for the completion of particular value chains. Similarly, looking at these processes can provide a much better understanding of how some local actors in the EU (e.g., the energy companies RWE and E.ON) would come to support specific Russian initiatives such as the South Stream (and, later, Nord Stream) pipelines, even when such initiatives were not supported by the European Union. Understanding actor coalitions as unfolding *through and throughout* specific value chains has direct implications for key EU policy issues, such as the separation (unbundling) of energy production, transportation, and retail in EU states required by the EU's Third Energy Package (2009), as well as Russian companies' responses to these, such as attempts at gaining control over regional gas distributing companies in EU states. It is impossible to understand Russia's energy power—and the constraints to it—without understanding these value chains and how they deeply permeate local politics and business in each state through which this chain goes. Energy power does not end at the border, and it is only by understanding these value chains, how deeply they go into the affected countries, and how they tie in with domestic players, that we can understand the true extent of this power. Thus, following the physical, material chain is not just a means for bringing the reader along on this journey; it is also central to the story as looking at energy power through a materiality and value chain lens takes you to a different place than when not looking at materiality.

Looking at resource politics more globally, an "entire value chain" approach to energy can make an important contribution to our understanding of energy security. By looking at the full spectrum of midstream activities, we gain a new perspective on the role of consumer states that are also providing infrastructure and refining services important for the producer, such as Singapore, the Netherlands, Belgium, and Malaysia.[43] And last but not least, the book makes an important contribution by bringing coal—largely ignored in the literature on energy and security—squarely to the center of the political economy of energy discussion.

But before getting to the book's concrete value chains spanning from Siberia to Germany, let us review the connection between the materiality characteristics of the three goods traversing these chains—natural gas, oil, and coal—and the sets of market and power relations taking shape around them. We tackle this in chapter 3.

CHAPTER THREE

Energy: Materiality and Power

AS PREVIEWED in the last chapter, understanding actors' interactions *through and throughout* energy value chains offers a more powerful lens for explaining post-Soviet energy interactions than does a simple focus on energy as state power.[1] These relationships are best understood in terms of the interaction between three key sets of factors: the material characteristics of an energy good, the way involved actors "use" energy, and the governance environment. This book deals with the governance environment as well as actors' various uses of energy in chapters 4 through 6 as we follow concrete physical value chains for oil, natural gas, and coal from Russia to Germany via Ukraine. This chapter introduces the materiality side of the issue—that is, how the material characteristics of different energy goods can affect the constitution of power relations around them.

Our starting point is the fact that various types of energy—such as oil, natural gas, and coal, fossil fuels that have dominated Russia's energy relations with both post-Soviet neighbors and more distant partners—are not analytically interchangeable; rather, the characteristics of each specific type have important implications for their further use.[2]

Thus, this book aims to analyze energy interactions by starting from the very nature of the specific energy resources in question and how their concrete characteristics ("materiality") affect their value chains, and, through them, power relationships. The physical characteristics of (various) energy goods are taken as a starting point, in the sense that materiality is both *enabling* and *constraining* human choices.[3]

WHAT WE ALREADY KNOW ABOUT MATERIALITY, ENERGY, AND POWER

But before we dig deeper, let me briefly recapitulate what we already know about how the characteristics of different types of energy affect power relations. At a general level, the literature on sustainability has discussed the environmental and other implications of reliance on broad categories of energy, for example, fossil fuels as opposed to renewables. By necessity, however, this literature has missed the insights that can be gained from comparing various types of fossil fuels. Specifically concerning fossil fuels, research has examined how reliance on imports of specific types of energy—as reflected in different import energy-mix profiles—can make an impact on an energy-dependent state's ability to fend for itself against a supplier's intentional stoppage of supplies.[4] We know, for example, that the means by which an energy resource is most efficiently transported (e.g., by pipeline for natural gas, as compared with a variety of options for oil) will affect how easy it will be for a supplier to turn off supplies, along with how easy it will be for the affected state to replace such supplies at short notice and, thus, withstand an interruption in supplies (see table 3.1). (For example, Lithuania shifted to oil supplied by tanker after Russia interrupted oil supplies via the Druzhba pipeline in 2006.)

However, such a framework, focusing on the impact of energy import mixes on the importing state's ability to cope with supply disruptions, still looks at differences between types of energy solely in terms of their external impact. We still know little about how these differences affect power relations at the intersection between their domestic and external dimensions.

This chapter develops what such an analysis would look like, unpacking the various power implications of differences between different types of energy (materiality). It tackles the issue in several steps. The first step sets the scene by contextualizing the impact of materiality and discussing its interaction with other important factors. In the second step, I compare oil, natural gas, and coal, the three fossil fuels at the center of this book, on the basis of key physical characteristics and their secondary manifestations. I then analyze the main mechanisms through which these materiality differences come to affect power at the international and domestic levels.

TABLE 3.1
Differences between Oil, Natural Gas, and Coal, and Their Impact on Importing States' Ability to Withstand an Interruption in Supplies

Aspect	Oil	Natural Gas	Coal
Transportation options	A variety of options available: tanker, pipeline, rail	Shipped almost exclusively by pipeline (not including liquefied natural gas technology, which is currently significantly more costly).	Due to its high weigh-to-energy ratio and high cost of transportation in proportion to value, usually shipped by tanker and rail.
Importers' ability to respond to blockades / supply suspensions by switching to other suppliers?	Switching to other suppliers can take place relatively quickly; can also be supplied by tanker or rail.	Switching to other suppliers is more difficult due to infrastructure issues (whether fixed pipelines or liquefied natural gas facilities).	Switching to other suppliers is more difficult due to long transportation times.
Capacity to be easily substituted by other energy sources?	Relatively low (especially in transportation sector)	Relatively high	Medium for electricity generation; medium to low for industrial uses

MATERIALITY UNBOUND, MATERIALITY CONSTRAINED: CONTEXTUALIZING ENERGY MATERIALITY

Understanding its contextualizing factors is essential for applying the materiality framework proposed in this book. These factors have to do, first and foremost, with nature as a human co-creation, the role of technology, legacies, and politico-economic systems. These factors mediate how the primary physical characteristics of an energy good manifest themselves in secondary characteristics and, further, in power relations at both the international and domestic levels.[5]

Materiality cannot be seen as a purely external or "objective" force;[6] rather, its impact needs to be seen in the context of the mutual production of society–nature relations,[7] and, more generally, of how humans and inanimate objects ("things") co-constitute each other.[8] What this means is that humans as observers, measurers, and users of nature not only experience it as an external factor but also co-create it. Concerning natural resources, including energy resources, De Gregori reminds us that "resources are not; they become," in the sense that they are not so much an objective that is given but are related to human actors' perceived needs and technical capabilities to use different nature-given objects to fulfill these—all of which are changeable rather than given.[9]

At the same time, the impact of a good's key physical characteristics is not absolute but is mediated by the state of technology used on it. Indeed, though some of the differences between types of energy are unambiguously given by nature, others lie at the intersection of what is given by nature and what is physically doable given available technology. Thus, for example, the very viability of liquefied natural gas (LNG) as an internationally traded substitute for gaseous natural gas is predicated on the existence of natural gas liquefaction technology—before it became available, it was impossible to think about natural gas as being anything but a gaseous substance.[10] Another example concerns the way we look at natural gas and oil. Natural gas is often—though not always—extracted from the same fields as oil; even in those cases, their value chains depart at the wells themselves, solidifying separate identities for both energy sources.

