

Network Challenges in Advancing Energy Technology in the U.S.

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Introduction to Challenges in Energy Policy

Energy runs the world, and its importance is ever-growing: by 2040, global energy consumption is projected to increase to over 230 trillion kilowatt-hours (kWh) up from 161 trillion kWh in 2012. Simultaneously, greenhouse gas emissions are rising: CO₂ concentration in the atmosphere is now over 400 ppm, a substantial increase from ~280 ppm at the start of the Industrial Revolution (Chu et al., 2016). Though there is still debate among policymakers on the degree to which such fuel-generated carbon emissions have caused recent increases in global temperatures, many nations, including the U.S., have modified their energy infrastructures to include more renewable sources, especially considering the transience of remaining oil and gas reserves. As one of the world's leading energy producers and consumers, the U.S. is especially responsible for maintaining high energy throughput while sensibly developing sustainable & environmentally benign energy technology. But in developing energy policy, myriad contrasting societal, political, and cultural forces in the U.S. compete for influence.

To probe how these competing groups have affected energy policy, this paper utilizes the STS framework of actor-network theory (ANT). The main actors of the network include those who are directly involved with energy policy: lobbyists, energy companies, researchers, energy technology, energy consumers, and U.S. policymakers.

These actors pull each other in contrasting directions. For instance, a societal push to develop more renewable energy may be at odds with companies' motives to maximize profits using well-developed petroleum-based systems rather than inchoate expensive renewable energy sources. Simultaneously, people are influenced by their local communities. A recent paper in *Nature Human Behavior* concludes that “second-order normative beliefs—the belief that community members think that saving energy helps the environment—play [a role] in curbing

energy use” (Jachimowicz et al., 2018). Therefore, the beliefs of society affect how individuals behave in terms of selecting sustainable energies.

The network is intrinsically subject to perturbations that threaten its stability. Government action is designed to stabilize some of these disruptions, but since resources are limited, it is impossible to appease all relevant actors through policy alone. The government itself is a divided entity, whose actions may contradict one another and are affected by lobbyists and party ideologies. This paper assesses the risks to the energy policy network and recommends future actions to ensure the network’s success.

Research Questions: Network Analysis and Energy Legislation

What are the biggest threats to the success of the network of energy producers and consumers in the United States? How can fair policy be negotiated among governments, lobbyists, lawmakers, researchers, and energy consumers? To answer these questions, the policies that have been enacted by legislators to mediate energy production and usage are studied. Network analysis is the main method used to examine literature, which includes energy consumption and production statistics published by the U.S. Department of Energy (DOE) and federal bills, especially pertaining to natural gas. Studies of difficulties in adopting sustainable energies, along with research into upcoming green technologies including those for solar and wind energy, are examined.

Background of Energy Policy in the U.S.

Energy has been a key resource to society since the first human scavenged for wood to light a fire. Societies now face challenges in generating, storing, and distributing vast amounts of energy to fuel industries and residences.

In the 1970s, the U.S. experienced a series of energy shortages following the 1973 oil crisis, sparked by an oil embargo in the Middle East (Parkinson 2012). These events re-oriented U.S. policy to focus more strongly on energy independence, with policymakers realizing that a dependence on other countries for precious energy weakened the U.S.' hegemonic position. James Carter, who created the Department of Energy in the face of continuing natural gas shortages ("Our History"), addressed the public in his famous "malaise" speech of 1979: "From now on, every new addition to our demand for energy will be met from our own production and our own conservation (Carter 1979)." Policymakers in both political parties have taken this vision seriously. As of 2020, the U.S. became a net exporter of oil products ("Petroleum & Other Liquids"), a sign of full energy independence brought about mostly from the development of fracking technologies in the 2010s.

The second big issue in recent American energy policy is its adoption of sustainable and environmentally-friendly technologies. On this issue, the government is more divided. For instance, under the Obama administration, the U.S. adopted aggressive sustainability goals, many of which were rolled back under the Trump administration in favor of achieving energy independence through fossil fuels (chiefly natural gas, petroleum, and coal). The divide is not simply between party lines; for instance, Republican president George Bush advocated for replacing oil with renewable energy, signing the Energy Policy Act of 2005 providing billions in tax incentives for renewable energies (United States 2005).

