Encouraging Green Data Centers: Social Construction and Economic Policy

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Cloud Computing and Green Data Centers

Cloud computing has recently become an integral part of how humans and businesses interact with the digital world (Accenture, 2020). Email services like Gmail, social media apps like Facebook, and business software like Salesforce all depend on cloud computing to store massive amounts of data and run intensive computations on that data to provide impatient users with the service they expect. Amazon Web Services (AWS), the top cloud provider in the world, defines cloud computing as “the on-demand delivery of IT resources over the Internet with pay-as-you-go pricing” (AWS, 2021, p. 1). Businesses, researchers, and students rent storage and processing power from cloud providers like AWS in order to avoid owning and maintaining large amounts of servers themselves that may not often get used to their full extent. Cloud providers instead build or purchase data centers filled with servers to provide these services to many customers simultaneously. Data centers can be used practically around the clock, and since the servers are usually located within one building, maintenance can be done more efficiently and cost-effectively than if many companies had to maintain their own private sets of servers.

Though data centers may seem like self-contained systems that make little impact on their surroundings, they have a large effect on local and global communities. Building a data center brings jobs to the area, and their services can have immense reach by making the Internet faster and more reliable. Data centers are currently estimated to use about 1% of the world’s electricity, and their impact on the environment cannot be ignored (Masanet, Shehabi, Lei, Smith, & Koomey, 2020). A green data center is a data center that provides reliable computing while reducing environmental impact. Green data centers may focus on reducing water usage or increasing the efficiency of their servers, but one of the largest ways a data center can reduce its impact is by using renewable energy to power its operations.

This paper explores the acceptance of green data centers and the renewable energy that undergirds them through the perspectives of various stakeholder groups. The Social Construction of Technology (SCOT) framework will be used to analyze the influence different groups have had on the development of green data centers over the past few decades. The electricity industry that powers green data centers as well as homes and businesses will then be brought into focus and analyzed. This research will identify economic policies that promote renewable electricity production. Through this discussion, multiple strategies for encouraging renewable energy and green data centers will be clarified.

Social Construction of Renewable Energy: Clarifying the "Public" in Public Acceptance

Public acceptance of new technology is extremely important for the benefits to be realized, but the "public" is composed of several groups whose interests may not entirely overlap. Paying closer attention to the intertwining groups can benefit the climate as well as the groups themselves. The Social Construction of Technology (SCOT) framework will be used to analyze the relevant social groups and how they have influenced the development of green data centers. The main argument Pinch and Bijker (1984) make is that technology is developed by a process of negotiation between various stakeholders that have differing needs for the technology to solve their problems. These stakeholders can belong to any socioeconomic class, with any level of power or influence, because the way ordinary people use, speak about, and accept or reject technology has real impact on the relationship the technology has with our society. SCOT is a rejection of technological determinism, or the idea that when one looks back upon the path of a technology, each step of the process was inevitable, and the final product came linearly from its beginnings. Instead, the development of a technological artifact is a "multidirectional" process, where at many points there were a large number of possibilities and the circumstances of the culture of the time greatly affected the development path. In that vein, the people and their circumstances come together to decide whether and how a technological artifact is used and changed over time. Different groups of people have different pulls on how the artifact is seen and valued, and how it should be adapted to fit their needs – the authors call this "interpretative flexibility" because many groups can see the same artifact and interpret its importance and meaning in completely different ways. After this period of nascent uncertainty and negotiation, the different meanings and uses are integrated and the artifact approaches "closure" as change becomes more difficult and the number of interpretations decreases. An underexplored area of socio-technical research, according to the authors, is the "closure mechanisms" that take an artifact from the stage of interpretative flexibility to the closed state. When the technology is still being studied, scientists, engineers, and other researchers close in on the "truth" about the artifact and spark the process of closure by narrowing how the technology is viewed by the public. Both simultaneously and after that process is the cultural consensus which occurs gradually as people determine the best ways to integrate the new technology into society.

To illustrate the multidirectionality of an artifact, the authors use a graphical representation of the social groups, problems, and artifacts (solutions) that will solve the problems for the associated social groups. The following figure displays a sample graphical depiction of social groups, their problems, and artifact solutions according to Pinch and Bijker's framework, see Figure 1.