Similarly, the impact of materiality is mediated by the choices made by involved actors, including societal choices. It is intertwined with human knowledge structures and the socially contextualized priorities of various politico-economic systems, including each system's understandings of the preferred uses of energy within it. Even widely used energy concepts, such as the distinction between recoverable and proven oil and gas reserves, are not based on objective criteria but are related to actors' subjective and socially contextualized understandings of acceptable risk and profit margins. A standard definition of proven reserves is what is proven to be "economically producible" using current technology.[11] Thus what gets counted as a proven reserve is using current technology as well as the current understanding of what constitutes an appropriate economic return.[12] (Technically recoverable resources, conversely, are resources that "can be recovered with current technology, but whose recovery is not economical under current conditions."[13]) Thus what constitutes proven reserves is not an objective given but also depends on social conceptions of what constitutes an economically sensible investment and acceptable profit, and to what extent energy investments should be guided by profit motives as opposed to other goals (see below). We should not assume that a profit-based capitalist logic of value and priorities is always at play. Rather, we can see a situation where a profit imperative may be the priority, situations where the use of energy supplies for social welfare and populist goals may be the priority, or situations where reducing the CO_2 footprint of energy use may be the priority.[14]

In Soviet-style socialism, for example, profitability and economic efficiency considerations played a very limited role; they were secondary to the supply considerations that were key for Soviet-style material planning and the use of energy supplies as means of fostering cohesion in the system.[15] Similarly, we need to acknowledge that "corrupt energy," the use of energy for corrupt rent-seeking (which is not necessarily innate to socialism or capitalism but whose growth can benefit from the inconsistencies of a transition period), has its own rules of the game that do not necessarily align with efficiency or company profitability criteria. Similarly, the decarbonization initiatives unveiled by the European Union in the 2010s also imply a certain hierarchy of priorities. That is, different politico-economic systems have different priorities in making choices about energy production and use. The hierarchy of priorities also involves substate-level actors' preference rankings concerning the various uses of energy. Thus, for example, an actor's choice to use energy for external pressure may preclude actions based on economic profitability criteria.[16] All this mediates the direct impact of materiality.

Returning to the example of LNG, we see that its ability to function as an internationally traded substitute for pipeline natural gas is predicated not only on the existence of the necessary technology (which was first patented in 1915) but also on LNG fetching sufficiently high prices (and an "appropriate economic return") to justify the high cost of liquefaction and further regasification.[17]

Last but not least, the impact of the materiality characteristics of various energy goods is also mediated by the regulatory and governance of materiality does not imply arguing that forms of ownership, regulatory, and governance issues do not matter. Rather, I am arguing that if we were to assume equal regulatory framework conditions, the materiality characteristics of the energy good under consideration would make a difference. Regulations, moreover, do not arise in a vacuum; rather, regulations affecting a particular energy good arise out of a dialogue between the technical nature of the good and the goals of those defining policy. In analyzing the development of Europe's natural gas infrastructure, for example, Högselius and colleagues have shown how the governance and political imperative of building separate capitalist and socialist gas supply networks could not be sustained in the face of economic and materiality-related geographic realities, leading to the impetus for the creation of a single, pan-European system.[18]

The impact of materiality is also mediated by legacies, including socially sedimented technological infrastructures. Because of their high cost and difficulty of replacement, infrastructures may continue to embody outlived technologies even when newer ones may be available, as if freezing them in time. In the cases discussed in this book, this is seen most clearly through the issue of transportation infrastructures inherited from the Soviet period, which have continued to affect the management of post-Soviet oil and gas by, for example, limiting the import and export options open to countries in the region.[19] I am not arguing, thus, that post-Soviet oil, natural gas, and coal functioned in the same way they did in the Soviet period but that the legacies of the Soviet ways of dealing with these issues deeply affected the infrastructural setup through which post-Soviet energy would work and flow. Although a supply-centered system like that of the USSR is no longer fully present in Russia or the other post-Soviet states, the *legacies* of those priorities are still relevant, intermingling with profit motivations and the governance environment. We may also see conflicts between priorities, such as when profit or foreign policy considerations coexist with the use of energy for social welfare or populist policies.

PRIMARY PHYSICAL CRITERIA FOR UNDERSTANDING FOSSIL FUEL MATERIALITY

These caveats notwithstanding, the physical differences between different types of energy do matter, making a structured comparison essential.[20] Before presenting a structured comparison of oil, natural gas, and coal, it is important to clarify its scope—a particular subset of the universe of all possible energy sources. Our inquiry focuses on *primary energy sources*, that is, raw energy before conversion or processing (in contrast to *final energy and energy services* consumed by end users, e.g., electricity, gasoline, or heating). Within primary energy sources, I focus on those types of energy that are easily tradable (i.e., "commodifable"), in contrast to local-use, nonstorable, and nontradable types. At the same time, we are comparing fossil fuels, a subcategory of nonrenewable resources.[21] Although this book focuses on the nonrenewable energy commodities oil, natural gas, and coal, I recognize that a community's reliance on local renewable energy resources creates a totally different set of political power dynamics between them and central institutions.

Different types of energy can be compared on the basis of innumerable criteria, referring back to different types of qualities. Including all possible factors, however, would be an insurmountable task. Thus, the list of criteria to be compared may be best tailored to the specific purpose that is being pursued in analyzing such characteristics. Scholars interested in the cultural representation of energy, for example, have paid attention to qualities such as the depth of its underground deposits (as in the case of Rogers's study of oil and culture in the Perm region of Russia[22]), smell, and color. In contrast, my own list focuses on those characteristics that are acknowledged by the energy industry as central and are key for shedding light on the main area of interest here: how various types of energy function as part of supply and value chains. Even with this narrowing of focus, this kind of enquiry requires comparing energy types across multiple criteria, which does not lend itself easily to the kind of parsimonious (e.g., a 2 × 2 table) presentation popular with political scientists; this may be a reason for the scarcity of work analyzing the impact of materiality in political science.

I first compare natural gas, oil, and coal according to primary physical criteria, and then on the basis of secondary features related to these primary characteristics. Primary physical criteria refers to basic characteristics of an energy good, before it is further processed or distributed. The secondary criteria we compare go back to these essential differences in physical characteristics, because they affect further sets of characteristics in the supply and value chains.

