using theory outlined in Chapter Two, it will be clear by the end of this chapter how unprecedented economic growth will arise from leveling the energy playing field through the promotion of free markets, with an efficiently enforced property rights structure, for the transition to decentralized energy.

What's Wrong With the Playing Field and How Do We Fix It?

The players in the energy game are not all on equal footing. Organizations in competitive markets are almost always playing on a field that is unbalanced due to technological innovation, however, the energy field is unbalanced because of government-induced forces such as subsidies, monopoly regulation, and poorly defined property rights. The question is: should government promote efficiencies by simply liberalizing the market, or should government tip the scale in favor of new technologies to speed the transition with renewable and decentralized subsidies? In answering this question, the reader must understand some of the underlying themes in this thesis: no one individual or group of individuals can know precisely what the consumer will demand like a free demand driven market can, and that the government should provide protection of clearly defined property rights for public goods. There will always be barriers to market entry for new technologies in competitive markets—the requisite for a healthy market is natural competition where consumer demand determines technological outcomes as opposed to government legislation. In order to ensure natural competition in the energy market, government-induced constrictions must be curbed both in favor of centralized and decentralized

energy technologies. Adding to North's sports analogy, no one likes to watch a sporting event where the referees are blatantly favoring one team, it is always best to watch the best team win.

From discussion in Chapter Two, the reader knows that individual and economic freedoms are paths to true democracy and that societies which restrict the free market by supporting specific technologies in order to induce economic growth are not truly democratic, they consist of central planning. The United States, for example, will never truly be democratic unless it eliminates market restricting subsidies and monopoly regulation in the energy arena. These restrictions are abusing the capitalist mechanism by limiting its ability to function properly in response to consumer demands, placing society at risk for economic decline. By the same token, the free market can just as easily fail the consumer and the environment unless there are clear and well-defined property rights. The rules must first be re-defined to protect public goods to allow this market to be free flowing within the structural matrix without the threat of exploitation. When the energy market becomes free flowing, where the playing field is level and competitive for all rule abiding competitors, efficiencies will be found and investment will flow toward the most promising technologies. Current incentive structures are perpetuating the existence of inefficient technologies. Prohibiting the encroachment of public goods, specifically the right to clean air and water, would shift incentives toward the production of cleaner, more efficient technologies. Government should no longer support centralized energy production because it is altering natural institutional evolution, perpetuating inefficient technologies and hindering more efficient decentralized technologies from entering the mass market. Further government support of the centralized energy distributional coalition will prevent critical funds from flowing toward new decentralized energy technologies that can potentially supply the increasing demand more efficiently. The world is ever changing and capitalism is designed to adapt to this change based on consumer demands. Subsidies, regulation, and poorly defined

property rights in the energy arena, however, are severely limiting capitalism's creative and destructive capacity to destroy old inefficient centralized energy institutions and create new efficient decentralized energy institutions.

What should be done to fix this problem? Unfortunately, it cannot be fixed overnight and will require delicate yet deliberate policy changes. Legislation cannot shock the entire market by constricting current centralized energy providers from producing energy before other decentralized providers have the capacity to supply the demand. However, the legislation needs to be powerful enough to encourage more investment in new technologies so that future energy demand will be satisfied before demand drastically exceeds supply capacity, hindering economic growth. The physical problems at hand are:

1. Producers not paying the total cost of energy production.
2. Public goods being taken without compensation.
3. Collective action problem about public goods.
4. Perpetuation of the socially inefficient centralized energy distributional coalition.
5. Lack of investment in socially efficient decentralized energy technologies.

All of these issues must be addressed by facilitating smooth, rather than abrupt, institutional change.

Capitalism: Battered but Not Broken

Capitalism's creative and destructive capacity over the centralized energy distributional coalition in the United States is severely limited. However, there are a number of factors contributing to the push toward renewable, decentralized energy: niche markets, threat of resource scarcity, volatile energy costs, increasing environmental awareness and activism, and entrepreneurship.

Contributing niche markets consist of any type of energy consumer that cannot be connected or is too expensive to connect to the grid. Centrally produced electricity is

competitively priced with PV cells, wind turbines, gas fired micro-turbines, and perhaps even fuel cells, in some remote locations such as country homes, highway maintenance signs, newly erected cellular phone towers, etc. These markets are being realized by many small-cap decentralized energy technology firms that are desperately seeking revenue wherever they can sell their product in order to stay afloat while reducing production costs. As more niche markets expand, firms in these markets will begin to realize economies of scale and hence reduce their prices to levels competitive with those of primary energy markets.

The threat of fossil fuels depletion is very prevalent. The timing of depletion, however, is a hotly debated topic. Whether these resources run out in 10 years or 100 years from now, rapidly increasing world demand for these precious resources will ultimately deplete supplies and drive the prices up. The threat alone is causing energy consumers and investors to hedge their energy bets with alternative energy technologies that don't require the use of fossil fuels. In early 2006, for example, Whole Foods Market® purchased renewable wind energy credits to offset 100% use for all its stores electricity.[lxxxix] Wal-Mart® has implemented renewable energy testing at some of its facilities, utilizing PV panels and small wind turbines, hoping that the test results will conclude reduced cost potential for many of its stores across the US.[xc] Colleges and Universities are taking a lead role as well. Connecticut College and Harvard are among the many to purchase renewable energy credits to offset their electricity demand from the grid and support renewable energy in other places of the country where it is economically viable.[xci] University of Minnesota at Morris is using electricity generated directly from a large wind turbine near the campus.[xcii] Even individual homeowners are taking advantage of long term financing programs, from companies like BP Solar and Sun Edison, which make PV paneling competitively priced with grid electricity.[xciii]

The location of different fossil fuels are not evenly allocated throughout the countries of the world, that is to say for example regions of the world that are well endowed with reserves of oil are not necessarily endowed with reserves of coal.[xciv] Meteorological, geological, geopolitical, and political factors play into the cost of these commodities. Consumers in the United States have not only been experiencing fluctuating prices due to some of these factors but steadily increasing prices as well from world demand outpacing supply. Many consumers prefer to purchase their energy from providers who guarantee prices will remain constant for a preordained time. These providers are the owners of renewable sources of energy that take advantage of free resources, the sun and wind.

