The Culture of Energy: Innovation, Society and Energy Security

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Abstract

Energy culture describes the reasons for the choice of energy technologies in a location. Culture is a compilation and evolving host of processes, reflecting a territorial perspective, resources and history to shape how changes to technologies evolve to meet social and economic needs. This paper is based on three concepts that expand the theoretical construction of energy culture. This attempts to encapsulate the inter-relationships between technology *innovation, geopolitics and energy justice*. Society's interpretation of equitable access to energy services is expressed through energy justice, which influences the choice of technologies and the focus of innovation efforts and geopolitical expressions of power. Energy culture shapes the foundational structure of the state and domestic and international expressions of authority, including attempts to meet societal expectations of energy resources and services. Three brief case studies on Eastern Europe are reviewed through the energy culture lens: Hungary, Lithuania and Poland. This includes a broad overview of Soviet efforts to modernize the energy system; and later efforts within the EU, to implement regulation as a means of market control. The findings demonstrate how countries in Eastern Europe balance demands over their sovereignty and provision of energy resources and services at least cost.

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1 Introduction

Energy culture describes the reasons for the choice of energy technologies in a location. Culture is a

compilation and evolving host of processes, reflecting a territorial perspective, resources and history to

shape how changes to technologies evolve to meet social and economic needs. This relationship between resources, technologies and society affects the type of energy technologies, relations with firms and the innovation systems of countries. This paper is based on three concepts encapsulating the inter-relationships between technology *innovation, geopolitics and energy justice*. First, the choice of energy technologies extends to how and why nations *innovate*. Second, a country's geography, including energy resources, along with domestic and foreign political-economic actions influence geopolitics, expression of power, and choices around energy technologies. *Geopolitics* influence both the geographic and political reasons for choosing energy resources and technologies. Third, society's interpretation of equitable access to energy services is expressed through *energy justice*, which influences the choice of technologies and the focus of innovation efforts and geopolitical expressions of power. Energy culture shapes the foundational structure of the state and domestic and international expressions of authority, including attempts to meet societal expectations of energy resources and services.

This cultural legitimacy for energy technologies, reflects the normative values of societies, how problems and solutions are identified, and society's pursuit to improve the energy system, and reduce the environmental damage. It is argued here the choice of energy technologies is both a bottom-up and top-down process. Society and the embedded normative values of society propel and require technological and legislative solutions to address social injustice. This bottom-up approach confronts political actions driving the top-down geopolitical actions with control of resources and technology. The culture of energy shapes the economic, political and social landscape of countries.

Energy is an interdisciplinary topic with each academic discipline bringing its own sets of assumptions and analytical tools. This necessary process provides in-depth detail relevant for understanding why and how parts of the energy system are impacted and impact selected areas such as society, law or the environment. Nonetheless, missed is the opportunity to see interconnected elements impacting and interlinking each of these silos. The involvement of the social sciences into a more direct understanding

of the energy system opens-up a greater understanding of socio-political and political-economic interlinkages. Epistemologically, this approach uses energy as a framing device to draw together different academic disciplines that hold the state central in delivering social justice through the provision of investments into technologies and protection of state sovereignty. The term energy culture sets out to advance this interdisciplinary perspective by offering to frame diverse and rich sets of literature around a simplified concept that expresses evolutions in society, technology, economics and politics.

Empirically, this paper will focus on Eastern Europe and its energy policies within the European Union and relations with the Soviet Union and Russia. Studying Eastern Europe enables local interpretations of energy justice to be contrasted against more universal proclamation of EU linked neoliberal regimes (LaBelle 2009), energy security powerplays, and explain more how post-socialist countries "have experienced a much more complex and variegated path of energy restructuring, underpinned by issues of power, space, path-dependency and place-making" (Bouzarovski 2009, 461). Energy culture provides the grounding and theoretical depth to interlink the three biggest themes running through current energy transitions literature: innovation, energy justice and geopolitics.

This paper examines specific examples within three Eastern Europe countries attempt to balance energy justice, geopolitics and the choice of energy technologies. Energy geopolitics in Poland demonstrates the importance of energy security shaping the choice of energy technologies. In Hungary, nuclear power and natural gas are chosen to deliver low cost electricity and heating within a country with limited natural resources and limited capacity for innovation, while marrying the country to Russia for generations. In Lithuania, the forced closure of a nuclear power plant by the EU, reduced domestic generation and forced it to open its energy system to EU neighbors and the world, while reducing ties to Russia. In all three cases, the chosen energy strategies addressed a lack of domestic innovation, resources, geopolitics and a need to deliver low cost energy to society.

The definition of energy culture is described and outlined in the next section. Why and how culture is central to understanding energy as a component of the modern state is described. The benefits of framing energy culture in terms of service to humanity and the environment is described as essential for transforming the present energy system to an environmentally sustainable system. Energy culture is broken down into three main parts, 1) the state and geopolitics; 2) energy justice; and 3) national innovation systems (NIS). These key parts (as described above) enable energy culture to remain rooted in academic debates while contributing to an overall perspective that interlinks society and the state within the benefits of the energy sector. The third section outline three brief case studies on Eastern Europe. First, a broad overview is given of Soviet efforts to modernize the energy system; and second, efforts within the EU to implement regulation as a means of market control demonstrate how countries in Eastern Europe balance demands over their sovereignty and provision of energy resources and services at least cost. The final section (section four), breaks down the tripartite of geopolitics, justice and innovation to explain application to the case of Eastern Europe sitting between centers of hard and soft power, each expecting Eastern Europe to conform to their wishes. Energy culture provides the term to begin to understand these interlinkages.

2 Components of energy culture

2.1 Defining Energy Culture:

This article will operationalize energy culture by connecting it to three overarching themes running through energy transition studies: innovation, geopolitics and justice. The selection of these three themes provide categories to group much larger and diverse sets of literature and elements of any energy system, spanning from resource use, engineering to legal studies and societal issues. Energy culture becomes a term representing a range of scientific and socially accepted practices related to state and societal structures.

The literature used to explore energy cultures is primarily based in recent understandings of energy transitions. Nonetheless, much of this literature deals with a political-economic perspective of a neoliberal world infused with a neo-Marxist understanding of the state, tied to regimes and market regulations. The empirical analysis in this paper deals with a period in history of Communist countries and societal and political norms developed during this time period. Rendering analysis based on Western capitalist thought difficult to interpret over a post-World War II energy system in Eastern Europe. Therefore, energy culture – while not precluding this literature – must find a way to sit atop these theoretical perspectives and then engage with them in a post-1989 energy system dominated by the EU. Therefore, 'culture' provides a semantic construction that both signals a timeless meaning and can represent periods of time within society.