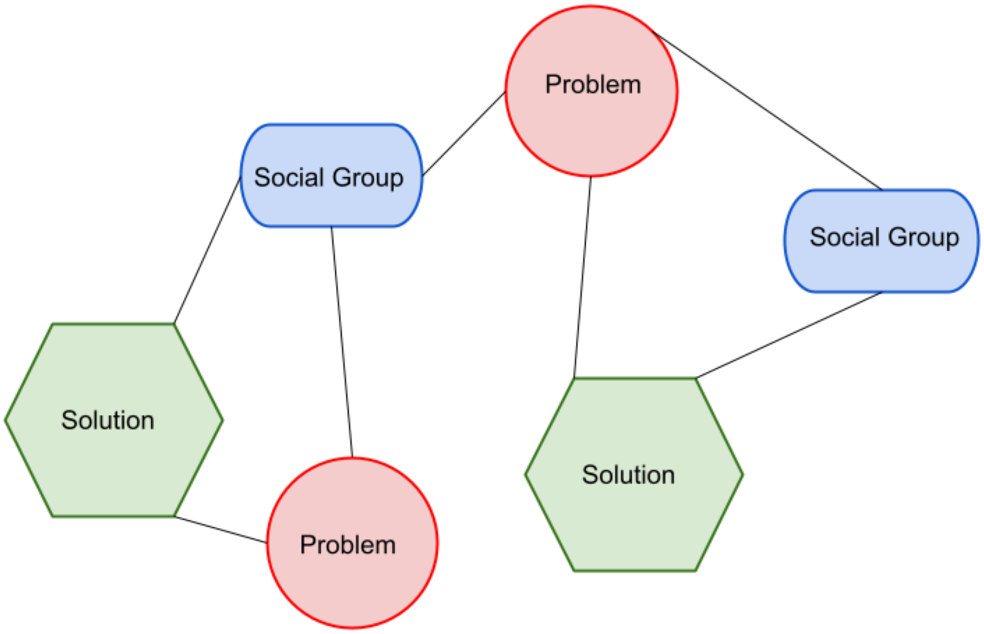

Figure 1. Sample SCOT analysis graph of the various artifacts (green), social groups (blue), and problems (red) related to how data centers and societal groups impact each other.

When discussing the social groups that impact a technology, it is imperative to acknowledge that not all groups have equal voices or power. Perceptions of a particular project can be influenced by powerful incumbent forces like governments, special interest groups, and companies. Stirling (2014) claims that some representations have more legitimacy than others and are valued more in society, especially when it comes to sustainable energy, which is a foundation for green data centers. These agents have a disproportionate effect on where and how data centers are built, and they often affect the way research is done to asymmetrically favor pathways approved by the institutions. These pathways represent choices between which renewable energy technologies to support, which policies to implement, how best to support innovation, how to convince producers and consumers to transition towards renewables, and more. The multitude of pathways available in reality mirror the multidirectionality concept in SCOT, but Stirling’s argument implies that institutions can partially or fully force closure by limiting creativity and plurality in the field in order to boost their public image (ibid). One example of the power of institutions to prematurely close pathways is the United Kingdom's fascination with nuclear energy. When a government study identified nuclear energy as "unattractive," the Labour Government rejected the study they had commissioned and conducted their own review to place nuclear back on the table. When this action was criticized and overturned by a judicial review, the Prime Minister admitted that further scientific evaluation "won't affect the policy at all" (ibid, p. 87). This exertion of institutional power to crush alternatives illustrates the restriction of interpretations towards closure that certain social groups can achieve through their concentrated power.

Case Context: Advancing Renewable Energy

According to the United States Energy Information Administration, the United States consumed more renewable energy in 2019 than ever before, totaling at 11% of total energy consumption for the year (EIA, 2020). U.S. wind power has tripled over the past decade, and there are now more than 60,000 wind turbines in the country (AWEA, 2020). In their quest to become greener, cloud providers have turned to renewable energy as one of the simplest, most effective ways to reduce the environmental footprint of their data centers. Since 2017, Google has "purchased enough renewable energy to match 100 percent of [their] annual global electricity consumption" and has been carbon-neutral since 2007 (Google, 2019, p. 1). Companies are also taking advantage of the rapid expansion in renewable power generation by powering their data centers directly with renewable. Facebook's data center in Odense, Denmark runs on renewable energy with excess heat going to 6,900 local homes (Henriksen, 2019). Another of these is Lancium, a small cloud provider that is developing technology to use excess wind energy to power their operations, with which I completed my technical project (Lancium, 2020).