Environmental awareness and activism has been gaining momentum as well as scientific ground over the past few decades in response to irresponsible business operations that have abused the environment. Businesses will exploit every possible resource available to earn a profit even if it causes negative externalities at no fault to the competitive nature of the beast. The fault is on the incentive structures of the institutional matrix that does not protect against this exploitation. Increasing awareness and activism has improved the stock of common cognitive competence about the environment as well as long term sustainability for business. Some large corporations are addressing their sustainability by taking steps such as purchasing renewable decentralized energy to reduce their ecological footprint, creating demand for technologies that are more expensive than centralized sources of power.

Finally, entrepreneurship is the best example of what makes the free market so great. Free and private enterprise that begins with an individual idea for a product and grows into a technological innovation can change the way society works. People are constantly looking to find more efficient ways to do just about everything, not only so that they can reduce transaction costs but to make money. Entrepreneurship is the drive that leads to the innovation of

disruptive technologies like the steam engine, automobile, electricity, personal computer, internet, etc. The prospect of being the person to either invent or commercialize the next big disruptive technology is very alluring and is the reason why as long as there is money to be made from innovation, capitalism, no matter how battered, is not broken.

Make Way for Large-Scale Growth and Institutional Change, Worry Not about Stability

If the playing field were transformed from a supply driven market to a democratic demand driven market, by enabling adaptive efficiency, there would be a greater chance for disruptive energy technologies to replace existing technologies and subsequently spur large-scale economic growth. Society's adaptive efficiency will determine the pace at which organizations respond to technological change. Helpman indicates, "the ability of a country to grow… depends on its ability to accommodate such changes, and the ability to accommodate change depends in turn on a country's economic and political institutions."[xcv] Rules will need to be changed in order to induce this technological shift and institutions will need to adapt in order for society to accommodate the change.

As discussed in Chapter Two, economic growth is positively correlated with a society's TFP, or increasing efficiency of utilizing inputs. TFP will dramatically increase, if technological change is allowed, by making the transition to decentralized energy where fewer inputs will be required to generate a greater output. Economic growth caused by the reorganization of energy institutions in the United States could potentially be as big as or larger than growth caused by previous science based disruptive technologies. It is possible that the next milestone on the timeline of economic growth will be the technological shift from centralized to decentralized energy technologies. The efficiency of coal fired, natural gas, or nuclear power plants may be

greater than that of some current individual decentralized technologies like PV paneling, however, this is a myopic way of analyzing efficiency. The energy lost in transmission, waste of fossil fuel inputs, and hidden costs to society caused by pollution and other negative externalities, are a few of the *system inefficiencies* that are often overlooked, which cost the system a great deal of money. A widespread use of decentralized technology would solve many of these system inefficiency problems, thus reducing production and transaction costs, both up front and hidden. The system will then experience large-scale growth, as discussed in Chapter Two, because the increased system efficiencies will cause the growth curve to become steeper. The marginal economic growth that society is currently experiencing is being caused by the tail end of centralized energy sustaining technologies whose supply will soon be outpaced by increasing demand.

The barriers to market entry are too high at current energy prices to support widespread institutional change. In order for disruptive decentralized energy technologies to break down all barriers to market entry society must improve its adaptive efficiency, which will allow for institutional change to occur. The barriers to entry explained in Chapter Four are what North would call a bottleneck that society must resolve so that growth is not stifled. This bottleneck is due to organizational path dependence, which North explains is difficult to alter.

> The difficulty of fundamentally altering paths is evident and suggests that the learning process by which we arrive at today's institutions constrains future choices. It is more than simply that the organizations brought into existence by the existing institutional matrix owe their survival and well-being to that matrix and therefore will attempt to prevent changes that would adversely affect their well-being. It is also that the belief system underlying the institutional matrix will deter radical change.[xcvi]

Improved adaptive efficiency will help society to diverge from its current centralized energy path dependence. How can society improve it's adaptive efficiency? Adaptive efficiency is comprised of a few primary elements: the institutional framework or rules that shape an economy by

providing incentives, the willingness of society to undertake change through acquiring knowledge from innovation, undertaking risk, encouraging creativity, and a willingness to resolve bottlenecks. The United States' adaptive efficiency, which is limited by a very large distributional centralized energy coalition, will not improve unless the incentives provided by the institutional structure are changed to level the energy playing field. As Helpman indicated, if society's economic and political institutions cannot accommodate such changes presented by technological innovation the country's economy will have a difficult time growing. The current institutional framework has been conducive to the growth of centralized energy, consequently leading to the development of an outdated technological distributional coalition. A restructuring of the rules to protect property rights of public goods would give the market incentives to improve adaptive efficiency, causing organizations to change their business models in favor of natural competition based on the learning by doing and the development of tacit knowledge for improved technologies. This would ultimately cause the economy to experience large-scale growth due to disruptive energy technologies commercialized through natural market forces. This natural evolutionary growth of the economy caused by the maximum generation of free flowing market trials is more sustainable than rapid growth caused by specific government-induced incentives for specific technologies because in a world of uncertainty, no one individual knows the answer to the problems we face.