Energy, likewise – holds the same semantic construction in both timelessness and rootedness in time and place. The impact of modern energy system the world grapples with today, was born at the time of the Industrial Revolution where there was a twin process of understanding society, "as something which was both more than the mere sum of its constituent individuals and different from the state in which it was constituted" (Knutsen 1992, 128) and the establishment of the sovereign rational state, away from an organization around a monarchy and towards state "institutions which claimed to represent the people" (Knutsen 1992, 129). The Industrial Revolution fueled by coal and iron developed at this same time. Nowadays, we have returned to a similar twin development that unifies the world, addressing the Anthropocene – as a result of Industrial Revolution, and a societal attempt to build an economic system void of carbon emissions. Theoretically, the term energy culture embraces the optimistic wonder of innovation and transformation of the natural and social worlds present at the start of the industrial revolution, without theoretically accounting for the rise of capitalism or communism, but focusing on the process of innovation regardless of political systems. Rather than class or regimes providing tension within the development of the state, it is the provision of energy which serves as the central unifying

force of the organization of state and society, including the use of armies to express and maintain geopolitical power.

Energy culture is based on building the structure and access to energy provisions for society. For Nobel Leurate, Wilhelm Ostwalds', writing in 1908, "*The general task of culture as a whole consists in ensuring the most favorable transformation*" of energy (Stewart 2014, 344). This conversion is not just a mechanical or a thermal process, it is a *cultural process* where individuals and society play an essential role in contributing towards efficiency gains. Ostwalds states, energy in the world is finite, the most effective means to alleviate human suffering is to improve yields from gains in efficiency. The calculations of an experienced engineer or the resolution of a political problem by a "statesman," demonstrate more efficient utilization of energy. These are ethical acts for the common good of humanity. "If it were possible to invent a transformer that would yield only a few per cent more, that would bring the working classes more relief than all the welfare institutions in the world" (Stewart 2014, 344). We know from attempts to tackle the causes of climate change and efficiency gains in products like cookstoves or LED lighting, efforts in engineering and policy implementation transform lives and reduce energy resource use (including the inventors of LED technology winning the Nobel Prize for Physics in 2014). Energy culture provides a means to understand interlinked behaviors and efforts.

Essential to understanding energy culture are the supporting conceptual elements that alter and change over time – just as culture continually changes. The three themes of innovation, geopolitics and justice are *processes*. Innovation, "in contrast to the concept of technology… cannot be transformed into an object since it is a process", loaded with uncertainty and highlighted by opportunities (Nowotny 2006b). Likewise, geopolitics is a process highlighted by conceptual interactions around physical resources, territories and armies. Justice, prescribes the social and institutional process of interaction within and between states (Harvey 1996). Linking these processes is technology, which binds to energy – driving the innovation process, geopolitical maneuvering, and the pursuit of justice to gain access to the

benefits of technology (or protection from its impacts). Energy culture encapsulates these complex processes around technology driving gains (or losses) in efficiency affecting society and the environment.

Updating Ostwalds' energy culture places the environment more central to efficiency gains, while maintaining the strong social element for change. *Environment and society* is the reason for change; the method of change resides within the positive motive of innovation between state and society. Thereby, "Innovation signals the positive direction where the unknown is to be found" (Nowotny 2006b). It is this positive outlook of unknown solutions that drives engineers and policy advocates to innovate in all areas of the energy system. Technology and innovation play-out as positive and future orientated elements, even if later there are negative side-effects. This embedded cultural element provides an emotive driver to transform technology to better serve society and the environment. Technological innovation is connected to socio-political choices.

> Cultural struggles in innovation journeys are thus played out as 'technological dramas' on the public stage with actors aiming to influence the perceptions of relevant 'audiences' (who provide resources, support, acceptance etc.)(Geels and Verhees 2011, 913).

This cultural legitimacy for technologies reflects normative values of societies and how problems and solutions are identified including societies' environmental perspectives (LaBelle 2017a, 28). Public perceptions and interactions with technology serve as the basis for developing a definition of energy culture.

The definition of energy culture is, embedded systems of knowledge, behaviors, beliefs mobilizing state and private resources within a geographic area, through a process of intent to innovate new energy technologies and business platforms, improve security and practices benefiting society and the environment. Previous joint usage of 'culture' and 'energy', provide a starting point for developing a definition and applying energy culture to understand technological choices. This definition is informed

by a diverse range of studies prioritizing culture as shaping energy use and justifying technology choices (Sheller 2014; Stephenson et al. 2010; B. K. Sovacool 2016; Hadfield 2016).

The term, energy culture is used to emphasize concrete goals and organizations of practices and knowledge. Sheller, defines energy culture within 'mobilizing state and private resources' into an "assemblages of matter, energy, practices and meanings…embedded in ongoing processes," such as the second industrial revolution involving electricity and electro-chemical processes producing aluminum (Sheller 2014, 134). Sovacool, develops an energy security perspective by examining five categories to identify priorities of people across countries (geographic, economic, political, professional and epistemic), thereby reflecting their own cultural perspectives around security. (B. Sovacool 2016, 812). This security perspective also informs actions at a state level of patterns of behavior and habits, such as the 'strategic energy culture' between the EU and Russia which perpetuates past energy relations (Hadfield 2016). Energy consumption habits, for Stephenson and others, are the building blocks for a cultural framework based in knowledge, beliefs and behavior to explain patterns of energy use (Stephenson et al. 2010, 6123). Culture, is the common element running through deeply rooted societal energy practices and state relations, influenced by and around, resources, security and technologies.

Missing from the above definitions is the environment as a motive of change. Each of the above approaches to energy culture holds the centrality of the state over habits and relations attached to economic relations. The mandate for governing energy systems reside at the nation-state level; it is here where significant decisions are made to avoid climate change (Cherp et al. 2018) and ensure security. The impact of climate change (and associated negative environmental impacts) results in the environment acting as an equal motivator as economics to deliver benefits to society. Conversely, a lack of action on the environmental impact of our energy system negatively impacts society and the economy. Thus, societal development is linked to technological innovation to solve environmental and economic problems. Or conversely phrased, innovation provides opportunities to address

environmental and economic challenges to improve society. Cultural struggles perceived through 'technological dramas' (Geels and Verhees 2011, 913) provide opportunities to improve energy cultures in societies through increased access thereby, for Ostwalds, "ensuring the most favorable transformation" (Stewart 2014, 344) towards a sustainable and equitable energy system.

2.2 The state and energy

The centrality of the state runs throughout the modern energy system: power plants are not built, building codes are not implemented, central heating systems are not installed, wars are not waged without the consent of the government. The state is the arbitrator of societies, including energy practices and habits. Both democratic, and autocratic states decide on the type of resources and technologies consumers use to meet their energy needs. This perspective clashes with a consenting state cooperating within a multilateral organization through a governance mechanism of common interests, such as the EU. An epistemological difference in approaches emerges between a hard-power, a realist perspective (in terms of security), and a normative, soft-power approach in transformations of infrastructure and global energy systems; this is identified between centrality "of security and geopolitical dimensions, … versus those that prioritize market relations and co-operation," (Bouzarovski, Bradshaw, and Wochnik 2015; Westphal 2006), or rather a realist government approach versus a normative governance approach.