Primary Criterion 1: Physical State

The most obvious physical difference between oil, natural gas, and coal concerns their *basic physical state.* Although they are all fossil fuels—that is, energy sources formed from decayed organic materials through millions of years—the basic physical state of each at ambient temperature differs: gaseous for natural gas, liquid for oil, and solid for coal. (The discussion here concerns physical state at reference ambient pressure and temperature points;[23] natural gas can be turned into a more compact and energy-dense energy carrier, LNG, when processed at extremely low temperatures.) We will be coming back to these distinctions once and again, because they form the basis for a number of other differences. Differences in physical state have significant implications for differences in the secondary characteristics discussed below, such as transportation options, the typical size of markets, value chain–specific challenges, and the potential autonomy or networkness of users.

Primary Criterion 2: Degree of Homogeneity within the Good

A second key differentiating factor concerns the degree of homogeneity within the good, that is, the degree of difference between subtypes of the same good, in particular those concerning caloric value and other characteristics affecting their use, fungibility (i.e., the mutual replaceabilty of units), and marketing as commodities. This is a complex issue to tackle, given the fact that no fossil fuel is totally uniform and that human-made categorizations and classification blueprints (e.g., branding and blending into brands) have been introduced as a means of managing this internal diversity so as to make possible the marketing of these goods as commodities.[24] Branding and sale as different types is an integral part of the coal and oil business, with different brands (oil) and benchmarks (coal) being marketed and priced separately. However, these intra-energy type differences are smaller than the differences between different types of energy, with the range of observable within-good variation being very different for natural gas, oil, and coal.

Coal is highly heterogeneous. The caloric (heating) value per weight of different coal types differs widely—from about 14 megajoules per kilogram for brown coal / lignite to 24 for bituminous coal to 32.5

for anthracite coal.[25] This wide diversity also makes it hard to achieve transparency in pricing. In addition, different types of coal also differ widely in terms of the level of humidity, ash, and sulfur content, which are key for determining their potential uses. These differences can take place even within relatively small geographical areas; even neighboring coal mines may produce different types of coal; these different types and their main uses are discussed in more detail chapter 6. The key point here is that, even more than in the case of oil, different types of coal are more narrowly specified for use in specific infrastructures (e.g., specific electricity-generation plants) than in the case of natural gas or oil. This means that high dependence on both coal and legacy infrastructures can be mutually reinforcing. (This is in addition to the distinction between coal used for electricity generation and as feedstock for the metallurgical industry, which is discussed separately.)

This situation has implications for all coal industry players, but in particular for importers, because imports sourced from a particular area or mine may be extremely hard to replace in case of a supply suspension. Legacy infrastructures may exacerbate this situation, as in the case of Ukraine: especially in its eastern regions, where key infrastructure was specifically developed to operate with the type of coal supplied by geographically nearby mines in Russia while both were constituent republics of a single and energy-centralized state. Such mines later became part of the separate state of Russia, which since 2014 has been involved in military aggression against Ukraine. (After independence in 1991, Ukraine continued large-scale imports of coal from mines located on the Russian side of the border.) Moreover, Ukraine's dependency continued to be reproduced by the infrastructures inherited from the Soviet Union: not only the often-discussed oil and natural gas pipelines directly tying Ukraine to supplies from Russia but also less visible but no less important electricity generation and industrial infrastructure specified to work with specific types of Russian-sourced coal. This is also a reason why, despite Russia's military aggression since 2014, it has been very difficult for Ukraine to replace coal imported from Russia, even as it has made important strides in replacing oil and natural gas supplies.

Although, as noted, the substitutability of coal in general for electricity generation can be considered medium, the substitutability of specific types of coal in closely coupled generation plants, such as many built during the Soviet period, is low. And though hardly homogeneous in absolute terms, *oil* is relatively homogeneous compared with coal. Crude oil from various sources differs in terms of density (with less dense oil actually containing "higher quantities of hydrocarbons that can be converted to gasoline"[26]), as well as sulfur content, which is more popularly understood in terms of their role in producing "sour" or "sweet" (lower-sulfur) oil. These different source oils are then blended to produce separately marketed brands. Although there are dozens of officially certified brands of crude oil worldwide, three are used as main price benchmarks: West Texas Intermediate (WTI), Brent, and Dubai/Oman.[27] In contrast to coal, which can differ significantly from mine to mine, crude oil from relatively broad regions tends to share certain general characteristics, to the point that geographic denominations (e.g., WTI and Brent, a combination of oils from fifteen North Sea fields) are often used to refer to the major subtypes. In addition to the inherent homogeneity or heterogeneity of oil as a good, the oil denominations (brand) system's ability to capture crude oil's existing heterogeneity within well-defined brands is also of interest. The technical possibility of batching—transporting oil via pipeline in batches separated by a buffer fluid so different types of oil may travel on the same pipeline without mixing—helps strengthen such branding and differentiation between brands. A key consequence for consumers is that oil has widely quotable prices (with about two-thirds of world contracts using Brent prices as a benchmark reference[28]), which, together with the existence of a global market, should aid in promoting transparency in pricing.

Natural gas is relatively more homogeneous than oil or, especially, coal. Small differences do exist—which are related to the level of natural gas liquids (NGLs) and calorie content, in turn related to the relative methane content—but these are dealt with in the cleaning processing that usually takes place immediately after production before natural gas is brought into a pipeline (i.e., "bringing up to pipeline specification"). Despite these differences, of the three fuels discussed here, only natural gas is widely traded as a relatively uniform "good" with no widely used benchmark brands.[29] This lack of widely used benchmarking is compounded by the technical impossibility of batching, that is, transporting natural gas via pipeline in batches of different qualities, in contrast to the case of oil, where such a possibility helps strengthen the branding of different oil qualities.

One of the main implications of natural gas's relative homogeneity is that it has made possible the development of a technically smooth-functioning (albeit expensive) pipeline infrastructure, with a number of further implications. It allowed for the concept of natural gas as a swappable energy carrier to develop—one molecule of Russian methane (the main component of natural gas) in the pipeline is chemically undistinguishable from one molecule of, say, Norwegian methane, although one may be contractually Russian and the other Norwegian. The relative homogeneity of the good makes technically possible extensive virtual swaps (taking place in Europe already from the 1960s[30]) as well as the development of gas trading hubs, where natural gas from various sources is available and can be sold at spot prices. (The limitation here is not so much the interchangeability of the gas but—as is discussed in chapter 4—the governance setup and the ability of pipelines feeding from these hubs to maintain the necessary pressure if not fully used.[31]) Although the sale of natural gas at spot prices is a relatively recent phenomena related to the move away from long-term contracts, such spot sales—and competition by LNG—could not work as well with a less homogeneous good.