Direct political action is only part of the picture. Part of the longevity of the petrochemical and fossil fuel industries come from their effectiveness and their cashflow. For instance, ExxonMobil in 2018 was the world's 2nd largest company by revenue, earning nearly \$280 billion that year alone. Energy companies play a crucial role in our economy, and have a competitive motive to dissuade legislators from siding against them. Perhaps unsurprisingly, the top two recipients of oil lobbying money from 2019 – 2020 include a senator from Texas and a House representative from California, the states of which rank 1st and 3rd in oil production (OpenSecrets).

To maintain its economic and geopolitical strength, the U.S. derives most of its energy from natural gas and petroleum-based fuels. However, pressures from around the world and at home to develop carbon-neutral and renewable technologies, have grown rapidly in recent decades. The Intergovernmental Panel on Climate Change (IPCC), a body of the United Nations, was founded in 1988 to review “certain human activities” that could lead to “global climate patterns, threatening present and future generations.” In 2007, the IPCC assessed that “warming of the climate system is unequivocal” and very likely caused by human activities, including production of greenhouse gases. Another point of worry with fossil fuels is with their limited supply. Combined, these have catalyzed global development of renewable energy, and energized a large portion of the U.S. population. A study by the Pew Research Center found in 2017 that two-thirds of Americans prioritized developing alternative energy over fossil fuels (Kennedy 2017).

The U.S. government's position on climate change has been complicated. It is true that the U.S. has provided provisions for efficient, sustainable energies, such as the Energy Star program founded in 1992 which recognizes energy-efficient products—and whose stickers likely

mark appliances you use (Energy Star). However, the government did not endorse the Kyoto Protocol, an international treaty to reduce greenhouse emissions, and withdrew from the 2015 Paris Agreement, a United Nations agreement to mitigate carbon emissions, (Wong), in favor of having more freedom to generate energy without regulation.

The government, corporations, and regular citizens have driven usage of sustainable energy technologies in conflicting ways. The path forward for greener technology is not yet clear. The interactions among these groups and with nascent carbon-neutral technologies are studied further in the rest of this paper.

Actor-Network Theory and Energy

The issue of energy policy is complex, involving numerous sets of people whose relationships bind each other to behave in particular ways. In this study, I am primarily interested in how these groups affect each other, as examining these relationships using sociological principles may more deeply explain the current state of energy policy while illuminating areas of improvement in the future. Therefore, I utilize actor-network theory (ANT), which is an STS framework that examines the relationships between human and non-human elements, or *actors*, in a conceptual network.

Originally developed in the 1980s by sociologists Callon and Latour, ANT explicitly rejects any distinction between human and non-human elements. Things or groups of things are given conceptual forms based on how other entities interact with them. That is, things do not inherently exist, but are “assembled” into existing by their relationships with others (Alcadipani, Rafael, and Hassard 2010). Hence, ANT focuses on the alliances between actors, especially the factors that enable these connections to endure.

Critics of ANT lambaste the theory for inherently ignoring cause-and-effect and failing to consider factors such as actor history and human intentions that lead to multiplicities of roles actors play in multiple networks at multiple times (Cresswell 2010). Moreover, successful application of ANT depends on sensible ordering of things into groups, which in itself is an artificial process that risks oversimplifying the network of myriad things that relate to individual actors. Hence, perhaps it is useful to consider ANT as a useful tool to distill complex issues targeted at specific entities, rather than a comprehensive theory.

Still, these problems limit the theory's power to generalize. To mitigate these shortcomings, I consider prominent examples of entities in each actor group and their context in the network, e.g. ExxonMobil as an energy company and its history with lawmakers, thereby presenting illustrations (though not a full account) of how the network has evolved over time. In considering which factors most broadly present themselves in society, actors directly involved with the U.S. energy policy were identified, with U.S. government policymakers comprising the primary network builder.

These actors may pull each other in different directions. Though a society's citizens may want to consume a higher proportion of sustainable energy due to ethical reasons, this may be at odds with a company's motives to maximize profits using well-developed natural gas systems if developing the required technology is intractable. People in today's world may decide to choose fossil fuels for their better prices while morally (or for any other reason) wanting to use different technologies. It may not be viable for companies to profitably tap into those interests without government intervention to lower prices to consumers; this would prompt the passage of bills designed to offer incentives for developing renewable energy, as the U.S. has done before. On the other hand, if everybody in the U.S. only valued alternative energy, then they would be

willing to pay a higher price as energy makers compete to set prices, and the sustainable energy-makers would set the market without need for government intervention. The network is therefore subject to perturbations that threaten its stability.

In this paper, ANT as a conceptual, theoretical framework lends itself to pragmatic use. I examine how the network of energy policymakers can succeed despite their misaligned motives, in particular examining critical points in the network that may lead to the network's failure. I then suggest societal and policy-based changes that I argue will ameliorate these identified weaknesses.