The approach taken in this article is the preservation of state power over technological energy choices with conditional acceptance of governance as a means to organize commercial energy markets around commodities. The state structure remains relevant for encouraging or discouraging long-term acceptance of an energy technology, rather than giving up sovereignty through a governance mechanism, (see LaBelle and Goldthau 2013). Within the EU the choice of power generation is controlled by governments, (exemplified by contestations around nuclear power) but operation of power markets is strongly regulated by the EU.

2.2.1 Geopolitics: Hard and Soft Power

Hard and soft-power is present in different forms. Goldthau and Sitter apply these distinctions to energy security (Goldthau and Sitter 2015). Soft power is expressed in EU regulations and market access. Because of the market size it is an attractive as a place to do business. Soft power relies on attraction to obtain the desired outcome (see Nye 2008, in Goldthau and Sitter 2015, 5). EU Governance reflects control over rules and regulations of commodities and markets. An example of this in the EU, is institution of ACER, controlled by the European Commission and setting the rules and regulations over European gas and electricity markets. It arranges and monitors national and regional wholesale energy markets, including terms for transit of gas and electricity between and through countries. This soft power of governance may be a political-economic 'weapon' for the EU to pry open national markets and project power abroad. The neoliberal perspective also conforms with the use of ideological powers to express soft power (see Nye 2004, Lukes 1974 in Goldthau and Sitter 2015).

Hard power, is supported by military and economic force. States, and government, express hard-power through control of institutions around energy infrastructure, through economic means (Nye 2004), and permitting processes which decide or decline building infrastructure. Indirect forms of hard power "include the ability to shape the settings in which actors operate (institutional power), the very identity of social actors (structural power), or even the way global politics is interpreted and given meaning (productive power)" (Goldthau and Sitter 2015, 6). Interpretation of geopolitics and transfer of this vision to domestic energy policies and technologies, therefore is central in the state's expression of hard power. Other expressions of hard power include bilateral energy contracts, support for state or private national energy champions (Goldthau and Sitter 2015, 8). Hard power is expressed in both an active means, in building infrastructure, and in an inactive means, not building infrastructure, such as 'foot-dragging' over multi-lateral beneficial projects such as interconnectors (and their size) or LNG facilities. The state controls economic activity on its territory, including how and what infrastructure operates.

Hard power in the energy sector is expressed through the relationship between the EU and Russia over access to resources and technologies. On one hand, the EU exercises soft power over market access, in energy sector this is an attempt to counter Russia's exercise of hard power in Eastern Member States. Drawing on Halfred John MacKinder, Heartland theory, a view can be developed how Russia (and the Soviet Union) use natural resources (such as gas) and technology (such as nuclear) to extert influence. The rich natural resources the Eurasian landmass provides, hard power and influence to an equivalent level to those countries exercising sea power as a means of influence (such as Great Britain) (Mackinder 2004). Energy resources directly input to the economic health of a country.

The strategic construction of Soviet pipelines demonstrates the use of natural resources and infrastructure to influence the actions of other countries by relying on this lower cost land-based approach. The economics of gas, and the delivery method, become hard power projections within strategic relationships between countries and companies. The price of gas is essential for the economic and social needs of a country, and in particular for Eastern Europe, integration into the Soviet energy system continues to this day with Russia. Therefore, hard power projections influence the price of inputs into Eastern Europe's energy infrastructure, such as the cost of heating and nuclear power; soft power projections influence market operations, trade between countries and the price of commodities delivered to businesses and households. Sovereign power resides in an EU member state in the area of oversight and the choice of technology.

Soft power is a reflection of an "energy-governance-territory nexus," using transformative regulations by opening-up national markets and controlling the operation of infrastructure on the territory of a Member State (Bouzarovski, Bradshaw, and Wochnik 2015, 219, 226). Nonetheless, the state controls the type of energy infrastructure on its territory through a broad range of regulatory institutions (e.g. environmental and safety). The state allows soft power (governance) of commodities with supranational regulatory control of markets (such as the EU) but maintains control over the choice and location of

energy technologies. This control can even extend to bidding procedures over capacities of the infrastructure, such as gas pipelines.

Technical rule making and coordination lends itself to the concept of technical, or technocratic governance (This can also be referred to as Regulatory Capitalism, see: Levi-Faur 2009, 2011a; Levi-Faur and Jordana 2005). Regulatory governance emerges as a means to operate the energy system without political approval over technical issues – which ultimately impacts the functioning of energy markets, through technical cooperation and coordination of the underlining rules and regulations. Thus, a strong de-politicization of the operation of the energy sector is attempted.

The rise of the regulatory governance, perceived to be part of a neoliberal ideology (Harvey 2005) is tied to the development of transnational National Regulatory Authorities (NRA) networks and the diffusion of knowledge and best practices (Eberlein and Grande 2005; Eberlein and Newman 2008, 33,42-43). The focus in the literature, to date, has been on the regulatory networks in the EU (Eberlein and Grande 2005; Eberlein and Newman 2008; Levi-Faur 2011b; Coen 2005; Coen and Thatcher 2008). Importantly, advances in regulations are dependent on connections to other state institutions (Knill and Lehmkuhl 2002, 47). "Even 'independently' constituted regulatory authorities are shaped by their relations with other national institutions and actors." (Eberlein and Grande 2005, 97). Therefore, the energy culture within a country is also important to understand when considering the role of regulatory governance and the political independence exercised.

The state remains central in the exercise of soft and hard power. The state holds experience dealing with both forms of power. For society, there is a history of a normative cooperative approach, such as state institutions addressing societal pressures over choosing energy technologies aligned with particular values. This cooperative approach can be translated internationally, to deal with similar pressures within a multi-lateral framework where governance requires a cooperative relationship. In this

relationship, the state remains the central player that permits or excludes practices and investments into and around energy technologies. It is national cultures, interpretations how to protect the environment or security that influence policy choices, innovation and infrastructure on state territory and interactions with external actors (B. K. Sovacool 2016; Walsh 2012). The organization of the energy sector matches to society's cultural expectations. This territorial authority is expressed through state institutions ability to assist and punish industries through the power to regulate; it gives permission through domestic policies for technologies to participate in the national energy system on its territory (see LaBelle 2017a, 28; Freeman 1995). Soft power and hard power, (a normative governance approach and realist government approach), these sets characterize competing approaches to state theory and serves as a means to differentiate authority within the energy sector.

Table 1 Description of organizational and power structure of state relations

Institutional arrangement	**Organizational structure**	**Epistemological approach**	**Empirical expression of power**
Multilateral organizations	Governance	Normative	Market and commodity organization
Power expression	Soft ↓		
	Hard ↑		
State	**Government**	**Realist**	**Regulatory and Sovereign-territorial power, seen in energy infrastructure and institutional mandates**
Power expression	Hard ↓		
	Soft ↑		
Nation/Society	Governance	Normative	Energy technology and innovation choices

Table 1 summarizes how the institutional arrangements of the state, society (or the nation) and multilateral organizations (such as the EU) influence state actions in the choice of energy technology, innovation styles and organization of commodity markets in a governance structure. The influence in these spaces is soft through normative policy choices that assist in choosing technologies and organization of commodity markets. The state is at the center and holds to a realist paradigm to assert

its power to regulate, including permission for energy technologies, thereby influencing the type of technologies available on its territory. The expression of hard power, includes the threat of force, places energy security as justification for pro and anti-market actions taken. Energy security, is externally expressed by actions of the state, while at the same time, an equitable energy system must develop that is affordable and accessible to society. The state holds the central role in securing energy resources and technologies for society's uses and to ensure economic development.