Before 2007, sustainability was not a priority for data centers, but rather an afterthought to the primary profit drivers of reliability and uptime (Beaty, 2013). These early targets represented a multidirectional model as the general public had little knowledge about the potential data centers had, and companies solely aimed to profit. However, metrics such as power use effectiveness (PUE), a measure of how green a data center is, have been a powerful driver for change and closure in the data center industry (ibid). PUE is the ratio between the power consumption of the entire facility and the IT equipment that provides value, such as servers. A score of 2 means that for each watt of power used by the servers, another watt is used for overhead, which includes cooling the facility and distributing the power to the IT equipment. The minimum theoretical value of 1 signifies that every bit of power used in the facility is used by servers, without any overhead (ibid). While it is impossible to achieve a value of 1 due to the inherent inefficiencies in the physical world, most major data centers have decreased their PUE value substantially over the past decade. For example, Google's fleet-wide quarterly PUE has dropped from 1.23 as of their first report in the third quarter of 2008 to 1.09 in the first quarter of 2020 (Google, 2021). Now, nearly every major company in the industry releases annual sustainability or Corporate Social Responsibility (CSR) reports, including Google's top competitors, Amazon and Microsoft (Amazon, 2021; Microsoft, 2021). In these reports, the companies compete for certifications and metric scores like PUE. As shareholders, researchers, government committees, and the general public demanded transparency and improvement in the industry, sustainability has led data centers towards closure by solidifying itself as a top priority since the wild-west days of the early 2000s.

While several social groups have been working together, or at least in parallel, to advance sustainability in the data center industry, the bulk of progress seems to stem from institutional power. Following Stirling's argument, while major tech companies want to serve their customers, they are moved most by institutional powers with deep pockets. Governments have the unique ability to work outside the free market to create and enforce policies throughout their region through programs like tax credits and subsidies. As the United States was rebuilding from the Great Recession of 2008 and 2009, the Obama administration began pouring money into sustainable jobs and technology as part of the American Recovery and Reinvestment Act. $47 million was earmarked for green data centers and IT facilities in particular (Burt, 2010). State governments have also gotten involved in policy promoting green data centers as well as renewable energy in general. Maryland's Data Center Energy Efficiency Grant Program, for example, subsidizes energy efficiency improvements up to $200,000 per project for data centers located in the state (MEA, 2021). In fact, the factor used to determine whether funding is disbursed is an improved PUE (ibid). These institutional programs, enforced by industry-standard metrics, helped push companies in the direction of sustainability using their pocketbooks.

Research Question and Methods

When governments interfere with the free market, some actors may benefit more from the changes than others, which could create excess profits for some companies with previous advantages. These excess profits are called rents. This research aims to answer the question: How can economic policies effectively promote renewable energy production while minimizing rents? The policies in focus aim to divert carbon-based energy demand toward renewable sources by working from the supply side. Rents increase the cost of the policies, since to achieve the desired benefit across the market more money must be put into the system when some is expected to disappear into companies' coffers. This extra monetary burden is often placed on the taxpayer if the policy is publicly funded or passed through to the energy consumer if the costs fall on the producers (Kwon, 2015). Thus, a major focal point for many policy-creating committees and agencies is the reduction of rents created by new policies. The two major policies that will be examined are the feed-in tariff (FIT) and the renewable portfolio standard (RPS). The effectiveness of these policies will be analyzed using several cr2iteria from prior literature. The rent potential of these policies will also be discussed using prior literature, which utilizes both economic theory and case studies.

RPS and FIT Systems

An RPS system is a “state-mandated program in which a percentage (or share) of a state's overall electricity generation must come from renewable energy” (Carley, 2009, p. 3071). Most RPS programs mandate that utilities either produce renewable energy themselves or purchase an equivalent amount of energy to meet these requirements using renewable energy credits (RECs). According to the Environmental Protection Agency (EPA), “RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from a renewable energy resource” (EPA, 2016, p. 1). These RECs are most often traded within a state or region, but can sometimes be traded inter-regionally as well (Carley, 2009). While an RPS system can be classified as a quantity regulation, an FIT system “can be regarded as a price regulation” (Kwon, 2015, p. 677). FIT systems augment the price of electricity or set a fixed price above the market price to encourage producers to expand or start generating renewable energy. The main economic difference between the two systems, as pointed out by Kwon, is that the price of renewable energy is determined by a regulatory agency and the quantity is driven by the market under FIT, whereas the quantity is determined by regulators and the price is driven by the market under RPS (ibid).

I will use several criteria discussed by Schallenberg-Rodriguez (2017) to analyze how each of these systems impact the social groups involved and the development of renewable energy technology. *Effectiveness* denotes how a policy created by the government helps renewable energy technologies grow in a quantifiable way. *Innovation and diversity of technologies* shows how companies work within the bounds set by governments to develop technology at different paces, affecting the economic future of new and established technologies. *Administrative costs* mark the financial impact on governments and thus taxpayers of a policy; companies and governments can work together to make the implemented system run efficiently, but only if it fulfills their organization-wide goals to do so. *Market interference* measures how a government can affect a technology using the force of an economic and political system, which impacts companies and individuals in that region. Each of these factors build on Pinch and Bijker's idea that the interactions and negotiations between social groups influence the path of a technology.