Network of Consumers, Producers, Regulators and Natural Gas

The nature of energy technology, along with the complex web of interests surrounding consumers and producers of energy, have led to our modern energy infrastructure in which natural gas dominates the energy landscape. Energy is bought by consumers, sold by corporations, regulated by governments, and centers around discrete energy technologies. This network is inherently stable so long as the political system endures; it is undermined when the democratic and legislative process is disrupted. Perhaps the most illustrative example of this is can be seen in the aftermath of case *Phillips Petroleum Co. v. Wisconsin* in the early 1950s.

The story begins with the Commerce Clause of the Constitution of the United States. Countless policy decisions have revolved around the intricate interpretation of the clause, which imbues the federal government with power to regulate interstate commerce. Natural gas was once able to escape regulation under the Commerce Clause by being sold and distributed within states (i.e. avoiding *interstate* trade). Tensions arose, however, when legislators from natural gas-consuming states, such as Wisconsin, began to enter into conflict with natural gas-producing

states, including Texas. In this case, the former claimed that the lack of regulation led to exorbitant gas pricing for the consumers, while the latter sought clemency under the Constitution. This court case became known as *Phillips Petroleum Co. v. Wisconsin* (Minton and Supreme Court of the United States, 1953), and showcases how direct needs of consumers for cheap energy – and the role of local legislators in representing their representatives – came to a head with companies and legislators that sought to preserve their company profit and make what they believed to be the best decisions for the market. Making market-driven decisions may not be solely profit-driven, though, as ideologies that guide a company’s success also have repercussions for the nation’s economy. Either way, natural gas-distributing companies were at least partially motivated by making more money.

The case, brought to the Supreme Court and unpopular to most energy companies, was designed to close off a loophole that allowed companies to escape regulation by selling at the surface of oil wells (“wellheads”) or their connecting lines. The Court ruled in favor of Wisconsin, causing sales of natural gas at wellheads to be regulated. Though unpopular, this case quickly faced “corrective” Congressional legislation which sought to offset some of the decision’s consequences by reinvigorating the natural gas market. For a while, the bill was slated to pass, having been supported by the Eisenhower administration.

However, in the midst of voting, Senator Francis Case (R-SD) announced that he had been offered a cash donation of \$2,500 to support the legislation. In other words, Senator Case announced that he had been (unsuccessfully) bribed. This near-malfeasance prompted an FBI and Senate investigation, and precipitated a dark cloud over the bill. Ultimately, the legislation passed the Senate, but considering the shady conditions surrounding the case, Eisenhower vetoed the bill. By this time, the DOE did not yet exist, nor did the EPA. Thus, the regulation of this

energy was left to the Federal Power Commission, which was not adequately prepared to regulate the market, thus causing financial harm to the energy companies that explored and recovered natural gas – ultimately leading to higher prices and lower supplies of energy to consumers (Nordhaus and Kalen, 2018).

Consumers demanded cheaper energy, precipitating this push for sharper regulation. Companies moved to preserve their profits. Legislators sought to represent their party & their represented constituencies. A fair compromise could have been reached: judicial action followed by corrective legislation. However, bribery – or perhaps, a facetious political move to create the image of bribery – disrupted this settling process. The biggest threat in this case was the introduction of money to unduly sway the interests of politicians, further degrading the representation that constituents get compared to bodies backed by money. The network of energy producers and consumers is governed by checks-and-balances but can still fail. Among consumers and distributors, seemingly irreconcilable differences can be mediated through executive, legislative, and judicial corrections. The true risk is when the democratic system is undermined through undue influence such as in bribery.

Perhaps not as obvious is the effect of the technology itself: natural gas. Primarily gaseous methane at standard temperatures and pressures, natural gas flows easily through pipes, constraining engineering designs to include individual pipelines that were argued to not fall under the Commerce Clause. Compare this to the electric utilities industry, in which power is generated and sent to a national grid. This distinction led directly to the regulatory loophole that had allowed natural gas to be sold at higher prices, a loophole was impossible for electric power. These consequences impacted the future of natural gas prices for decades. In short, the network

is limited by the nature of the technology. And so, the physical limitations of energy sources are a critical part of the network.