2.3 Energy Justice

In economically advanced countries, insuring the provision of energy services is the responsibility of the state. Organizing the marketplace, creating institutions to monitor and shape the rules and regulations energy these are important state functions. The delivery of energy services – at a fair and affordable price – is also within the remit of the state. Just as civil and criminal courts oversee the functioning of society and ensure a common social justice is achieved, the state ensures energy services are provided in an accessible and affordable manner. This can also mean providing assistance to ratepayers having difficulty paying their energy bills. This perception of social equity is enforced by courts and regulatory institutions ensuring energy is provided in a fair and transparent manner to consumers. Since the 1990s, the global rise of energy regulators has ushered in an era where consumer prices are reviewed by an independent board. Regulatory capitalism, relies on regulators mediating between consumers and firms (see above). Institutional responsibility and social expectations of an equitable energy system develops. An overall, 'energy justice' develops because of this institutional structure and moral obligation to provide energy services to all citizens. Heffron et al, identify the concept of energy justice to be intertwined with giving access to new energy infrastructure through policy delivery. Energy justice is spatial and temporal, the societal concepts include "the physically unequal allocation of environmental benefits and ills, and the uneven distribution of their associated responsibilities", related to technology and location and allocation of resources (Heffron, McCauley, and Sovacool 2015, 169). Energy justice is

reflective of deeper concepts of justice developed over thousands of years. Two defining camps of justice emerge, these are universal and particular energy justice with the following attributes, as defined in LaBelle (2017b):

1) Universal energy justice holds to values reliant on historical judicial and philosophical groundings that are based in (a) procedural justice, (b) distributional justice, and (c) cosmopolitan justice (for a discussion of these forms see Heffron et al. (2015), Jenkins et al. (2016), Sovacool and Dworkin (2015));
2) Particular energy justice, is defined as a nuanced accounting of localized issues and interpretations of social, political and economic actions affecting access to energy resources and services. recognition justice, which provides cultural and political representation of groups with distinguishing features such as social, ethnic and gender differences; freedom from distortion, devaluation, degradation and physical threats by other groups (Heffron and McCauley, 2014, p. 436) (cited from LaBelle 2017b).

Bridging universal notions of justice, such as the basic right to energy services with localized (particular) interpretations of justice stems from situatedness and positionality of individuals in society (Harvey, 1996, p. 342). The historical and geographical representation of the state is expressed through national cultures and state institutions (Harvey, 1996, p. 351). Therefore, building a sense of a 'just energy system' constitutes a range of cultural, institutional and historical experiences and structures which are designed to deliver energy services to social expectations.

These institutional structures and interactions developing energy justice within society reflect similar routines and normative influences as national innovation systems. Together, society and the embedded normative values of society propel and require technological and legislative solutions to address social injustice: This argument shifts the locus of innovation from a neoliberal-corporatist affair to a socially and state driven construct that demands technological solutions to perceived social problems where the state, due to its strong central role, is in a position to coordinate.

Energy cultures are based on social agreements over specific technologies. A more broadly framed cultures of technology, "highlights how social interaction is mediated through technologies, and how technologies can only function when embedded in societal institutions" (Bijker 2006, 54). Energy

technologies draw upon the same interactions with society to give legitimacy and shape further interactions and policies of institutions. Energy justice provides a perspective that holds core societal values at the center of national energy (technology) cultures. Through an energy justice lens, 'technological dramas', are played out; whether over nuclear power or shale gas, society holds the right to decide on the type of energy technologies and the function these technologies play in satisfying social objectives. "Energy justice is a precondition for the realization of social justice" (B. K. Sovacool, Sidortsov, and Jones 2013, 47). The development and deployment of technology is wrapped into the form of the state and social innovation rather than just the innovation of new technologies. Social justice, and in-turn, energy justice, is tightly connected to broader national systems of innovation, rolling out new forms of energy technologies to meet user needs.

2.4 National Innovation Systems

Despite the focus of NIS on technology and the state, "social innovation might become more important for the wealth of nations than technical innovation," because, "established organizational and institutional patterns might prove to be important obstacles to the exploitation of the full potential of new technology" (Lundvall 1988, 366). Freeman (1995) points to the drive for social and democratic change by Gorbachev in the USSR. NIS provides the means to reflect on the role of the state, for example to reflect on the shifting and collapsing socialists/communist regime in the Soviet Union and Eastern Europe. It is here, where the distinction emerges to apply NIS with a strong social focus, which helps explain present trends and divisions between Eastern and Western Europe, despite the attempted unification of Europe through the EU.

Capitalist countries, focus on "manipulation of financial variables" to accelerate technical progress, in both developed and developing countries, there is a strong "need for social innovation and institutional change," (Lundvall 1988, 365) to accommodate technological changes. Technology is only one part of a broader social and political equation to improve the livelihood of society. Culture encapsulates these

myriad processes of change towards developing an innovative state effectively interacting with society and other countries, meeting the needs of users. Qualitatively, a NIS approach goes beyond a quantitative approach to explain innovation, diffusion and productivity gains in technologies; the Soviet Union and other Eastern European countries demonstrate greater R&D resources but this did not guarantee success (Freeman 1995, 11).

Innovation of energy technologies is dependent on networks of knowledge. Just as geography, geopolitics and perceptions of justice influence the development of certain technologies in a country, so are cultures of innovation dependent on national knowledge networks. *Innovation* describes both the chance and planned discovery and development of a technology, or way of doing business. Innovation in the energy sector is dependent on institutionalized routines and regulations; pushing or channeling technologies and services to advance or fulfill social or political objectives. Engineering innovative energy technologies is a portion of the innovation process. Full deployment of a technology or service is also dependent on political and social acceptance (LaBelle and Goldthau 2013), or at a minimum, a lack of barriers to deployment.

Cultures of energy innovation are marked by normative influences embedded into institutional relations, rules and procedures. This structuralist perspective provides a theoretical construct to understand how state structures (institutions) “influence an actor’s cognition and behavior as well as the diffusion of practices, e.g. regulations, norms, values, culture, actors or practices” thereby assessing how actors decision making is contingent on institutional logic and arrangements, which reflect broader social “beliefs, norms, values and practices” in dominant societal institutions” (Fuenfschilling and Truffer 2014, 774). This largely social construct places society in a dominant position which approves or rejects technologies.