Results

Both the RPS and FIT systems have been shown to be effective in different socio-political systems and in different stages of renewable energy technology development. Overall, FIT systems appear to more effectively encourage renewable energy deployment, support technological innovation and diversity, reduce administrative costs, and minimize market interference and rents. Both systems have their place in different environments, where renewable energy technologies are established and emerging, so it is important to discuss the benefits and costs of both systems so that each region can decide which policy will most effectively support their energy producers through the transition from carbon-based to renewable energy generation.

Social Groups and Power

In each of the following measures of effectiveness, it is clear that the various social and institutional groups that make up a country, region, or state have different priorities and different amounts of power. Using the SCOT framework as well as Stirling's idea that different groups' perspectives carry different legitimacy, this research can be placed in a more complete context. The following figure displays my graphical representation of the social groups, problems, and artifacts to model the topic of green data centers and the renewable energy that powers them, see Figure 2. This research focuses mainly on the government and power producers, as well as the citizens of the "public," which consists of taxpayers, electricity consumers, activists, and more. Yet the relationships between companies in the burgeoning cloud industry and power producers as well as governments have been salient in this discussion because the demand for power is only growing. Exploring the perspectives of each of these groups allows the research to connect to the broader socio-technical theories that underlie the intricacies of the economic policies studied.