Polities need not worry about the threat of creating instability by changing the fundamental rules of the game. Short-term stability will remain if proper steps are taken to induce the transition, however, this goal becomes insignificant if the system is not sustainable in the long run. The growth and stability that the United States has been able to experience due to government regulated centralized energy since the early 1900s is irrefutable. However, because the institution has slowed down society's decision making process, erected entry barriers for new

disruptive technologies, required complex legal and regulatory frameworks, complicated the role of government, and damaged capitalism's ability to bring new technologies to market in a time when demand is outpacing supply capacity, it has crippled the economy's adaptive efficiency and thus it's ability to grow. As Huntington indicated, stability is vital but change is not necessarily harmful to society. Change that comes from natural economic growth in particular is in fact good for the survival of regimes, where a lack of change resulting in a decline in per capita income is detrimental to survival. Natural economic growth is usually a gradual process, indicating that once large-scale growth is experienced from a new disruptive technology, society will develop sustaining technologies and become economically and institutionally stable once institutional change has taken place. Therefore, with the daunting task of providing a nation with enough energy capacity to satisfy its ever-increasing demand at hand, polities need not worry about short-term stability but instead shift gears and start thinking about long-term sustainability. Further support of centralized energy could threaten sustainability because the rate of growth of income per capita will decline if the rising costs of energy and the negative externalities caused in its production continue to take money out of people's pockets.

A Glimpse of the Future

Taking giant steps without being able to see where one is going is a daunting and risky endeavor. Therefore it is no wonder why one might be skeptical about the alleged improvements in societal welfare spoken about in this paper after the proposed drastic institutional change has occurred. What would a society look like after such a transition? Perhaps something seemingly out of a futuristic science fiction novel, however, the future is upon us.

Prince Edward Island (PEI) rests off the eastern coast of Canada. Its economy imports nearly everything that it consumes, including the resources to generate energy. Wishing to relieve

itself from costly imported energy, the PEI Energy Corporation partnered with Canadian fuel cell maker Hydrogenics to evaluate the PEI energy system and come up with a more efficient solution. The island's most abundant natural resource is wind, so naturally the energy companies decided to use this green resource for electricity production. What they came up with is a wind to hydrogen village energy system. Wind farms at the northern most tip of the island generate electricity that feeds the grid and is used to electrolyze water into hydrogen and oxygen.[xcvii] The oxygen is sold as a commercial gas and the hydrogen is stored and shipped to local automotive refueling stations for fuel cell or internal combustion powered cars. Since wind is an intermittent power supply and cannot supply uninterruptible power, the hydrogen can also be used to store the wind's energy for use by fuel cells in micro-energy markets. This energy restructuring relieves PEI's dependence on foreign energy sources and creates jobs in the restructuring process. Money is kept on the island as opposed to sending it offshore for energy, freeing up capital for economic growth and thus increasing wealth. Using hydrogen, as opposed to fossil fuels, as a primary energy carrier is beneficial to the environment. Overall, societal welfare is improved as a result of restructuring PEI's energy system.

This is just one case where the ideas brought to life in this thesis are actually being implemented today. In the future the grid will exist only for the purpose of trading energy on micro-levels. High tension power lines that mar the landscape will no longer exist because centralized energy providers will no longer be the least costly provider of energy. The most centralized energy providers of the future will be wind farms. Wind farms are renewable energy providers that will generate the electricity necessary to electrolyze water into hydrogen and oxygen, which are clean storage mediums for energy. The hydrogen generated by the wind farms will be shipped to local refueling stations for fuel cell powered Hypercars[xcviii]. The hypercar concept is an ultra-light hybrid vehicle that weighs two to three times less than conventional

steel cars, has ultra-low drag, and is powered by efficient hybrid electric systems that require much less power than that of steel vehicles because of weight savings. "Since the average car is parked 96 percent of the time…" a hypercar that runs on a hydrogen fuel cell could be plugged into an intelligent Hydrogen Energy Web (HEW) "…during non-use hours, to the home, office, or main interactive electricity network, providing premium electricity back to the grid"[xcix] turning the car into a zero harmful emissions micro-power plant on wheels.

> If just a small percentage of drivers used their vehicles as power plants to sell energy back to the grid, most of the power plants in the country would be eliminated altogether. This is because a hydrogen-fuel-cell-powered transportation fleet of 200 million vehicles has four times the generating capacity of the entire national power grid.[c]

During the transition period from today's conventional automobiles to hypercars, PV paneling can provide intermittent power when energy from the hypercar supplied HEW is unavailable. Real-time energy meters can account for personal energy usage to the micro-second, and whether energy is produced by the consumer or by the a micro-network, the meter would charge the user whatever the current rate relative to the cost to produce the power, providing incentives for conservation.

This type of decentralized supply driven market for electricity frees up capital for economic growth. Economic development in the form of job creation will be in the wind, solar, fuel cell, information technology, and micro-energy trading industries. No dollars will be exported for energy resources that are currently purchased from politically unstable regions of the planet. Keeping dollars at home, as is happening in the PEI case, increases wealth, and provides a path toward environmental improvement. An entirely decentralized, renewable energy system such as this will have a dramatically reduced environmental impact relative to the current centralized, fossil fuel based system. With virtually no emissions, the negative externality cost of the old system are dramatically reduced. The threat of human induced global warming is

reduced because of the reduction of green house gas emissions. There will be improved air quality because of a reduction of nitrous oxides and other gasses contributing to urban smog. There will also be an improvement in water quality because of a reduction of sulfur emissions that are known to cause acid rain. Not only does this new system improve our own environment, it also has a huge positive impact on the global environment. Down stream issues related to long range transboundary air and water pollution are reduced as a result of this improvement. Increased demand for green energy technologies in the developed world will drive the price of these technologies down, potentially enabling technology spillover into developing countries due to price competitiveness. A reorganization of energy institutions in the developing world may solve an overwhelming number of problems that face the world today, improving global societal welfare.