Energy cultures are entrusted by society to institutional logics to deliver socially acceptable technologies which fulfill social (and environmental) expectations. In this paper, the examination of state institutions and internal logics is expanded outward to assess institutional activities. The National Innovation System of the state becomes a measurement of expertise and ability to deliver to market cutting edge technologies and services. NIS, provides a means to conceptualize and bridge national styles of innovation in energy technologies with the socially constructed state institutions (which also act to deliver socially accepted forms of particular energy justice). NIS, are rooted in common systems of production and innovation; labor, knowledge, and even the institutional structures that assemble and foster interactions are less easily transferred across borders (Lundvall 1988, 360–61). “National economies have idiosyncratic technological capabilities,” with cultural proximity of geography, language and perceptions of home markets, which may extend beyond the nation-state and include other countries with strong historical ties (Lundvall 1988, 360).

NIS provides the tools to analyze differing energy cultures. It places the state central to the innovation and production process; government is central to economic development rather than an international system of governance which is perceived to erode sovereignty (see above). Central to NIS in the 1990s, is that “external international connections are certainly of growing importance, the influence of the national education system, industrial relations, technical and scientific institutions, government policies, cultural traditions and many other national institutions is fundamental” (Freeman 1995, 5). The state, as container of society and innovation systems provides structure to foster innovative energy technologies to potentially match the demands of society, however, it is another question *how well* these demands are met.

Broader interactions in the cultures of technology (Nowotny 2006a) demonstrate how national institutions shape policies, opportunities and firm capabilities in developing new technologies. “Thus, the emergence of new technologies is situated in a collective enterprise involving firms, government

organizations, universities and consumer groups, such that firms not only engage in economic activity but are also involved in social relationships" (see Swaminathan and Wasde 2001, in Vasudeva 2009, 1249). Energy cultures encapsulate the delivery of technological solutions for societal benefits because of the impact energy infrastructure holds for societies. Both innovation and justice are dependent on the shifting cultural landscapes they inhibit both globally and locally. Cultures of energy become encompassing of societal and institutional interactions affecting how innovative technologies and forms of justice are delivered to meet social demands.

2.5 Discussion of Energy Culture

The pursuit of social innovation to improve the wealth of nations (Lundvall 1988) echoes Ostwalds' call for a cultural process of contribution. Individuals and society need to build more efficient energy systems due to the social and economic benefits to society (Stewart 2014). In addition, the tripartite process of geopolitics, justice and innovation push society, the state and technology in a direction to deliver more efficient energy technologies to reduce the environmental impact. Both society and the environment benefit by the pursuit of more sustainable energy systems. Uniquely, energy culture is an assemblage of national practices and meanings embedded in the tripartite processes of the state, which is territorially rooted. Energy culture stems from the idiosyncratic [citation??] socio-techno relationships developed over the history of a country.

Empirically, this paper set out to develop and define the concept of energy culture to be applied in national setting. The definition draws on key sets of literature that focus on energy transitions, energy justice, energy security and geopolitics, and NIS. On the surface this is an eclectic and novel mix of recent and mature literature. However, as demonstrated in the review, state structure and society are at the heart of processes that result in continual change in energy technologies meeting the evolving

needs of society, such as security and justice. The impact affects access by citizens to energy services and international relations between states.

Theoretically, accounting for the authority of the state is important to link energy justice and innovation processes. Through this perspective, authority over different areas of the energy system are either retained by the state or given over to multilateral organizations. The expression of soft and hard-power emerges as a modern adaptation to facilitate the flow of commodities in markets (such as oil and gas) while the state retains the right to control energy infrastructure. This perspective over state authority is important to link central concepts of energy justice with innovation (expressed through NIS). Energy justice is divided into universal (cosmopolitan) and localized (particular) concepts of justice. Innovation systems, described by NIS, are localized and globalized, Innovation is both embedded in national institutions of knowledge characterized by production unique to each country, while technology is global in nature and goes through a process of international diffusion. Jointly, energy justice and technical innovation seek to enlighten, and answer the call of Lundvall (Lundvall 1988) to create a system of social innovation serving as a primary driver for national development rather than just technological innovation to increase economic growth (improving technology for technology's sake).

Application of this theoretical construct of energy culture to an empirical case study can draws on the experiences of Eastern Europe and their mix of Communist and free market experiences since 1990. Institutional legacies of Soviet planning married to EU neoliberal multilateral structures provide an opportunity to view embedded social and institutional practices adapting to market forces and governance mechanisms. Energy technologies, such as nuclear are reliant on international scales of cooperation, while energy resources, such as gas, are reliant on international networks of pipes. Both are also reliant on national cultures for acceptance or rejections of technologies and resource integration into national energy systems. Eastern Europe is reliant on Soviet era technologies and resources but fused into an EU system of regulatory governance. Social innovation on the part of

politicians and citizens requires finding a balance between deeply rooted social behaviors and practices around energy technologies (Communist) and meeting the financial requirements of competitive markets (neoliberal). Energy culture provides a concept to organize and examination the *embedded systems of knowledge, behaviors, beliefs mobilizing state and private resources within a geographic area, through a process of intent to innovate new energy technologies and business platforms, improve security and practices benefiting society and the environment* (the definition of energy culture).

3 Energy and government in Eastern Europe

Reflecting back to the East-West division that dominated Europe during the Cold War is important to provide us with a sense of diverging social and economic spheres. In the 1980s, the General Secretary of the Soviet Union, Mikhail Gorbachev and President Reagan pursued a strong bridging strategy. That is Reagan played the stern bargainer, while Gorbachev sought to loosen the cultural and centralized economic chains constraining economic growth in the Soviet Union and the Eastern COMECON countries. COMECON was set up in 1949, as an economic counter weight to NATO. It served as a driving force in the building of gas and nuclear energy infrastructure cementing economic and political relations between the Soviet Union and other COMECON countries throughout the Eastern Bloc. Thus, the energy infrastructure influencing today's political landscape in Eastern Europe is a relic of this Cold War division.

The high energy intensity of the Eastern Bloc countries also meant a huge amount of financial resources were expended to support unsustainable energy development. The entire Communist sphere was ripe for modern western technologies, management skills and individual liberties to allow citizens to pursue their own economic paths. In the 1981 – 1985 period, the Soviet Union planned to allocate 85% of all new investment money to energy projects, drilling new oil and gas fields and building pipelines westward (Gustafson 1989, 36). Subsidized gas pipelines and nuclear power plants in Eastern Europe all

necessitated these energy and economic ties to the Soviet Union. Gorbachev attempted to manage a social and economic opening. The rapid failure of the political-economic system underscored the social tension with the imposed political system. After the political and economic collapse of Communism Eastern Europe opened to the west to try market capitalism, resulting in an inflow of FDI along with industry experts and financial institutions.

The Soviet satellites of the COMECON countries developed significant levels of interconnections for electricity between countries, while gas was distinctly piped directly from the core of the Soviet Union with little interconnection between Eastern European countries. Although this transmission structure should be viewed here as an engineering feat rather than a geopolitical design of infrastructure. Entrusting Ukraine with Soviet gas transmission to Europe would only later turn geopolitical, as the 'reclamation' of Crimea by Russia. Integration of cross-border infrastructure was engineered in the East for security of supply and later viewed as a geopolitical weapon, once these countries joined EU and tensions with Russia increased. During the 1980s, in the West national markets were largely protected and generation was heterogeneous compared to eastern Europe's almost homogeneous reliance on nuclear and coal as common sources; national mixes dependent on natural resources, such as hydro power or natural gas.