Primary Criterion 3: Energy Density of the Good

A third important difference concerns an energy good's energy density, which is defined as the amount of useful (extractable) energy per unit, usually measured in megajoules per kilogram.[32] Whereas crude oil and coal are measured by weight, natural gas is usually measured by volume (in cubic meters),[33] making it difficult to compare both directly. In terms of energy density per weight,[34] however, natural gas is the most energy-dense energy carrier (at 47.2 megajoules per kilogram), followed by crude oil (41.9 megajoules per kilogram) and coal (which varies from about 10.0 to 31.4 megajoules per kilogram).[35] Volumetric density—that is, the energy density per unit of volume—produces a different ranking, with crude oil by far the most energy dense, at about 37,000 megajoules per cubic meter, compared with natural gas, at about 34 to 39 megajoules per cubic meter (i.e., a thousandfold difference).[36] Thus it is reasonable to say that for most practical purposes, oil can be considered the most energy-dense of the three fossil fuels.[37] This also means higher revenue per unit for energy-dense types of energy. Energy density becomes important for value chains because energy-dense types of energy are less expensive to transport globally relative to total value; this also makes oil more suitable for global, non-pipeline shipment than natural gas.

Primary Criterion 4: CO_2 Profile and Other Ecologically Problematic Emissions per Unit of Energy

A fourth criterion concerns each type of energy's carbon intensity (i.e., the grams of CO_2 emitted per kilowatt-hour generated as electricity), along with its level of negative environmental impact.[38] Of the three main fossil fuels, given current technology, natural gas produces the least ecological damage per unit of energy produced, followed by oil and coal. This becomes important for the value chain because decisions on energy investments, transportation means, and infrastructure will also be made on the basis of their ecological consequences. (At the same time, as seen with the boom in worldwide coal use for electricity generation in 2015, in the absence of clear legal regulations or a meaningful CO_2 emissions trading system, price considerations often trump ecological ones.) These differences in CO_2 intensity will also affect other secondary differences discussed below, such as substitutability (one energy commodity's ability to be substituted by another), given that decisions on substituting one energy source with another may need to be reconsidered in the context of growing carbon constraints and actors' relative prioritization of decarbonization as a policy goal.

Primary Criterion 5: Ubiquity and Spatial Footprint

Finally, an important difference in terms of an energy good's physical characteristics and footprint concerns natural differences in ubiquity and natural distribution (as well as related differences in the quality and ease of access of deposits). One aspect of this concerns whether concrete resources are only available in a geographically concentrated area, or are more evenly distributed worldwide. Although coal reserves are available in almost every country (and there is a relatively globalized market with several strong suppliers, including Australia, Colombia, Indonesia, and Russia), oil and natural gas reserves are predominantly concentrated in a narrower area (mainly North Africa, the Middle East, and some areas of North America and Eurasia). Differences in quality and ease of accessibility compound these, leading to widely different production costs, which have traditionally been significantly lower in the Middle East (unchallenged even by recent "low-cost" shale gas production in the United States), leading to differential rents between producers endowed with varied natural advantages.[39] Such differential rents have key implications for power issues through the issue of the profitability of the industry in a concrete location and low-cost producers' ability to drive out other, higher-cost producers, affecting the relative bargaining power of specific producers.

Access to capital-intensive exploration technology becomes even more important in the case of resources that are less uniformly distributed and harder to access (oil and natural gas, as opposed to coal), exacerbating differences in various producers' access to differential rents and ability to capture economies of scale.[40] So in the case of less ubiquitous energy types such as oil and natural gas, we see more potential for inequality between states, inequalities that will also be exacerbated by differences in access to know-how, technology, and financing. Another aspect concerns whether a resource is "diffuse"—that is, scattered widely, and at least in theory amenable to be extracted by a large number of small operators; or is a "point resource"—that is, concentrated in small areas and more likely to be extracted by a few producers.[41]

MAIN DIFFERENCES BETWEEN OIL, NATURAL GAS, AND COAL: SECONDARY FEATURES

The differences in primary physical characteristics discussed in the last section also lead to differences in secondary features related to the marketing and use of various energy resources (see table 3.2).This section describes these differences and their impact on power relations.

Secondary Feature 1: Transportability

The physical state of an energy commodity at ambient temperature and pressure is the most important characteristic affecting its *transportability*. Differences in transportability, in turn, bring a variety of ripple effects for exporters, importers, midstream processors, and all actors involved in that good's value chain, from producer to end user.

TABLE 3.2
Natural Gas, Oil, Coal, and Their Main Differences at a Glance

Energy Type	Natural Gas	Oil	Coal
Primary physical criteria			
Physical state	Gaseous	Liquid	Solid
Homogeneity	High	Medium-high	Low
Energy density/value-to-volume ratio	Low	High	Low
CO_2 intensity	Medium	High	Very high
Ubiquity and spatial footprint	Less ubiquitous	Less ubiquitous	More ubiquitous
Secondary features			
Transportability/best transportation options	Pipeline	Pipeline, tanker, rail, truck	Rail, ship, truck
Size of typical markets	Regional	Global	Regional/global
Processing needed	Near production site	Variable	Mainly near production site
Exporter states' ability for unified action (cartel)	Lower	Higher	Lower
Substitutability	High	Low	Medium
Role in nonenergy value chains: Where in value chain does additional revenue from participation in nonenergy industries come in?	At start of value chain, immediately after production	At midstream level—as products of refining process	At downstream level—already processed coal is used as industrial feedstock (coking coal) or heating source (steam coal)
Networkness	High	Medium	Low

At the level of producers (and exporters), transportability affects producers' choices on how to bring a product to market. Here I have in mind not only the theoretical possibility of using one or another means of transportation but also their cost and other issues affecting exporters' choices. From an exporter's perspective, alternative transportation choices—including decisions on the upkeep and repairing of existing pipelines, building new pipeline routes, transport by tanker, and/or (for natural gas) liquefaction into LNG for shipment via tankers—also mean different profit structures, different possibilities for obstructability of these shipments, and different patterns of relations with other actors involved. They may also affect whether a producer decides to prioritize sales to domestic or foreign markets, decisions that may synergize—or not—with state-level decisions about using energy as an externally directed influence resource. At the level of midstream players, alternative transportation means imply different patterns of relations with other actors involved along the supply and export route (i.e., pipelines, ports, and transshipment infrastructure crossing multiple borders) and different degrees of replaceability of services provided by a transit state. At the level of consumers, the means by which an energy commodity is best transported will affect the ease with which supplies may be stopped, and the ease with which an importer may be able to tap into alternative supplies. (This is also related to how various means of transporting energy may make a route more flexible or, on the contrary, predetermined. Thus, e.g., shipment via tanker has a high degree of flexibility, whereas pipelines follow a fixed route.)

In the case of crude oil, the liquid nature of the good at ambient temperature means maximum flexibility in the means by which it can be transported. Although, for most continental routes, the most economical (and for landlocked areas the only) means of transportation is through pipelines, it is also possible to transport the good on seaborne tankers and by rail as well as—in extreme cases—by truck. (For longer distances, transportation by tanker is more economical.) The availability of these two other means of transportation in addition to pipelines means more flexible options for both exporters and importers, but also means that oil pipeline operators need to contractually disincentivize the possibility of empty pipelines through flight to other transportation means (the sunk costs problem).