Chapter Notes

[lxxxix] http://www.wholefoods.com/company/pr_01-10-06.html (04/10/06)
[xc] http://www.walmartfacts.com/newsdesk/article.aspx?id=1485 (04/10/06)
[xci] http://www.cleanair-coolplanet.org/for_campuses.php (04/10/06)
[xcii] http://www.morris.umn.edu/greencampus/ (04/10/06)
[xciii] http://www.sunedison.com/index.php (04/10/06)
[xciv] BP. "Energy in Focus." BP Statistical Review of World Energy June 2004.
[xcv] Helpman 140
[xcvi] North (2005) 77
[xcvii] "PEI Wind-Hydrogen Village." Initial Public Forum – North Cape. April 22, 2005. http://www.hydrogenics.com/pdf/PEI_Wind_Hydrogen_Village.pdf (04/12/06)
[xcviii] Hawkewn, Paul, Amory Lovins, and L. Hunter Lovins. Natural Capitalism; Creating the Next Industrial Revolution. Little Brown and Company. Boston, New York, London. 1999. 22
[xcix] Rifkin 208
[c] *Ibid.* 208

6

Policy Recommendations

> *…a private enterprise system cannot function properly unless property rights are created in resources, and, when this is done, someone wishing to use a resource has to pay the owner to obtain it. Chaos disappears; and so does the government except that a legal system to define property rights and to arbitrate disputes is, of course, necessary."*
> *(Ronald Coase, The Federal Communications Commission)*

Ideas raised by Pigou (1920) and Coase (1960) in their works on welfare and social costs did not have a significant impact on environmental legislation until the 1970s. Common place perception of property was not as fully developed as it is today at the time when centralized fossil fuel based energy began to emerge as the nation's dominant electricity provider. Yet the United States still does not have a clearly-defined, well-specified set of property rights with regards to public goods (air, water, climate, etc.). Until these rights are established, organizations will continue to alter the institutional landscape by negatively exploiting property belonging to the public, causing markets to ultimately fail.

> The development of well-specified property rights… will make the overall environment more predictable but will increase uncertainty for those who traditionally have used the land in question without having formal title. Hence an essential question we must ask is, who makes the rules and for whom and what are their objectives? There is no necessary identification between institutions and efficiency as economists use (and misuse) the term. Indeed one of the major puzzles to be explained is how, and under what conditions, humans create the conditions necessary that make for markets with low costs of transacting and increase material well-being.[ci]

Those who have been using these public goods without title and their investors will be forced to invest in cleaner technologies, resources, and lesser cost solutions for generating energy. I propose that the government establish these rules via Constitutional Amendment specifying to whom these goods belong, for the purpose of promoting efficiency and sustainability. The

objective is to create the incentives for new institutions to emerge that make markets work more efficiently and reduce transaction costs, thus improving societal welfare. The energy market is not free because reliable access to energy has for so long been perceived to be a natural monopoly that government has an obligation to provide, which is consequently carried out by the support of centralized energy. Market barriers are hindering emerging technologies from becoming competitively priced in this environment. Removing these barriers will change the incentive structure, garnering new developments in renewable, alternative, and decentralized energy technologies that are more efficient than current technologies, thereby altering the institutional framework and encouraging large-scale growth. Scholars such as Robert Stavins and Howard Geller have suggested a series of policy recommendations to remove these market barriers, however, none to my knowledge thus far mention amending the Constitution or creating a new government funded organization to represent the people's goods as I have suggested based on this model. Following a discussion of the logic and reasoning behind this proposed solution, I explain why it may not work and explore more realistic solutions that also fit the model.

Constitutional Amendment and a New Player in the Game

The United States celebrates July 4th to commemorate the signing of the Declaration of Independence. In that document, Thomas Jefferson wrote that citizens of the United States have the right to "life, liberty, and the pursuit of happiness," said unalienable rights. This idea was taken from John Locke, who actually wrote of the right to life, liberty, and estate. Jefferson had replaced "estate" (or property) with "the pursuit of happiness" because he thought property was too closely tied to feudalism, which could potentially be diverging from the idea of liberty.[cii]

Not discrediting Jefferson's inclusion of "the pursuit of happiness," but perhaps he should have not manipulated John Locke's insight. Locke's idea of property is very important in the creation of markets, which modern economies are based around. Public goods that are shared by us all are the people's forgotten property and are not mentioned in all of the Declaration of Independence, original Constitution, Bill of Rights, or subsequent amendments to the Constitution. Why? When economic agents are able to use goods whose title is not defined in any of the country's primary institutional documents, how can anyone expect the outcome to be sustainable? The unalienable rights Jefferson noted should read: life, liberty, the pursuit of happiness, and the legal protection of public goods and private property.

The Fifth Amendment to the United States Constitution, in the Bill of Rights, reads that: "No person shall… be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation." This statement mentions private property but does not mention public goods. Without mentioning public goods the institutional framework that evolves around this restriction regarding private property will not have any reason not to exploit public goods. Therefore, I propose an amendment be made to the document which all must abide by in the United States that declares the existence of and assigns title to the citizens' public goods. The amendment, which I hope will later be critiqued and improved upon, will look something like this:

An Amendment for the protection of the public goods belonging to the citizens:

> **Section I:**
>
> Amendment V of the Bill of Rights shall now include this statement after the final line. "The public goods belonging to the citizens of the United States, including those that are not divisible and cannot be monetarily quantified or personally owned, such as clean air, clean water, and naturally occurring climate, shall not be negatively infringed upon or be exploited beyond an excessive level for public or private use by any one person or business organization without just compensation to the citizens of the United States."