The Cold War system of outputs, both in Eastern and Western Europe, was based on government political decision making of both defense and building-up national systems of technology industries (such as nuclear and coal). The end of the Cold War brought about a shift towards integration between the two halves in Europe and an attempt to foster a unified energy market. Dampening down national political interests in the energy sector was done by shifting oversight to the EU level and reliance on Directives pushing through EU and national institutions, rather than national parliaments. A brief review of three countries' energy systems demonstrate this shift of resource and technology intensity to meeting EU Directives on market structure.

3.1 The Energy Union: Energy governance

The Energy Union Package issued by the European Commission in the winter of 2015, attempts to build an Internal Energy Market (IEM) by boosting energy security through market integration. "The key drivers of energy security are the completion of the internal energy market and more efficient energy consumption"(European Commission 2015b, 4). To accomplish the task, the Commission lays out the regulatory governance mechanism that will put an end to 28 national regulatory frameworks (European Commission 2015b, 3). The central actor in driving the IEM forward and eroding market separations is the Agency for Cooperation of Energy Regulators (ACER). “The Energy Union also needs an integrated governance and monitoring process, to make sure that energy-related actions at European, regional, national and local level all contribute to the Energy Union's objectives.” P 17 (European Commission 2015b)

The regulatory approach, represented by ACER and NRAs, holds significant potential for implementing key agenda points for the Energy Union. Unification with common standards is the pursuit. To accomplish the task, the Commission lays out how ACER will achieve coherency across the 28 Member States and differing regulatory environments by building the IEM. The IEM also serves to boost energy security (European Commission 2015b, 3). Nonetheless, market and regulatory failures are cited as leading to a situation where “an unacceptably high percentage of European households cannot afford to pay their energy bills” (European Commission 2015b, 3). The Energy Union pursues a coherent IEM to improve both energy security, and reducing inefficient costs and consumption of energy.

In 2016, The European Commission launched an energy security package that for the first-time linked energy efficiency to energy security. Consolidating more authority in ACER and to oversee a technological transformation in the EU’s heating and cooling systems are top priorities fitting within the concept of the Energy Union. The connection between the heating and cooling sector are linked to the level of gas consumption, “59% of total EU gas consumption (direct use only) – which equates to 68% of

all gas imports" (European Commission 2016). This is particularly relevant for Eastern European countries who import large quantities of gas for residential heating. In the view of the Commission, financial outlays for energy services for households can drop from €1500-2000 to €300-500, based on switching to heat pumps and solar water heaters (European Commission 2016). The explicit policy connection between energy efficiency and energy security is a first by the Commission and may create a confrontation between eastern Member States who are not investing in energy efficiency (this will be discussed in later chapters).

Increasing transparency in the gas sector is also a central element for the energy security package, which heavily involves ACER. In the view of the Commission, "Energy policy is often used as a foreign policy tool" (European Commission 2015b, 6); the Commission seeks to defuse this by *ex-ante* review of intergovernmental agreements; this would specifically target Russia and mainly Eastern Member States. NRAs would also hold greater authority to review private gas transactions impacting regional security of supply (Portfollio.hu 2016; European Commission 2016). Thus, boosting the role of energy regulators. In regards to moving towards the IEM, nine energy regions would be created with each country agreeing to assist the other in a state of energy crisis. In the short term, this would expand risks within a region, with one country forced to assist (possibly) at higher costs, another Member State. In the long term, this would also prompt countries to work together to build infrastructure to mitigate risks. Thereby fulfilling key IEM criteria. Market integration is the primary goal of the European Commission to create coherency across countries. This is done through regulatory mechanisms implemented and overseen by ACER.

3.2 Sovereignty of energy technology[1]

The increasing powers of ACER highlight the attempt to implement the IEM across Europe. Through regulatory means, conformity to EU Directives requires a realignment and integration of markets to enable the ease of moving energy between countries. In the case of Poland, as will be discussed next, sovereignty still exists over the choice of generation technology and strong unwillingness to pursue a renewable energy mandate. Rather coal and gas are set to continue to dominate the national energy mix. Hungary, for energy resources and technology, remains wedded to Russia to provide oil, gas and nuclear technology which underpin the country's energy system. While market integration of electricity and gas flows is increasing with surrounding countries – integration echoes a similar process previously completed during COMCON. Lithuania, demonstrates a country that shifted strongly towards an EU focused regional integrated market approach, and even now holds a global perspective. After forced closure of the country's NPP by the EU and total reliance on Russian gas, the country choose to connect with neighboring countries and build an LNG terminal. Each of these examples demonstrates a willingness to agree to EU governance demands on market integration. They also show a willingness to continue with previous energy resources and technologies. Only Lithuania, because of the forced closure of its NPP, broke strongly with its previous Soviet era energy system. These case studies are discussed next.

Poland maintains a consistent energy strategy with a political vision and economic strategy to retain fossil fuels while constraining the use of RET; this spans political parties and governments. In 2013, former Prime Minister Donald Tusk (2007-2014) stated, coal and "soon shale gas" will remain dominant with renewable energy sources remaining "limited as much as EU rules will allow" (PHYS.ORG, 2013). In

[1] This section draws on LaBelle, Michael. "A State of Fracking: Building Poland's National Innovation Capacity for Shale Gas." Energy Research & Social Science 23 (January 2017): 26–35. https://doi.org/10.1016/j.erss.2016.11.003.

addition, for energy security, "the exploration and production of shale gas seems to be absolutely crucial" (CBC News 2012). In 2015, Polish elections ushered in a new government, under which; continuity remains with support for fossil fuels and suppression of RET. Poland's Energy Minister Krzysztof Tchorzewski, asserted that the EU's pursuit of zero carbon emissions in the power sector by 2050 is impossible to apply to Poland, stating: "we (Poland) reject that, clearly unacceptable". The sacrifices for Poland would be too great to move away from coal. Rather, Poland will pursue an energy strategy that utilizes high efficiency coal fired power plants that require less coal for power output. As such, the capacity of renewables should be limited to ten percent, as the grid cannot handle more, variable power output reduces efficiency of coal power plants, meaning there is no more room for renewables (Tchorzewski 2016). Therefore, policy continuity in limiting RET and promoting fossil fuels remains.

Poland's future is dominated by fossil fuels. Diversification with gas provides a hedge against high carbon prices and a slight greening of the sector. Poland remains committed to fossil fuels for socio-economic reasons, subverting environmental impacts to larger economic and social goals of economic expansion and social stability. The domestic energy sector is centered on state owned enterprises which are expanding the use of fossil fuels. The latest large-scale project is the state owned LNG terminal in Swinoujscie, Poland, this is now spurring expansion of the domestic and regional gas network. The terminal contributes to increased security of supply (access to global markets) and contributing to fuel diversification.