In the case of natural gas, its gaseous physical state at ambient temperature makes for a high-volume product that is best transported via pipeline. But movement within the pipeline is far from automatic: being lighter than air, natural gas easily dissipates if not contained, and it also needs to be under a certain minimum amount of pressure in order to move through the pipeline. This has two further implications: first, gas pipelines are expensive to build; and second, the need to maintain a certain pressure in the pipeline means using a pipeline at half-capacity is not an option, because certain minimum volumes need to be maintained for the pipeline to be functional. This means that high pipeline utilization rates are needed not only because of the need to amortize the significant investment already made but also because of the technical requirements for pipeline transportation, adding an important technical component to the sunk costs issue (discussed below). Similarly, natural gas needs to be stored under pressure (or under cooling, in the case of LNG), making the cost of storage much higher than that of oil.[42]

Yet LNG transportation involves its own sunk cost challenges: though in theory the reexporting of imported volumes is possible, in reality this is often not possible due to contractual clauses requiring that the LNG must first be unloaded and then reloaded—something not all regasification terminals are able to do. Moreover, if the utilization rate is low, the relative cost of keeping the temperature low enough to prevent vaporization (i.e., to keep LNG liquid) increases; any gas that evaporates in the tank needs to be flared because it cannot be injected into the grid.[43] In this sense, references to LNG behaving in ways that are more similar to oil than to pipeline natural gas are only partially correct, due to the need for expensive and technically demanding cooling systems to prevent evaporation. On the contrary, for LNG to remain in a liquid state in order to "behave as oil," an expensive, sunk-cost-intensive, and technologically demanding process needs to be guaranteed.[44]

In the case of coal, the solid physical nature of the good means that it cannot be transported by pipeline;[45] it is shipped primarily by rail and ship, the latter being the less expensive option but not one available to all producers; sea and rail transportation are often combined, making for a less "fluid" and uninterrupted process than that associated with oil transportation.[46] For exporters, this means more direct human intervention (workers) is needed to transport the coal, making it relatively more susceptible than natural gas or oil to potential disruptions created by workers themselves, as compared with the case of oil—one of the reasons for coal miners' prominent role in social democracy's rise in twentieth-century Europe.[47] For importers, this situation means more theoretical supply options (because coal supply is not tied to pipelines), but also having to deal with a variety of midstream actors each able to block supply, adding to the difficulty of accessing alternative supplies. Moreover, coal's low energy content per weight means higher transportation costs per unit of energy, making it less economically justifiable to transport for long distances. In the case of Russia's domestic coal supplies, for example, transportation

costs made up about 50 to 60 percent of the final cost of steam coal and about 30 to 40 percent of the final cost of coking coal, compared with less than 10 percent for oil.[48]

Secondary Feature 2: Size and Location of Typical Markets

Transportation issues related to the physical characteristics of a commodity, such as its physical state and energy density, also affect the size and location of its typical markets. Given the current costs of various transportation technologies (i.e., high-cost LNG processing and transportation costs relative to the price of natural gas), this means that whereas the oil market is largely global, gas markets continue to be largely regional.[49] One further implication is that whereas there is a widely quoted price for oil (most often the Brent quotation), there is no such "world" price for gas, with additional implications for issues of transparency and multiple pricing—as seen, for example, in mid-2014, when average natural gas prices in Asian markets were more than twice those in the United States.[50] The degree to which a market is global as opposed to regional can have important implications; in global highly integrated markets where participants have multiple supply options, intended coercion by means of suspension of supplies may be felt first and foremost in the form of higher prices and adjustment costs, in contrast to less integrated markets (and, consequently, less supply options), where the attempted coercion may be experienced by the target state as an actual shortfall in supply.[51]

Secondary Feature 3: Type and Degree of Processing Needed

The *degree of processing needed* before the good is brought to market, and whether this processing is best done directly at the production site or in a variety of locations, will affect the role of various actors in the value chain, both in terms of their location in the chain and their spatial location, also affecting their ability to access value-added profits. This will also affect actors' engagement with further sets of actors key for completing specific steps in the chain, such as in refining and transit.

In the case of coal, processing is relatively limited and is mainly related to the washing and sorting taking place in close proximity to production; the possibility of "refining" into much-higher-value products is limited. (The processing of coking coal into coke for metallurgical use refers to a separate process.) Although such processing is often done near the production site, it may also be done elsewhere, with the main reason for near-production-site processing being the economic inefficiency of transporting unprocessed coal containing significant amounts of stones and other low-value materials over long distances.

In the case of natural gas, processing usually takes place near the production site, leading to significantly less flexibility in how other players may become involved in the process. Most processing takes place in proximity to the wellhead, not only because of economic and marketing issues (bringing that gas to pipeline standard for a particular pipeline, extracting higher-value NGLs for separate processing) but also to make it possible for natural gas to be transported safely and efficiently in the first place—if allowed to enter a transit pipeline as raw gas, natural gas may damage the pipeline. Even more crucially, raw natural gas that is straight from the well contains hydrogen sulfide—a highly toxic and corrosive sulfur-bearing compound—which must be removed at the well to prevent damages to humans, pipelines, and other equipment.[52] If in the case of coal the main reason for near-production-site processing is financial (the economic inefficiency of transporting raw coal over long distances), in the case of natural gas this is first and foremost due to technical constraints.

In the case of oil, there are no overwhelming economic or technical reasons requiring this processing to take place at the wellhead. In fact, because oil is easily transported in crude form, refining often takes place close to the location of final sale, reflecting the needs of those end markets.[53] This creates more flexibility in terms of where refining can take place, opening new opportunities for midstream players. At the same time, refineries are usually specified to process one particular type or brand of oil (e.g., light oil or Urals).

This spatial spectrum of processing possibilities also has an impact farther down the road, because different grades of oil have different refined product mix profiles, which has an impact on refining profits and also affects the distributional impact on upstream, midstream, and downstream players alike.[54] A good illustration of how the issue can also affect transborder actors and relations between states is provided by the case of Belarus in the period 1996–2007, when local refineries and the country's budget agency were able to make significant profits from the refining of Russian crude oil.[55]

These differences between energy types concerning the type and degree of processing also mean that the degree of dependency on primary energy imports needs to be contextualized differently in situations where domestic processing for further export may take place (as in the case of crude oil), as compared with situations where this is not usual. For example, because natural gas is only seldom reexported as gas-generated electricity but is usually used domestically for electricity and heating, a 90 percent dependency on natural gas imports can mean something different than a 90 percent dependency in the case of crude oil—in the later case, a significant portion of the oil imported may be used for refining and the subsequent exporting of the refined products. Similarly, a low degree of dependence on crude oil imports means little if dependency on oil products remains high. This is important so as not to misunderstand situations such as that of Ukraine after 2011, when crude oil imports were drastically reduced, only to be replaced by oil product imports.