Section II:

The government is responsible for the creation of an agency to represent the citizens of the United States that is entrusted with the duty to seek out and prosecute violators of Section I, for the purpose of protecting and bringing one unified voice to the citizens who are not unified or incapable of action against those with superior budget and extra time to fight such matters in a court of law.

Section III:

The just compensation awarded to the citizens by court of law through this agency shall be used solely to clean up the contaminated environment using best available technologies and to pay for the rehabilitation of human ailments caused by polluting agents.

Section IV:

The leadership of this agency shall be chosen via national democratic election. All citizens eligible to vote for the President of the United States shall be eligible to vote for the leader of this agency. The chosen leadership shall hold no more than two terms, each term existing no more than three years.

Section V:

Section I of this amendment shall be enacted into law no more and no less than a period of ten years after its passage for the purpose of allowing those who would currently be violators to have sufficient time to take the appropriate measures to be ready for the passage of this amendment into law. After this ten year grace period, there shall be no grandfathering of any one person, organization, or legal entity, thus prohibiting any further infringement against public goods belonging to the citizens. Sections following Section I shall be enacted immediately after passage for the sake of the new agency's preparedness when Section I is finally enacted into law.

Logic and Reasoning

Who do public goods such as the air and water belong to? Public goods belong to the people, but the people are many and these goods are vast. Divided the people are powerless but together they have a voice that is larger than that of the centralized, primarily fossil fuel based, energy distributional coalition. The government, representative of the people, should be responsible for creating an institution, or a player, that represents the interests of public goods belonging to the people so that a presence could be made in a court of law when the people seek reparations for property rights infringements. Public goods cannot be protected against unless there is an incentive structure not to exploit them. Government should be responsible for

solving this problem of collective action which is causing this market failure because it exists to represent and act in the best interest of its people.

A Constitutional Amendment would give validity and title to the rightful owners of public goods, making it illegal to take and use them without paying—as is the case with private property—creating the proper incentive structure for beneficial societal evolution to take place via free market forces. Restructuring property rights would improve society's adaptive efficiency. The creation of a government-backed organization, addressing the problem of the citizens' collective action, to counter the centralized energy distributional coalition would level the playing field in a court of law, ensuring protection of the public goods belonging to the people. This change in property rights would be the catalyst for institutional change, as investors' money flows away from centralized energy sustaining technologies and toward decentralized energy disruptive technologies. Top → down centralized systems would, over the ten year grace period, transform into bottom → up decentralized systems that are demand driven as opposed to supply driven, thus increasing efficiencies. Increased efficiencies, as explained in Chapter Two, will improve social welfare and spur large-scale growth driven by disruptive energy technologies that no longer face high market entry barriers.

Vital to the success of this new system is the specification of recipients of the funds raised by the new organization through the courts. The funds raised could be designated for reinvestment in the infringing organization to "self fund" R&D for more efficient energy technologies, however, this would not create the incentives for free decision making and perhaps cause the creation of yet another distributional coalition. The just compensation belongs to the citizens for the purpose of fixing the problems caused by the infringement on public goods, so that the infringer pays the real total cost of producing their product, including its negative externality costs to society. This is why Section III designates that this compensation be solely

put towards the clean up of the contaminated environment (such is the case with waste discharges), and rehabilitation of human ailments caused by the polluting agents (such is the case with respiratory ailments).

This organization is meant to be representative of the people and not be influenced by the heavy hand of interest groups, which is why the President of the United States is not nor is any other individual given the power to elect its leadership, as in the case of the Federal Reserve Chairman or Supreme Court Justices. The citizens of the United States should be allowed to vote for such a candidate in a democratic election to facilitate appropriate representation. Naturally, this position may very well lead to the creation of various parties who promise to best represent the people. The potential downfall of this is that parties funded by the centralized energy distributional coalition will have superior funding to all other parties. The issue that needs more thought, and thus not mentioned in this Amendment's first draft, is campaign finance restrictions, which has become a hotly-debated topic in modern politics. Logically, I leave this up for debate as it is unclear what type of campaign finance system will best suit this situation. The three-year term life is intended to allow sufficient time for elected leaders to seek out and prosecute violators of Section I. The allowance of no more than two terms is intended to promote new ideas and fresh thinking in and around the organization.

Tinkering with the institutional building blocks of an economy will cause short term instability if appropriate counter measures are not taken. Shocking the system could prove more detrimental than beneficial. This is the logic behind the ten-year grace period between the passage of this amendment and the enactment of Section I into law. Arbitrary as it may seem, the ten-year period is taken from recent history during the 1990s when it took roughly ten years for personal computers to become mainstream means of communication, commerce, and information. Given sufficient warning, businesses will have a definite timeline to reorganize and

reinvest in order to be in compliance with the new law as decentralized energy technologies become the mainstream energy providers. If there were no grace period, grandfathering would be necessary so as to allow some cushion for the economy to sustain such a dramatic change in investment. However, since there is a ten-year grace period, grandfathering is prohibited because the goal is to maintain an aggressive and smooth transition for overall economic and social benefit.

Why This Conclusion May Not Work… Finding a Compromise

Based on the outcome from the analysis of current energy institutions through the theoretical model, my personal recommendation is a Constitutional Amendment. However, I also recognize that since the 1970s the government has, with the CAA (1970) and FWPCAA (1972), attempted to solve the collective action problems caused by undefined property rights for public goods. Solutions have allowed agents to discharge through command and control schemes or technology based emission standards, permitting, and giving away tradable permits. Although these efforts have not always been imposed to the best of the government's ability, they have in fact been used. The problem with setting very strict or zero emission standards for all contributing agents, as per the Constitutional Amendment, is that the date for which standards are set would likely be pushed back, if it is even technologically possible. For example, if the ten-year grace period detailed above was not enough time for decentralized energy technologies to supersede centralized energy, would the government bring the economy to a halt by telling companies to shut down power plants? No. The new unachievable standards would be postponed. Achievable goals must be set in order to solve the problems.