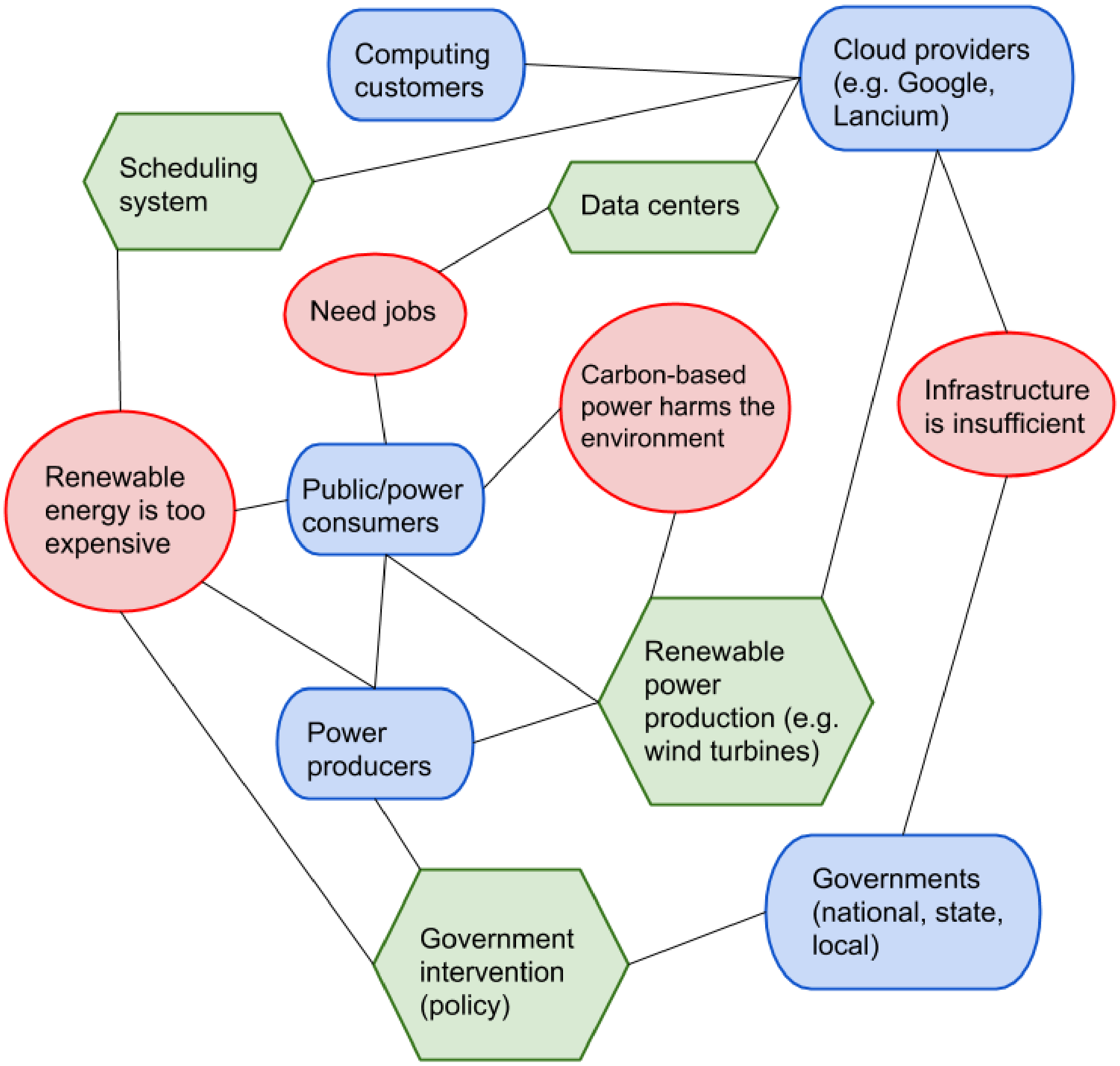

Figure 2. SCOT analysis graph of the various artifacts (green), social groups (blue), and problems (red) related to how data centers and societal groups impact each other (Jacobs, 2021).

Effectiveness

The effectiveness of these systems in different countries, states, and regions has been explored widely, with differing standards of effectiveness. Schallenberg-Rodriguez (2017) measured the two systems by comparing several case studies, mostly based in Europe. One metric was deployment, or how much production capacity was present in a country (e.g. wind farms, solar facilities). The author notes: "By the end of 2014, two of the classic FIT-countries, Germany and Spain, made up 48% of the total installed wind capacity in the EU-28" (ibid, p. 1434). Additionally, she cites an EU-wide study which introduced metrics for effectiveness and deployment; the countries that excelled in both were all under the FIT system (ibid). The main reason, according to the author, is that FIT systems create a sense of safety by guaranteeing a stable, predictable price for a period of time, whereas quota systems like RPS "introduces risk elements for investors" due to the market-based pricing and therefore "unpredictable income" in the future (ibid, p. 1435). Kwon (2015) studied South Korea, which has had the rare experience of implementing both FIT and RPS systems, FIT from 2002-2012 and RPS from 2012 to the present. The resulting study showed that the price of renewable energy paid by the consumer as well as the rents were both higher under RPS than under the former FIT system (ibid).

Around the world FIT systems seem to fare better than RPS systems, but are RPS systems still effective? Carley (2009) analyzed the effects of a mandatory RPS policy in each U.S. state over 9 years (1998-2006) to determine if the presence of the policy increases a state's share of renewable energy. The resulting model showed that while RPS policies did not seem to significantly increase the percentage of renewable energy generation, "for each additional year that a state has an RPS policy, they are found to increase the total amount of renewable energy generation" (ibid, p. 3071). This effect over time can help establish renewables, which will allow for more competition with carbon-based energy. Additionally, an increase in the percentage of states that had RPS policies was shown to lead to an increase in the percentage and total deployment of renewable energy. This, according to the author, was mostly due to regional and intra-regional REC trading; even states that did not have an RPS policy still benefited from neighboring states' policies because the economic opportunity of RECs encouraged renewables development and production (ibid). Since RPS policies were not shown to increase the share of renewables in the total generated energy for a state, the author argues that RPS alone is not enough if the goal is to reduce carbon emissions. Combining RPS with other policies that discourage fossil fuel generation (such as cap-and-trade mechanisms) could be even more effective in increasing the percentage of energy that comes from renewable sources (ibid).

Innovation and Diversity of Technologies

In terms of innovation, it has been demonstrated that FIT systems encourage greater diversity and innovation for emerging technologies than RPS/REC systems. Schallenberg-Rodriguez (2017) notes that FIT countries like Denmark and Germany supply almost all British and 66% of American wind technology. The policies in these countries supported wind adoption early and often and allowed them to gain a solid position in the global market. The author contrasts these cases with the trend demonstrated by Sweden that RECs can spur producers to lean more heavily on previously established and profitable types of renewable energy instead of innovating, which results in improved efficiency but also increased rents for already profitable producers (ibid). Kwon (2015) labels these particular rents as differential rents; those producers with mature technologies or prime locations will receive rents while new technologies may be too expensive to make participating in the RPS system worth it. This situation is depicted in Figure 3, where the price of an REC paid to producers (P_{REC}) is higher than the price of energy in the free market (P_E) and the rent is the difference between the marginal cost of each technology and P_{REC} (ibid).