Secondary Feature 4: Typical Investment Patterns, Challenges, and Opportunities

Various types of energy also differ in their investment requirements, which will also affect how actors in their value chains interact. The comparative *capital intensity* (how much capital is needed to get the energy off the ground and into final use) along with *sunk costs* (large investments that once made cannot be easily recouped) of an energy commodity's production, processing, and delivery will play an important role in relations between various participants in that good's value chain. At a minimum, the capital intensity of a good's production will affect actors' readiness to invest in one or another type of energy. Such capital intensity is especially high in the case of natural gas infrastructure, because the need to keep natural gas under high pressure for it to be able to move at all places high demands on the pipeline walls, requiring specially strong—and expensive—steel alloys. Also, even if oil pipelines are similar to natural gas ones in that both require pumping stations to help move the good along the pipeline, moving natural gas is much more technically challenging, making the compressors used for natural gas transportation much more expensive than those used for oil transportation.

Although all energy value chains present challenges concerning issues of coordination and sharing risk between participants (e.g., buyers and sellers), these challenges will be more acute in the case of those types of energy characterized by higher sunk costs. In particular, the level of transportation investments/sunk costs relative to the actual revenue or expected profits tells us much about the likely challenges in the relationship between suppliers and consumers. In the case of natural gas, for example, due to the higher levels of risk and sunk cost investments involved in its typical pipeline transportation, contracts have traditionally included provisions allocating risk between seller and buyer, such as long-term contracts and take-or-pay provisions committing the buyer to a certain level of yearly purchases for the duration of the contract.[56] Despite the recent rise in one-time, no-further-commitment natural gas spot purchases in a growing number of trading hubs in the EU, the need for risk-sharing between seller and buyer remains. Sunk costs related to dedicated infrastructure—which, having been specifically built for a very particular purpose, cannot be used for any other purpose—may also affect the intensity of related actors' lobbying, because the less portable investments in a particular project are, the more incentives investors will have to lobby to maintain a project's profitability.[57]

Secondary Feature 5: Impact on Exporters' Ability to Engage in Unified Action

Issues such as the degree of homogeneity of a good, its related fungibility, and whether it commands a global (as opposed to regional or local) market play an important role in determining whether a cartel including a significant number of producers will be possible. This is so because such conditions make it easier for cartel members to agree on a cartel price.[58] In addition, technical issues affecting how an energy good is produced and whether output can be reduced at will to manipulate prices will affect its exporters' ability to establish an effective (formal or informal) cartel. This explains why it has been easier for oil exporters to develop a cartel than for gas exporters because, despite is high degree of homogeneity, natural gas still lacks a truly global market.[59] Moreover, natural gas extraction techniques make it extremely hard to quickly stop production at will, something that is very important for a cartel to be able to agree on effective joint measures to decrease or increase supply as a means of managing prices. Although the issue requires additional research, it is also possible that these or other relevant characteristics may also have an impact on importers' ability to engage in unified action.

Secondary Feature 6: Substitutability by Other Energy Resources

Whether a type of energy can be easily substituted by another will affect the elasticity of demand for it. This also has an impact on power—an importer state can limit the negative consequences of a cutoff in supplies by switching, not simply to another supplier of the same type of energy (which may not always be possible), but to other types of energy that are either domestically produced or are more easily accessible as imports. Conversely, if a state's demand for a good is inelastic, that reduces its counterpower vis-à-vis a supplier. Seen in terms of the four main uses of primary energy (for electricity generation and for commercial/residential, transportation, and industrial use), the most substitutable types of energy are those whose use in one or more of these areas can be easily substituted by another energy type. In purely technical terms, natural gas is the most substitutable, because its main use in electricity generation and heating can be substituted by oil and coal—and, increasingly, renewables. Oil and coal are less easily substitutable, particularly in the transportation sector (oil) and some industrial uses (e.g., coking coal use in the metallurgical industry). Thus, for example, oil—which is used for transportation, industrial uses, and to a lesser extent in heating and electricity generation—is a flexible type of energy but is not easily substitutable, because only limited commercial alternatives currently exist for its use, for example, as fuel for truck freight.

It must be kept in mind, however, that substitutability is a function not simply of the technical characteristics of the energy good itself but also of the characteristics of the economy using that energy good (e.g., the relative weight of the service sector or heavy industry) as well as its infrastructure legacies; the specifics of interfuel substitution will depend on the specific structure of the economy.[60] Of particular interest is the case of many post-Soviet states, which inherited infrastructures fine-tuned for the use of specific types of energy that were easily available in the context of a centralized, energy-rich state but that—as in the case of Russian coal in Ukraine—were not necessarily so after 1991. Thus we can only gain a full picture of how an importing state's energy mix affects its ability to counter external supply disruptions when we also include in the picture the structure of its economy and the degree to which economic sectors within it can substitute various types of energy. In other words, even if an energy-dependent state could refocus its entire energy imports strategy on oil in response to a gas supply cutoff, this would be of very limited effectiveness if the country's infrastructure would not be able to actually use those oil imports for uses previously associated with natural gas, for example.

Substitutability issues can also have an impact on domestic relationships. As shown in the case of coal in Ukraine (see chapter 6), a lack of viable substitutes for the specific types of coal needed for highly specified uses (power plants and metallurgical factories) strengthened the bargaining power of those able to supply the exact type of coal needed, and also strengthened the incentives for control of the entire coal-to-metallurgy and coal-to-electricity value chains. The results are not insignificant—in an example of energy's role as constitutive power, and as evidenced by the power of Rinat Akhmetov, Ukraine's richest and most influential oligarch of the post-Soviet period.

Secondary Feature 7: Role in Production Chains of Nonenergy Industries

An additional criterion for comparing crude oil, natural gas, and coal concerns each of these fuels' ability to tie in with other industries not directly associated with energy. The different ways in which oil, natural gas, and coal-related feedstocks interact with the value chains of nonenergy products have important implications for relationships between players. All three fossil fuels at the center of this book play an important role in nonenergy industries also affecting the ways different actors will be related within the chain. Two such ways involve the use of fossil-fuel-related feedstocks as ***direct feedstock in other production processes*** (as in the case of NGLs and oil derivates) and the use of a specific type of energy as heating sources in situations where, due to technical reasons, the type of energy source matters in the production process because its specific properties may play a needed role for that specific production process (as in the use of coal in kilns to calcinate limestone in cement production or the use of coal coke in metallurgy). In addition, price, availability, and environmental considerations may make a particular fuel a key source of electricity generation in very energy-intensive production, such as chemical fertilizer and cement

These various feedstocks also differ in terms of where in the value chain of the source fuel they start to be marketed separately. So, for example these may be substances separated immediately after production (e.g., NGLs[61]) or refined from a fossil fuel (as in the case of ethylene derived from oil) in a midstream production process. In other words, both natural gas and oil provide important feedstocks for other industries, but in the case of natural gas this role is played mainly by substances separated immediately after production, such as NGLs, though in the case of oil these are refined products resulting from the refining process. So, for example, in the case of natural gas only actors involved (physically but also through ownership relations) in immediate proximity to production can reap the gains involved in the separation of NGLs, though in the case of oil, actors spatially located in various midstream locations can reap the gains related to the role of oil derivates as feedstocks for other industries. This has to do with spatial constraints but also with the fact that the natural-gas-derived feedstock used for other industries is derived mainly by means of separation at the start of the value chain, though in the case of oil the feedstocks are refined derivates.