The opportunity cost of the primary goal needs to be weighed with what is being given up in the transition process. Where is the compromise between the conclusion drawn from the model and reality? The physical problems previously identified must be re-identified.

1. Producers not paying the total cost of energy production.
2. Public goods being taken without compensation.
3. Collective action problem about public goods.
4. Perpetuation of the socially inefficient centralized energy distributional coalition.
5. Lack of investment in socially efficient decentralized energy technologies.

The goal, than, is for legislation to address all five of these problems within the confines of the model and reality. Harvard economist Robert Stavins identifies four categories of market instruments to address the externality issue: tradable permits, charge systems, government subsidy cuts, and reductions of 'market frictions,' which are similar to the frictions referred to in Chapter Two.

Tradable permits are a tried and tested market approach to solving all five of these problems:

> Under a tradable permit system, an allowable overall level of pollution is established and allocated among firms in the form of permits. Firms that keep their emission levels below their allotted level may sell their surplus permits to other firms or use them to offset excess emissions in other parts of their facilities.[ciii]

The stringent tradable permit scheme for SO_2 written into the Clean Air Act in the early 1990s was a great success in combating acid rain. Due to differences in abatement costs among emitters, this approach gave rise to cost savings on the level of $1 billion per year over the 1990s. In fact, industry actually cut SO_2 emissions by more than the law specified.[civ] Some ecologists have even argued that the cap is too low, indicating that industry could have sustained a more stringent cap while still saving the country money. Specific approaches to emissions permitting solve each of the five specified problems above. By setting emission caps and auctioning off tradable permits, the ones generating energy would be forced to pay for the public

goods that they are using as with any other resources input, raising the cost of producing their product without any grandfathering. Tradable permits encourage decentralized decision making that is technologically non-specific, allowing producers to either pay the cost for abatement technologies, or purchase a permit for their emissions. Producers are then paying the real total cost of production and the used public goods are being paid for. The government, by assuming the right to manage the sale of public goods, solves the problem of collective action. Stringent emission caps that dramatically increase production costs will force producers to raise the cost of purchasing the product, making such products less price competitive and cause investment to flow toward alternative energy technologies—solving the last two problems. Although there are historical examples where stringent emission caps have resulted in postponing standards, the model indicates that the investment shift may cause disruptive technologies to finally break down the barriers to market entry. Therefore, stringent emission cap and trade programs similar to SO_2 trading in the 1990s fit the theoretical model and solve all five problems.

Green taxes are another solution to the problem of externalities that get "the prices of goods and services to reflect their true environmental impacts… The guiding principle is that the polluter pays for the harm that his actions contribute to the environment."[cv] Taxing specific types of fuels or emissions would solve most of the five problems and lead to conservation of air and water usage. Producers would pay the total cost of their product and public goods would be paid for. Perpetuation of the centralized energy distributional would depend on how high the taxes are and how much investment actually flowed towards new technologies as a result of the taxation. Stavins indicates that identifying an appropriate tax rate is challenging for law-makers: "Ideally, it should be set equal to the marginal benefits of cleanup at the efficient level of cleanup, but policy makers are more likely to think in terms of a desired level of cleanup, and they do not know beforehand how firms will respond to a given level of taxation."[cvi] Also,

Vaitheeswaran notes that green taxes are "too often blunted by blanket exemptions granted for heavy industry on such bogus pretenses as preserving 'national competitiveness'…."[cvii] Although green taxes have worked in situations in which a government has wanted to influence a particular technological outcome, such as Europe's phase-out of leaded gasoline during the 1980s, the act of taxation conflicts with the models guidelines because it targets specific technologies.

Subsidies that attempt to get prices right "are probably the single biggest distortion of the markets in the developed world."[cviii] *Subsidy reductions* (or elimination) to both nuclear and fossil fuel based players in the centralized energy industry are a step in the right direction toward achieving these five goals because they often have a tendency to "promote economically inefficient and environmentally unsound practices."[cix] Reducing subsidies will not solve all of the five problems but this action is necessary for fixing market matrices to foster institutional evolution that is beneficial to society. In Chapter Two, I discussed market frictions as being an accumulation of laws, taxes, and subsidies that are technologically specific, causing an outcome that distorts the free-flowing nature of a market. This can potentially cause the market to clear at an equilibrium where marginal social cost does not equal marginal social benefit because producers are not paying the total cost of production and the playing field is not level for all law abiding players. Technologies that may be more sustainable for economic growth would fall to the wayside as the centrally assisted technological outcome will prevail, leading to unsustainable rapid growth.

Stavins also refers to a *reduction of market frictions* as sound market-based policy instruments to address environmental problems. The market frictions that Stavins refers to share some similarities with those defined in Chapter Two but are in fact different:

(1) *market creation* for inputs/outputs associated with environmental quality…

> (2) *liability rules* that encourage firms to consider the potential environmental damages of their decisions; and (3) *information programs*, such as energy-efficiency product labeling requirements.[cx]

What Stavins cites are not actually frictions, they are policy responses to frictions that exist either because of outdated regulations, improper utilization of public goods, or inadequate market information. Each of these policy responses to market frictions fit the theoretical model and solves at least one of the five problems.