Historically, Hungary is poor in 'traditional' energy resources. Coal, gas, oil are extracted but of are poor quality or limited. Hungary identified early on [source] essential to boost energy output to grow economically. During Communist period energy projects were areas of heavy state investment. Growth in this sector strongly tied Hungary to Russia in the area of oil, gas and nuclear power. Regional integration with COMCON countries leveled out Hungary's energy imports - including electricity imports.

Hungary operates under a 'scarcity' model, so provide for its own energy needs - even during non-market days, was expensive. Therefore, to achieve greater energy independence was viewed as highly expensive and impractical. Joint projects with Russia and other COMCON countries were viable and affordable solutions to Hungary's pressing energy needs.

In 1958, the National Planning Office stated to fulfill the objectives of the country, "must ensure above all...the development of the energy base" (Berend and Csato 2001, 1:325). 1958 also marked an overall change in approach for the Soviet bloc of COMECON countries, away from national energy self-sufficiency to regional cooperation of COMECON countries (Berend and Csato 2001, 1:326). This decision enabled the building of regional power grid between COMECON countries (Berend and Csato 2001, 1:327). Hungary became part of the United Energy System (CDU) which was managed in Prague enabling electricity imports to be better coordinated into Hungary (Bernat 1989, 131).

Importantly, trade balances including either hard currency or the Soviet style of bartering of goods made Hungary's increasing imports expensive by any measure. "Increasing imports [of energy] necessitates increasing exports of agricultural and/or industrial products" (Bernat 1989, 117). Greater electrification of transportation and energy efficiency measures were important to cut oil imports (Bernat 1989, 117).

Hungary’s current electricity mix is still dominated by nuclear power and natural gas (see below **Error! Reference source not found.**). In 2015, imported gas accounts for 70 percent of Hungary’s gas consumption (Directorate-General for Energy 2017). Much of this is Russian gas which might flow directly from Russia or be imported to Hungary through Slovakia or Austria. While spot trading of gas is on the increase, and therefore a ‘market price’ exists, Hungary still maintains a long-term bilateral gas agreement with Gazprom. Visits by Gazprom executives and Russian officials often revolving around well publicized gas and nuclear agreements. Nuclear power is over 40% of the Hungarian energy mix. An

additional 2 MW are being built by Russia to eventually replace the aging reactors providing near 50% of the country's energy supply.

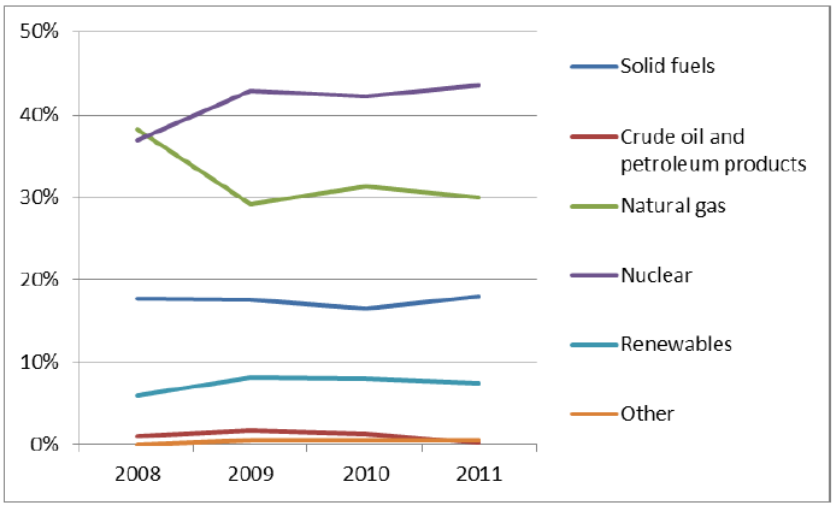

Figure 1 Gross electricity generation mix 2008-2011

(Source: cited from EU Energy in Figures -Pocketbook 2012-2013, LaBelle and Deak 2015, 106)

Lithuania is a country that was tightly integrated into the Soviet Union, but has since adapted an open EU model for energy diversity. While Poland and Hungary were able to peacefully pull away from the Soviet sphere of influence, Lithuania battled its way out with a standoff between Soviet forces in 1991. The small country of 2.8 million people also has a dramatically different size and vulnerability. Continued Russian harassment in Lithuania's energy sector, along with security and military threats propel its shift towards both the EU and NATO for greater security. Diversification and integration marks the steps taken in the energy sector.

In 1990, Lithuania's energy sector was characterized by an oversupply of electricity. With collapsing industrial demand the sector was oversupplied with very little potential to export to neighboring countries going through the economic transition from a centralized to a market based economy.

- Below market energy prices
- Limited or no metering of energy production and consumption
- Limited incentives for energy efficiency (IAEA 2004, 11)

The basis for the modern Lithuania energy sector was the Ignalina Nuclear Power Plant in Visaginas. The plant operated from 1983 to 2010. It held two reactors producing 1500 MW each. In 1993, it produced 88 percent of the county's electricity (Abaraviciene, n.d.). The reactor design was the same as the Chernobyl Nuclear Power Plant and despite investments to improve the safety of the plant, membership to the EU was conditional on decommissioning the plant. In 2012, after the closure of Ignalina NPP, Lithuania became a net importer of electricity, mainly imported from Russia, while imported natural gas replaced domestic nuclear electricity generation (European Commission 2015a). **Error! Reference source not found.** shows the shift from nuclear to natural gas for electricity production between 2009 and 2010.

After the closure of Ignalina NPP, Lithuania became even more heavily reliant on Russia for its energy supplies. There were three key infrastructure projects that sought was to open the country to regional electricity markets and the global trade in LNG. Two electricity transmission lines were built. NordBalt has 700 MW capacity (400kV) stretching from Klaipeda, Lithuania to Nybro, Sweden. The LitPol Link is has a capacity of 500 MW (400kV), linking the electrical grids of Lithuania and Poland (European Commission 2015a, 146). The third project was building a floating liquefied LNG terminal (FSRU) to receive global shipments of gas. This was commissioned at the end of 2014 and has resulted in the country receiving lowered priced gas from Russia. In addition, Lithuania has increased the amount of renewable energy from wind (48% of RES) with plans by 2020 to reach 23% by 2020 (Ministry of Energy of the Republic of Lithuania 2017).