What, then, of cleaner energies? If one wants to pay a higher premium on energy and is willing to do so in the name of sustainability, consumers need to generate this demand and governments need to provide incentives. The growth of coal is thanks in large part to federal regulations after the energy crises in the 1970s, and is certainly linked to the issues of energy independence previously seen with natural gas. Indeed, coal production ramped up heavily around the 1970s, and began to decline slightly only in recent years. As Carter said, “I would rather burn a ton of Kentucky coal than to see our nation become dependent by buying another barrel of OPEC oil” (Martinson 2015). Considering that coal is the “dirtiest” fuel in terms of greenhouse gas emissions, certainly no small amount of environmental damage was linked to issues in regulating natural gas, which was influenced by politicians, consumers, companies, and was ultimately begot by its very own gaseous nature as discussed prior.

New, cleaner technologies may not smoothly fit into the nation’s modern energy framework as natural gas did. New technologies should utilize energy sources that are as easily transportable, or modular, and may face regulatory challenges just as oil, natural gas, and coal did in their early stages. This is already being seen in the development of wind turbines and solar panels. Solar energy is inherently limited by the amount of sun that falls in an area; wind turbines are only efficient in various pockets of the U.S., limiting its distribution to the national grid. These two properties pose challenges to consumers and producers alike, as they preclude development of energy on such a distributable large scale as natural gas. If solar cells installed at houses become the norm for energy production, the burden of bearing energy costs will go into purchasing and replacing effective solar panels rather than drawing off of the mainframe. If the

prices of solar cells suddenly skyrocket (due to, say, a trade embargo that severely restricts access to a rare element needed to construct the cells), the network of energy consumers is severely disrupted. Low-income households would particularly be impacted if they are unable to afford a vital piece of technology needed to generate power for their house. Thus, the idea of energy independence is inextricably linked to American goals of achieving carbon neutrality & sustainability. Furthermore, note how this dependence arises from the nature of the technology; the same problem would not exist for natural gas, as there are sufficient supplies and stockpiles of this easily distributable fuel within the U.S.

Central to the energy production network, and in some cases more important than the people involved, is the energy source itself. Therefore, in considering future renewable energies, the people of the U.S. must carefully choose what technologies to pursue, as these will influence future policy via technological momentum and inherent limitations of the energy. These energy sources should be resistant to trade disturbances, widely distributable, and reasonably regulated to have accessible cost barriers.

Other considerations include the role of the government. To promote development of cleaner energies, especially for those that are not yet commercially viable, the government can provide financial incentives. In an ideal democratic society, if there is a public desire for policies that favor cleaner energy, then the complex interplay among representatives and their constituents should naturally lead these policies to be passed. This is complicated, however, by the introduction of processes that artificially undermine the process. Lobbying is not an inherent evil, but can introduce gray area where the democratic process is excessively tipped in favor of wealthy corporations – which, notably, generate money from the wills of consumers, and thus represent aggregate opinions in some sense. Regardless of the role lobbying plays, sensible

energy policy depends on the successful application of the lawmaking process, which itself has been seen to be sometimes contradictory. Despite all the complicating factors – politics, demands from industry, demands from consumers, limitations of technology – the system is ultimately designed to reflect the will of the people, for better or worse.

This paper has examined the many human and non-human actors who compete for influence in the U.S. energy network. By utilizing actor-network theory and examining how such a network acted in the *Phillips Petroleum Co. v. Wisconsin* case, this work showed the inherent stability of such networks in accommodating for the various positions held by actors, except for when the political process is undermined. The work also identified the importance of the energy source itself in the network, especially in constraining usage by companies and customers, and subtler ways in policy is influenced by the nature of the source itself.

The project is limited in its scope, as it mainly examined the historical development of natural gas. Future work should examine a broader scope of cases and the history of other important energy sources, especially petroleum and coal. Furthermore, the case studies presented in this work represent events from many decades ago. Hence, other studies should apply the arguments in this paper to more modern experiences to assess whether the same conclusions apply.

Conclusion

The network of energy producers and consumers in the U.S. is inherently a stable institution, but is disrupted when the democratic process is undermined. In this case, the push-pull relationship of consumers and companies is unduly pushed toward one side or the other; this has consequences for energy policy, and has previously contributed to heightened development

of coal – the dirtiest fossil fuel. The physical properties of the energy source itself is crucial, and constrains the applications and desires for industries and consumers alike. Finally, the government plays an important role in incentivizing development of sustainable energies – provided there is enough consumer interest, that companies are capable of finding suitable energy sources, and that the system is fairly adhered to. The most important concepts to successfully develop sustainable energy are hence to prioritize development of energy sources realistic enough to avoid political complications, while ensuring that the democratic system is as fairly adhered to as possible.

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