Another way in which energy industries interface with nonenergy ones has to do with the requirements that the transportation and processing of that type of energy entail for other industries. Thus, for example, the high pressure that the steel used for natural gas pipelines needs to withstand means unique demands—and also business opportunities—for metallurgical producers. This, as noted by Högselius, set the basis for unique situations, such as specific metallurgical companies lobbying for certain natural gas supply routes and related pipeline projects because they would create demand for their industries; it was also these requirements (i.e., Soviet requirements for some specific types of steel alloys for the kind of large-diameter pipelines they were seeking to build) that in the first place paved the way for the East–West trade in steel pipes during the Cold War.[62]

Crude oil's role in other industries takes place mainly in the form of its refined products or derivates such as ethylene, propylene, and "aromatics" such as benzene and toluene used as key feedstock for the chemical industry.[63] Coal, in the form of coke, plays a key role as a heating element in the metallurgical industry as well as—as discussed above—in some types of cement production.[64] Natural gas plays an important role in the production of fertilizers and cement; one of the most wide-fire the kiln at the heart of the production process.[65] Natural gas is also used for co-firing and melting of glass, as well as for drying and dehumidification in the food industry.[66] In the post-Soviet region, it has also played an important role as a source of electricity generation in all energy-intensive industries, such as metallurgy and cement production.

Secondary Feature 8: Effects on Autonomy/Networkness

Energy networkness has to do with the degree to which users depend on a network as opposed to autonomous supplies (e.g., from non-networked residential solar panels). More crucially, it is related to the degree to which the overall functioning of the system may be dependent on the network working properly *as a network.* Although all energy types work in one way or another as part of a network, in the case of natural gas, this networkness is especially crucial, because it has to do with the system being physically balanced as a system—that is, not overloaded or underloaded in its connecting parts.[67] For natural gas, such network balancing is also crucial in a very basic physical way: if the load and pressure in the pipeline system are not right, the entire system may not work properly, possibly leading to a standstill or other accidents, which is a real danger in the case of natural gas, where pipeline connections go all the way to individual residential consumers—as seen in the case of Andover in suburban Boston in 2018, when a failure to properly monitor pressure during a repair operation led to dozens of homes in three cities exploding and catching fire within minutes.[68] In this sense, natural gas is closely related to electricity where, due to storage issues, production and use also need to be closely coupled.

This networkness element (which is also related to the way different types of energy can be produced, stored, transported, distributed, and used) will also have an effect on the autonomy/networkness of users, with potential political implications. One side of this issue concerns a state's ability to successfully adjust to import supply disruptions, which may wreak havoc in a highly networked system (with the additional complication that networks are not necessarily coterminous with national borders and may also be the legacies of previous politico-economic configurations). Another side of the issue concerns domestic political relations, whereby communities with access to more autonomous sources of energy and energy services will have a better chance to withstand pressure from central providers (including the state through

MATERIALITY DIFFERENCES AND THEIR IMPACT ON ACTORS' RELATIONSHIPS WITHIN THE VALUE CHAIN

The last section discussed how oil, natural gas, and coal compare in terms of a number of key criteria. So how do all these differences affect power relations? I argue that they will affect power relations through the way in which they affect value chains and actors' relationships within these.

In order to do this, let us first clarify how we look at power. As discussed in chapter 2, this book conceptualizes energy-related power as involving not only relational ("power over") but also constitutive ("power to") elements. A constitutive view of power emphasizes "how social relations define who the actors are and what capacities and practices they are socially empowered to undertake" ("power to");[69] in an energy context, such a perspective pays attention to ways in which control over energy may both help constitute actors at a variety of levels (e.g., domestic-level political groups, firms, states, cartels, other international organizations) and relationships between them. Concerning relational "power over" someone, this book understands energy power as not only economic but also political, and understands that it may be manifested in ways that go beyond coercion. This view of power builds upon the work of international political economy theorists such as Susan Strange, which have considered power as going beyond coercion and also including elements of bargaining.

How does power work within the context of value chains? How do power and value chains intersect? Economists working on value chain issues—and, in particular, the global value chain (GVC) perspective popularized by Gereffi and colleagues—have dealt with the issue by looking at "the ability of one firm in the chain to influence or determine the activities of other firms in the chain" and the variety of patterns that this may take.[70] This is in turn related to the governance of value chains, which they define as "systems of governance that link firms together in a variety of sourcing and contracting arrangements."[71] For example, they discuss "market," "modular," "relational," "captive," and "hierarchical vertical integration" as alternative patterns of organizing these relationships.[72] Each of these types of global value chain governance has pluses and minuses and may lead to where a firm directly controls all steps in the production of a good ("hierarchical value chain," in Gereffi's terms), may appear as the most desirable option for producers facing sunk cost and stranded assets risks, a vertical integration strategy also involves significant costs and risks: a loss of flexibility, the opportunity costs associated with the significant investments required by such a strategy, and the need for political agreement (and related risks) in case of foreign acquisitions.[73]

The GVC literature focuses almost exclusively on *firms* as actors in value chains, neglecting the impact of political governance and regulatory nodes such as states.[74] Yet in order to make a value chain–centered approach more useful, it needs to be enriched with a recognition of the importance of political governance also including the role of states as regulatory nodes, a dimension often neglected by the GVC literature.[75] Here it is useful to keep in mind the fact that this literature itself has undergone a transformation, from its Wallersteinian world-systems-analysis roots focusing on how a "general capitalist or systemic logic drives commodity chains," a tradition that afforded more space for a view of governance including the role of the state, to a much narrower focus on firms.[76]

Thus, though largely neglected in the GVC approach, political governance—as opposed to governance by firms within the value chain—also matters. This includes two elements. First, we need to take into consideration the role of political governance—such as regulations affecting taxation, duties, and market entry—in affecting the way firms are connected in value chains (i.e., whether we will see hierarchical chain vertical integration, a captive relationship, etc.). For example, the specific governance situation in Ukraine's coal sector in the 1991–2014 period (when there was high political pressure for continued subsidies to the mining sector, which, together with lack of transparency, made it possible for metallurgical producers to accrue high subsidies through artificially low coal prices) made it possible for metallurgical producers to establish "captive" value chains involving domestic coal mines. Second, we need to recognize the role of legacies in helping shape regional value chains.

Understanding Typical Energy Value Chains and Their Challenges

To understand how materiality issues affect power relations in the value chain, let us first take a look at how energy value chains work in general

and how the typical value chains of various energy commodities can create different framing conditions for actors' interactions. This subsection discusses only the general characteristics of energy value chains as a whole; chapters 4 through 6 discuss in more detail the specificities of the oil, natural gas, and coal value chains.