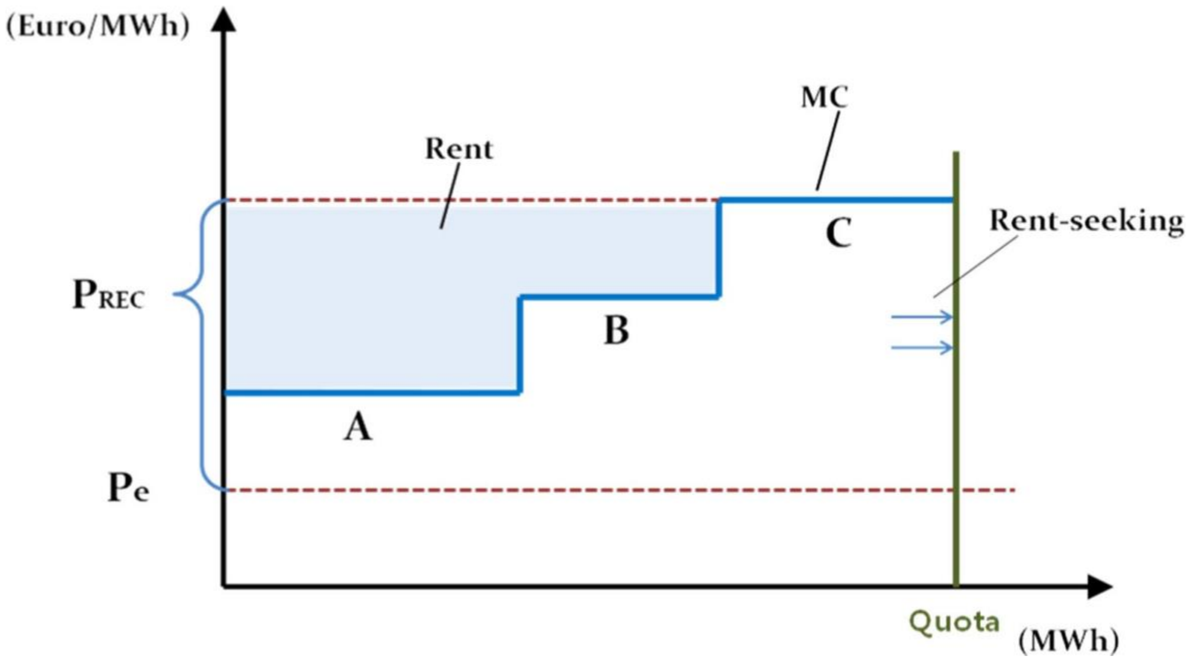

Figure 3. RPS price and rent graph. The distance between the red dashed lines represent the additional value brought by RECs. The blue line represents the marginal cost of each energy type A, B, and C, while the blue highlighted area represents the rent producers gain by generating energy using the three technologies (Kwon, 2015).

Schallenberg-Rodriguez (2017) adds that under quota systems like RPS, "lack of support for immature technologies… will eventually lead to higher generation costs in the long term since these technologies will not be ready" if and when standards increase past the capacity that established systems alone can provide (ibid, p. 1436). On the other hand, FIT systems support technologies in all stages of development and create the necessary spark for equipment manufacturers and other investors to gain footing (ibid). This future-oriented perspective is likely to be held by governments, who may tend to see these policies as long-term investments, whereas from the perspective of shareholder-driven companies, quarterly profits may take a more prominent priority. This difference in long-term versus short-term priorities signals the tension between the two social groups.

Administrative costs

When discussing the benefits and costs of these policies, another important consideration is administrative costs (also called overhead or transaction costs). Administrative costs, which include the amount of planning, maintenance, and enforcement effort by a government, increase when a policy is more complex (Schallenberg-Rodriguez, 2017). Generally, the simpler a policy is, the lower the administrative costs, but the higher the burden on taxpayers or consumers (ibid). The author notes that since FIT systems are "easy to implement from the administrative point of view," administrative costs are comparatively lower; this was supported by the EU-28 study in that FIT countries had lower administrative costs even as their effectiveness and deployment outperformed RPS countries (ibid, p. 1437). However, the higher burden on end consumers mentioned may be due to the system's lack of fine-tuning for less common situations, which allows producers to take advantage of those situations to collect rents. On the other hand, RPS is an example of a system with high administrative costs: in Sweden's example, administrative costs comprised "over 10% of the total system cost" due to the complexity of their REC program (ibid, p. 1434). Another important factor that affects administrative costs is information asymmetry; in the case of renewable energy this is the difference in knowledge between the energy producers and the government (Kwon, 2015). Information asymmetry can also be a source of rents under FIT systems: if the FIT is set much higher than the actual cost of generating the energy, then the producers can take that difference as excess profit (ibid). Figure 4 shows the effects of information asymmetry on rents under FIT. The difference between the FIT and the MC will be collected as rents by the producers, so the producers have a motivation to lobby for the maximum FIT possible for each technology in order to collect the most rents (ibid).