The first friction reduction Stavins refers to is precisely what this thesis has been calling for: further deregulation in the retail energy industry so that previously monopolized regions are opened up to competition from new firms and sources of generation. Stavins notes that the primary arguments for restructuring are:

> (1) the electricity industry is no longer a natural monopoly, since small generation technologies are now competitive with large centralized production; (2) consumers will benefit from buying cheaper electricity from more efficient producers, who currently face significant barriers to entry; and (3) the old system with cost-of-service pricing provides poor incentives for utilities to reduce costs (Brennan *et al.* 1996).[cxi]

As deregulation occurs, new markets are created for more efficient decentralized energy producers that drive prices down and are beneficial for the environment.

Stavins' second response to market frictions, liability rules, provides "strong incentives for firms to consider the potential environmental damages of their decisions. In theory, a liability rule can be cost effective as a policy instrument, because technologies or practices are not specified."[cxii] Liability rules fit perfectly into the model because there is no technological specificity. These rules, however, are generally more effective in the case of hazardous waste spills and are the primary founding mechanism for the Superfund program. Liability rules may not be effective in the case of air pollution because one agent's emissions that disperse into the atmosphere are not easily seen as in cases of hazardous waste spills, making the polluter unidentifiable.

Stavins' third response to market frictions is an attempt to create textbook style perfectly competitive markets. "Since well-functioning markets depend, in part, on the existence of well-informed producers and consumers, information programs can—in theory—help foster market-oriented solutions to environmental problems."[cxiii] Increased corporate transparency by means of product labeling would give consumers the ability to see how socially responsible companies are that produce the products they purchase. The *EnergyStar* label for example indicates that a product such as an air conditioner or refrigerator is efficient. Another type of information program is a reporting requirement. Whether the producer is required to inform the government or the consumer about its production practices and products, the increased transparency allows the consumer to make better informed choices about their consumption.

In conclusion, instead of suggesting an unrealistic policy such is the Constitutional Amendment calling for zero emissions, I compromise between the theoretical model and reality by suggesting a mix of policies. Aside from charge systems, or green taxes, each of the market-based policies that Stavins outlines fits the model and to some degree solves the major problems identified above. Auctioning tradable discharge permits forces producers to pay the total cost of production, compensates for public good usage, solves the collective action problem, and raises costs for the socially inefficient centralized energy distributional coalition making other energy producers more competitive, thus giving investors an incentive to move funds toward socially efficient decentralized energy technology R&D. As stated in the model, the more stringent the permitting, the more incentive there is for investment in disruptive technologies that can lead to large-scale growth and an improvement in societal welfare. Permits that expire after a period of time allow the government to re-auction the same amount or fewer rights to use public goods. By re-auctioning fewer permits, the market price of usage will be higher. This can be a helpful mechanism for the government to control the rate at which energy prices rise and other

technologies to become competitive, or in other words, facilitate a smooth transition. Technology spillover that may occur as a result of decentralized energy technologies becoming price competitive could also help solve global emissions problems. I also support the reduction of frictions as referred to in Chapter Two—such as technologically specific taxes, subsidies, and legislation—that cause markets to clear at an equilibrium where marginal social cost does not equal marginal social benefit. This will correct inherent flaws in the markets themselves by leveling the playing field, allowing for free-flowing market transactions to decide which technologies are best for sustainable economic growth. Finally, I also support the policies that Stavins suggests in response to what he calls market frictions that exist either because of outdated regulations, improper utilization of public goods, or inadequate market information. Further deregulation in the retail energy industry will foster the development of new markets for decentralized energy producers, creating new places for investment as well as competition for centralized energy. Liability rules hold the wrongdoers accountable for their actions and are not technologically specific. Holding high accountability standards forces companies to put serious thought into their operations and forces them to be more risk averse when operations could potentially harm the environment. These rules, as previously stated, may not work in the case of air pollution. Information programs improve the flow of perfect information, a problem that all markets have, thus improving overall market efficiency. The model tells us that solving these problems will improve societal welfare by encouraging decentralized energy to replace centralized energy and cause large-scale, sustainable economic growth. Based on the restrictions of the theoretical model and reality, a combination of these policies should solve the five specified problems, thus achieving the primary goal.

Areas for Further Research

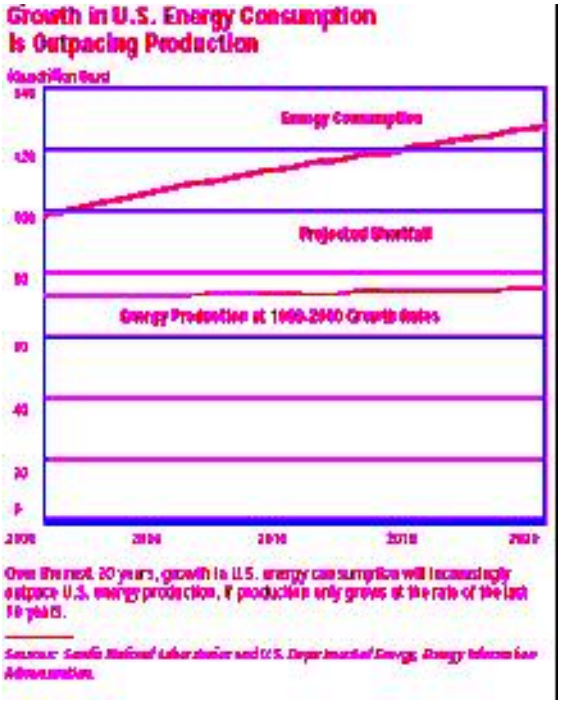
After outlining the theoretical model and analyzing centralized and decentralized energy institutions, four other particular areas stand out that deserve further research. *First*, similar in its centralized nature, an analysis of centralized oil institutions should be conducted through this theoretical model. Oil is a finite resource, whose derivatives provide the energy necessary for the majority of the world's transportation. It is also a fossil fuel that is primarily centralized in volatile parts of the globe. As this thesis suggested, the transition from centralized to decentralized electricity generation would improve societal welfare, perhaps the theory would also suggest the same for a transition from a petroleum-based economy to a hydrogen-based economy. *Second*, further research should be conducted to find the actual dollar amount of the hidden negative externality costs associated with the combustion of fossil fuels. The goal of this research should be to find whether the costs are higher than benefits. *Third*, an analysis should be conducted on the economic benefits of a hydrogen-based economy. If the US made the transition to a hydrogen-based economy and became independent of foreign sources of energy: no more money would be going overseas for oil, dollars would be re-spent at home, and potentially less money would be spent on health costs associated with the pollution caused by fossil fuel combustion (this amount depending on the outcome of the second study I proposed). *Finally*, if the US made the transition to decentralized energy, would there be decentralized energy technology spill-over into developing countries? If there were, would this benefit the developing worlds where centralized energy has failed? Would our own leadership in solving problems at home be the solution to international public good degradation and eliminate the need for international treaties such as the Kyoto Protocol?