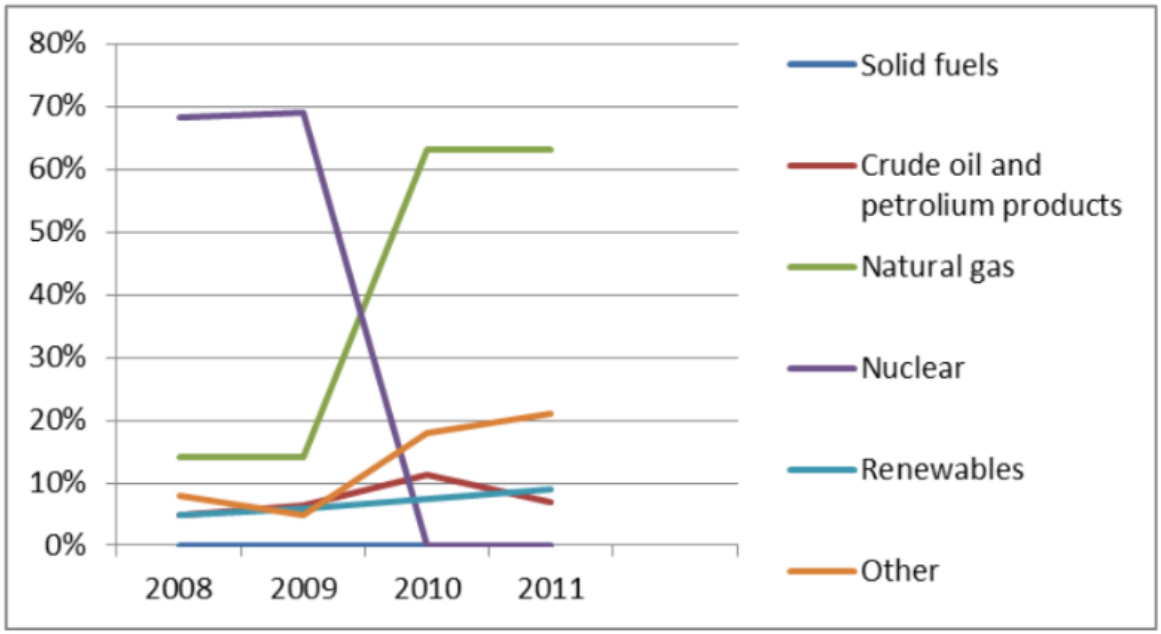

Figure 2 Gross electricity generation mix 2008 – 2011

Source: (European Commission 2015a, 141)

This snapshot of the three country's energy mix demonstrates both a reliance on Russian resources and technologies along with shifts and resistance to EU market rules. Poland pursues a strategy of building more coal fired plants, while Hungary is building new nuclear reactors. Lithuania, after being forced to close down its nuclear power plant, seeks to diversity both in the sources, through transmission lines to neighbors and by building up renewable energy sources. In this narrow example, these country's choose the energy technologies and resources used to generate electricity and heat. State's continue to be able to influence their domestic markets based on choosing electricity generation technologies and areas of expertise to invest in. Only Lithuania has plans to strongly pursue sustainable energy. These descriptions contrast against the role of ACER and asserting power over regulatory conditions and market access. It becomes an expression of government (over infrastructure) and governance (rules and regulations) which drive change. The intent is to lower consumer prices, while maintaining authority and independence through chosen energy technologies.

4 Discussion and Conclusion: Eastern European Energy Culture

Energy culture is a simplified theoretical construct to perceive more complex state-society economic interactions around energy issues. The choice of energy technologies, resources and access permeate actions at all levels of the state system. To bring back the terms of 'localized', 'globalized' and 'regionalized' from previous academic discussions in political-economic geography provides a re-territorialized sovereign state along with interlinked notion of state economic power. Soft and hard forms of state power are expressed in the energy sector through control of resources, technology and regulatory authority. In short, economic power may be more tightly connected to energy cultures, than military power, but the state system remains central to the development and innovation of new more environmentally sustainable energy systems. Economic power and independence is dependent on access to markets and resources. Exclusion or inclusion of market access influences power relations and ultimately the price consumers pay for their energy services.

The choice of Eastern Europe as a site of examination provides a means to partially asses from a non-capitalist perspective the development of an energy system. This analysis does not divide out the deeper working assumptions within the energy system of a communist/socialist/post-socialist or capitalist/neoliberal perspective in the theoretical difference of how these constructs influenced the development of energy systems. Nonetheless, following the working assumptions around innovation and social equity are important to explain regardless of the dominant economic system and connected ideology. Demonstrated is the profound deep cultural connections shaped by historical trajectories around perceptions of energy security, technological choices and delivery of energy services. Justifications for past energy choices emerge as influences over future decisions. Knutsen, held the industrial revolution brought a twin process of social understanding of the power of energy and rise of the sovereign state (Knutsen 1992, 128–29). Energy transcends political-economic ideologies, connecting with deeper social values of fairness, opportunities and growth, the very fuel innovation and

social equity requires to thrive. The sovereign state is a container for society to influence the energy culture to improve, what Ostwalds considers, “the most favorable transformation” in energy (Stewart 2014, 344). This conversion is not just a mechanical or a thermal process, it is a *cultural process* where individuals and society play an essential role in contributing towards efficiency and reducing the environmental impact.

The past trajectory demonstrates the pursuit of great energy efficiency fuels both a democratic-neoliberal and a communist- centralized pursuit of innovation in energy technologies. Delivering energy at lower cost to consumers and industries is the remit of the state and multilateral organizations. While in the past social transformation drove Gorbachev to decentralize and reform the economic system which was invested heavily into energy, provided a political impetus to direct and steer energy transformations for a centralized perspective; markets and finance were secondary to economic and geopolitical considerations. In Europe, markets and finance drove a move away from government control to a system of governance by experts (such as NRAs) and implemented through ACER to meet European Commission objectives for market integration. Eastern Europe now attempts to implement a system of governance of markets while maintaining government control over resources and technologies. This balance is one of the tripartite, of geopolitics, innovation and justice. The state remains central, exercising hard and soft-power to direct and foster innovation of energy technologies while maintaining international relations to ensure delivery of resources and technologies to meet social aims.

Differing energy cultures in Eastern Europe demonstrate different external and internal threats, opportunities and access to resources. Hungary’s near total reliance on Russia demonstrates a close working relationship over resources and technologies. Poland and Lithuania invest heavily to reorientate away from Russia and towards other EU countries and the global LNG market. These different decisions reflect social and political interpretations of geopolitical threats and choice of technologies utilizing

innovation ecosystems within each country. The demise of nuclear power in Lithuania was exchanged for EU membership and an increased security relation with Europe, over Russia. Hungary maintains and expands its nuclear fleet with limited security concerns while boosting its interconnections to the energy system in Eastern Europe. Poland, by contrast, maintains distrust towards Russia but also rejections a greater integration with the EU. Prompting it to build LNG facilities and maintain and renew its domestic fleet of coal fired generation plants. In each of the three cases, the price of energy for consumers remains a primary concern driving investment into particular technologies and infrastructure projects. Access to an EU energy market facilitates the trade of commodities, but decisions and functioning of energy infrastructure remains in the remit of national champions – indirectly under state control.

The explanation around energy culture holds the potential to expand to other geographic areas. The tripartite structure of innovation, justice and geopolitics can be applied to a range of energy systems, assisting framing of issues and delivering a more holistic and interdisciplinary explanations for social and political decisions affecting the economics of energy. Energy technology transcends beyond a single economic construct and remains rooted in culture which holds social equity and improvement as important tenets. This view provides a means to address pressing social and environmental transformations necessary in the current global energy system.

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