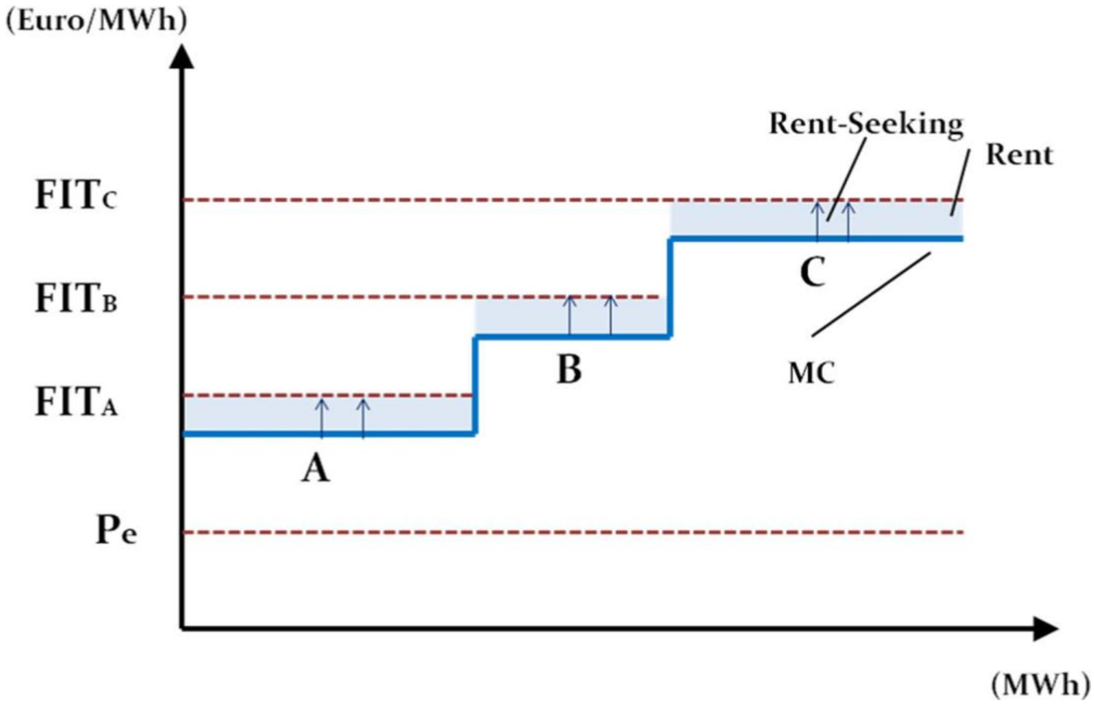

Figure 4. FIT price and rent graph. The red dashed lines represent the price set for each technology A, B, and C above the price of energy P_e. The blue line represents the marginal cost of each energy type, while the blue highlighted area represents the rent producers gain by generating energy using the three technologies (Kwon, 2015).

Banding, introduced in the United Kingdom, can help mitigate the aforementioned lack of diversity in RPS systems. Banding is the process of issuing multiples of RECs according to a multiplying factor or weight for each type of energy produced (Kwon, 2015). Unfortunately for governments, information asymmetry makes determining the weights of RECs challenging because each producer is motivated to get the highest multiplying factors for their energy types. In the South Korean example, “at a public hearing for the new RPS scheme held at Seoul on 2010/10/01, nearly all participants representing each RES-E demanded the modification of REC weights” (ibid, p. 678). This lobbying represents the increased administrative costs when using banding to make the RPS system more complex, as well as clearly depicting the different perspectives companies and government have when coming together to solve their problems. For companies, the aim is to maximize profit, while sustainability is a nice bonus, so withholding information and lobbying as much as possible can be a method of achieving their goals. For the government, the aim is to encourage renewables generation without wasting taxpayers' money, so the lack of information and wasted lobbying time works against their goals.

Market Interference

Both of these policies, like almost any economic regulation, constitute "nudges" to the free market in order to encourage an outcome beneficial to greater society. Thus, both of these policies interfere with how companies behave to make the desired behavior – transitioning from carbon-based to renewable-based energy production – more attractive to these actors. As Schallenberg-Rodriguez (2017) mentions, FIT systems "have often been criticised for distorting free competition and not being compatible with the creation of a liberalised electricity market" because they artificially inflate the reward for generating renewable energy and deflate the risk (p. 1436). RPS systems, on the other hand, claim that "competition among generators should automatically put pressure on prices, without any need of further public intervention" (ibid, p. 1427). Though as discussed previously, in RPS systems "immature technologies with high costs are forced out of the market even if they have the potential to reduce production costs in the long run" (Kwon, 2015, p. 678). Rewarding established companies and those who prioritize short-term gains may hamper the long-term future of renewable technologies. Another risk with any policy is market volatility in response to interventions. As Schallenberg-Rodriguez (2017) notes, "Most market booms in countries with feed-in schemes were caused by an imbalance between the tariff and the declining cost of the technology… Feed-in systems have to be designed to allow timely adjustments. Boom and bust cycles are caused by unstable policies" (p. 1437). For either of these policies, the government must consider how their implementation may influence the market.