Chapter Notes

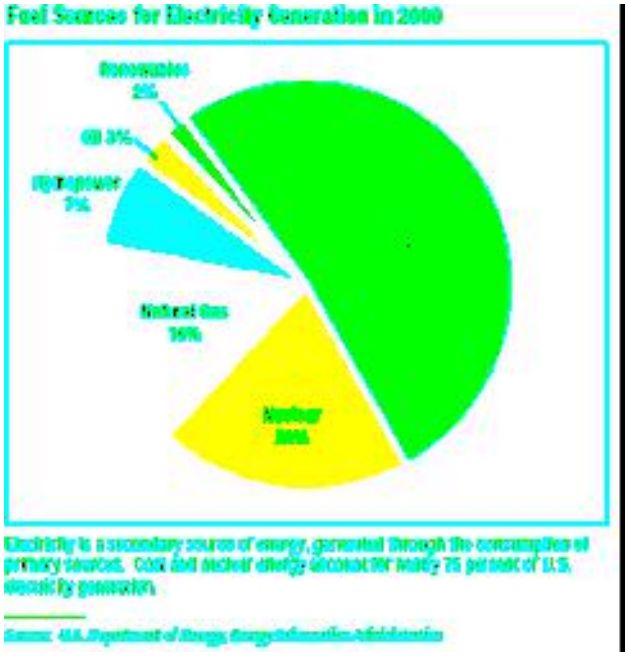
[ci] North (2005) 15
[cii] Life, Liberty, and the Pursuit of Happiness, http://en.wikipedia.org/wiki/Life%2C_liberty_and_the_pursuit_of_happiness (04/10/06)
[ciii] Stavins, Robert N. "Experience with Market-Based Environmental Policy Instruments." Prepared for The Handbook of Environmental Economics Mäler, Karl-Göran and Jeffrey Vincent. 2001. 4
[civ] Vaitheeswaran 210-211
[cv] *Ibid.* 211
[cvi] Stavins 4
[cvii] Vaitheeswaran 212
[cviii] *Ibid.* 212
[cix] Stavins 5
[cx] *Ibid.* 4
[cxi] *Ibid.* 34
[cxii] *Ibid.* 35
[cxiii] *Ibid.* 36

Appendixes

Appendix A

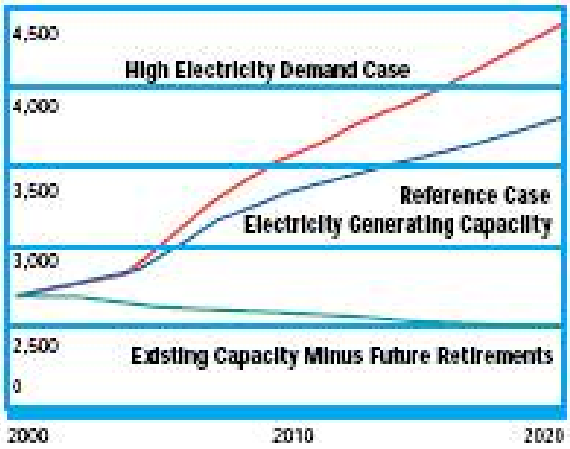


Appendix B



Appendix C

The U.S. Needs More Power Plants

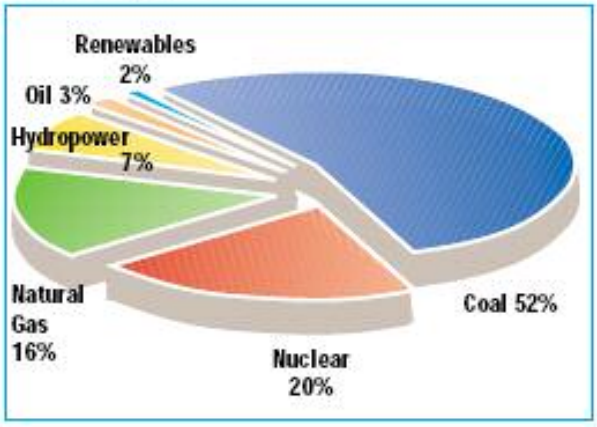


The nation is going to require significant new generation capacity in the next two decades. Depending on demand, the United States will need to build between 1,300 and 1,900 new power plants—or about one new power plant a week.

Source: U.S. Department of Energy, Energy Information Administration

Appendix D

Fuel Sources for Electricity Generation in 2000



Electricity is a secondary source of energy, generated through the consumption of primary sources. Coal and nuclear energy account for over 70 percent of U.S. electricity generation.

Source: U.S. Department of Energy, Energy Information Administration.

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