Discussion

Based on this research, the tension between the companies and the governments seems to stem from the existence of rents: companies aim to maximize them and governments aim to minimize them. Yet how does the "public" weigh in on these issues? It seems in my research the public had almost no power in these negotiations. However, businesses must consider their customers' perspective in order to keep their business, and publicly-traded companies are beholden to their shareholders. Energy producers court customers with disclosures that describe their energy mix and other environmental data; even as early as 2001, about half of all U.S. states required or were considering requiring disclosures (Roe et. al., 2001). From the producer's perspective, profits almost always take priority over sustainability, but marketing sustainable changes well could make the company more competitive. From governments' perspectives, there may be a pressure to accelerate sustainability to comply with previous commitments and maintain an image of environmental responsibility. Implementing these measures without creating an undue extra burden on taxpayers and electricity consumers is important as well.

On the consumer side, interpretative flexibility is evident; some consumers care about the sustainability of their electricity while some do not. Different consumers can see the problem of carbon-based energy in different ways with different solutions while some may think it isn't a problem to be solved at all. For governments and producers, it is still important to ensure that demand follows supply, so the interactions between these two groups and consumers matter. While the technology is still developing and commercializing in order to compete with the prices of fossil fuels, many power producers have been offering a green energy plan option instead while passing along the additional costs to the consumer. Knapp et. al. (2020) matched up the locations of survey respondents with ratepayer participation in green electricity plans across the

U.S. On average, respondents were willing to pay an extra $6.06 per month, or about $72 per year, which tracks a growing trend over time based on survey data from other sources (ibid). Furthermore, the higher the willingness-to-pay value in an area, the higher the actual participation in a green program, given the option (ibid). These findings go further than a survey that asks people if they would *hypothetically* participate in these programs; they are a source of optimism that, given the opportunity, people can and do put their money where their mouths are, and over time the amount of money on the line is growing. Thus, while the consumer's emphasis on sustainability over affordability depends on income and availability of these elective programs, the consumer perspective shows a willingness to support the transition to renewable energy even when it touches their own wallets.

One caveat to this research is that it did not distinguish between state, regional, and national policies or between the different economic and political systems of the countries in which the policies were implemented. Therefore, the systems may have been operating under a different set of rules, and interfering in different markets may produce different results. Originally, I was interested in focusing my research on state-level policies and I would have liked to make a specific policy recommendation for Virginia in particular. I later decided to study the policies more broadly, using state, regional, and national case studies around the world. If I were to continue this line of research or re-do this thesis I would have attempted to find a better quantitative measure for policy effectiveness at the state level in the United States. Connecting each state's plan in the US to a "green" score of some kind would have helped me create a stronger link between a state's plan and its effectiveness in encouraging green energy. This would aid me, along with research into Virginia's specific situation and resources, in making a specific policy recommendation for Virginia lawmakers. Additionally, there are more factors at play than pure economics and risk avoidance when a government creates a policy relating to renewable energy. As seen in the UK nuclear power example, not only can some decisions be anti-scientific, but they can also be anti-profitable. Further research into why people with power make these decisions would be helpful, and connecting these topics to socio-psychological research of belonging would further fill gaps in the literature.

This research has helped me understand that change is possible if several social groups work together to align their goals. The lobbying example in South Korea in particular illuminated the wasteful processes that slightly advance one group's goals at the detriment of another group's goals. I will use this research to advance my engineering practice by putting an emphasis on stakeholder analysis and considering the audience of everything that I build. Technology is not created in a vacuum, and keeping the social groups the technology will affect in the front of my mind and welcoming input from these groups will result in a product that benefits more people.

Conclusion

This research is a first step towards rethinking how we encourage the transition from carbon-based to renewable energy in every sector, not just for green data centers. While each state, region, and nation has a unique history and its own set of economic and political rules, it is important to consider how each social group can contribute to the development of a technology. Governments can use the concepts of SCOT to truly understand what each group needs. Then by aligning those needs with policies supported by analysis, each group can feel heard and work towards its goals while accomplishing the larger objective, which will take the technologies towards closure. As we become more dependent on the Internet to live and work, whether that be through multiple smart devices in our homes and buildings or through the ubiquity of the cloud in every sector of the economy, our reliance on data centers will only increase. The climate crisis we are facing will not go away and we need to future-proof our way of life by making sure our data centers can function sustainably. Renewable energy is an even bigger issue that needs to be solved as quickly as possible, and the intersection of the two can make a large difference given the right incentives for companies to work with governments and the public to make lasting change.

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