In their most general sense, fossil fuel value chains are composed of upstream, midstream, and downstream activities. The upstream sector refers to the prospecting for and production ("recovery") of crude oil, natural gas, and coal. It includes searching for potential fields, drilling exploratory wells, and subsequently operating the wells or mines to bring the crude oil, raw natural gas, or coal to the surface. The midstream sector processes, stores, markets, and transports these commodities. In the natural gas industry, the midstream includes gas treatment, separation of NGLs, LNG production and regasification plants, storage, and gas pipeline systems. In the oil industry, the midstream typically includes refining, transportation, and storage. In the coal sector, the midstream is more limited, referring mainly to cleaning, transportation, and (in the case of coking coal) processing into coke. The midstream is not limited to transportation but also involves value adding in the form of processing; the good delivered at the end of the value chain is never the same unprocessed raw material that entered the chain in the production field but is altered by processing, whether visible or invisible. In some cases (e.g., crude oil), this processing will be related to a physical transformation (refining). In the case of natural gas, the midstream contribution is less visible but is no less important, because its main role is preventing undesirable changes to the good so as to safeguard its necessary characteristics to be used by the end consumer (e.g., protecting natural gas from exploding or being dissipated into the atmosphere). The downstream sector involves the distribution and selling of final products to consumers; these products include, among others, natural gas and its derivatives, refined products from crude oil (e.g., gasoline, diesel, and chemical industry feedstock), and coal and coke. Related infrastructures include local gas distributors and gasoline stations.

Having established the importance of looking at energy relations through the prism of their entire value chain, let us look at the role of these value chains in shaping relations between actors—something that is deeply fraught with power implications. In contrast to the GVC perspective, this book sees power as closely related to the materiality in the value chain. At the same time, as discussed in chapter 2, the approach used here differs from more extreme understandings of materiality; in my approach, agency and actorness remain firmly with human subjects, but the materiality characteristics of the goods with which these actors deal will help shape the constraints and options open to them. Materiality (in its broader sense, having to do primarily with infrastructures) may also play a very different role: through human actors using it discursively to support specific perspectives or policies. In their discussion of the use and misuse of the concept of natural monopolies in the United States and Russia, respectively, Malkholm and Wengle show how materiality characteristics may be discursively recruited to support various policy options, such as giving a national champion like Gazprom special privileges as a result of the purported natural monopoly stemming from materiality-related characteristics such as natural-gas-specific economies of scale.[77]

Value Chains and Relationships between Actors: Three Mechanisms

Based on the differences between natural gas, oil, and coal discussed above, this section analyzes three main mechanisms whereby the material characteristics of energy goods make an impact on value chains and actors' relationships within them. Each of these mechanisms highlights one important element of how the distinct, materiality-related constraints of a chain affect power relations within it—through the distributive openings they create, through the differential power they may bestow upon actors at different locations in the chain, and through how their distinct challenges lead to distinct responses affecting power relations. These are not necessarily mutually exclusive; we may see more than one of these mechanisms at play in the value chain of a particular energy good. Let us look at these mechanisms in more detail.

In a first mechanism, the materiality characteristics of specific energy goods help set in motion processes that create *distinct distributive openings*. At the production/upstream level, this can take place through issues such as profit sharing with the inhabitants of a producing region, a sector's workers' ability to press for a higher share of profits,[78] or the general societal impact of types of production such as diffuse versus point production—that is, whether they are produced in a spatially spread-out or concentrated manner. At the processing/midstream level, these openings involve the way in which the technical

requirements for specific value chains create constraints on the location of processing actors, allowing (or not) actors located in specific locations to capture a portion of the profits. At the end-distribution/downstream level, these distributive openings may take place through the issue of possible arbitrage gains (including illicit gains) related to price differentials created by various subsidization plans for end users, or patterns of control created by specific energy distribution forms, such as those discussed by Collier in his study of Soviet-era heating networks.[79] Such openings can also affect the constitution of transborder coalitions—for example, a commodity's ability to be used as a focal point for rent-seeking and corruption can serve to facilitate transborder cooperation between actors sharing the goal of exploiting these opportunities and, arguably, as a means for a foreign state to weaken another state through corruption.[80]

In a second mechanism, the technical constraints of distinct value chains (e.g., in terms of processing, storage, and transit services) can *endow actors at various levels of (upstream, midstream, downstream), and spatial locations in the chain with more or less power*. The technical processes necessary to make energy available to its users often bestows power in unexpected spatial locations, affecting actors' relationships. The spatial constraints on the processing of different types of energy, for example, affect not only actors' profits but also their engagement with further sets of actors that are key for completing specific steps (at key nodes) in these commodity-specific value chains. Thus, whether the processing of an energy good can take place at a variety of locations or only close to production will affect the relative power of actors in various spatial locations. For example, oil processing (refining) can take place in a wide range of spatial locations, though in the case of natural gas, this is largely limited to locations close to the wellhead, limiting the role of spatially distant actors. As discussed in chapter 2, these actors are not simply producer, transit, and consumer states as unified actors, but they are a variety of actors spatially located in or between these. For example, the material characteristics of natural gas as a type of energy most efficiently transported overland via pipelines, along with the high sunk costs associated with such infrastructure, increased the importance of midstream actors, especially those able to provide the shortest route between producer and export markets, and set the basis for Ukraine's key role as transit state for exporting Russian natural gas to Western Europe, creating unique opportunities for a variety of Ukrainian actors able to benefit from both legitimate and corrupt business opportunities around transit operations. (This also means that technological breakthroughs affecting how a good can be processed also have the potential to affect the role and power of various actors in the chain, as seen in the case of LNG, discussed in chapter 8.)

The third mechanism may be the most interesting. In this mechanism, the material characteristics of an energy good affect the *typical challenges* affecting its particular value chain and, through these challenges and possible ways of dealing with them, also affect relationships between actors. All value-added chains present challenges—among others, those related to coordination, efficiency, and, most prominently, the management of investment risks.[81] With respect to investment risks, prominent types of risk are those related to sunk costs (costs that, once made, cannot be recovered) and, in particular, stranded assets (costly assets that may become economically obsolete before the end of their expected economic life[82]).

These challenges, however, do not affect all value-added chains equally—the value chains of various goods, due to their materiality characteristics, present various unique challenges, which influence the means used to deal with them (e.g., contractual forms allocating risk between buyers and sellers), creating specific framing conditions affecting actor relations within the chain. Challenges related to how to share risks between supplier and buyer when the infrastructure needed for such supplies is very costly (the issue of sunk costs) and inflexible (the issue of "asset specificity" and potentially stranded assets) are seen most clearly in those industries requiring high and unmovable investments due to their technical needs, as in natural gas and oil delivery by pipeline.[83] In particular, types of energy characterized by being both high volume but low value per volume and gaseous in form (e.g., natural gas) tend to have high transportation and storage infrastructure costs relative to the value of the goods, making them especially prone to risks related to stranded assets and sunk costs, in turn leading to producers' needs to share these risks with buyers, for example, through specific contractual forms such as take-or-pay clauses.[84]

In each of these three mechanisms, the materiality-related transit and processing differences and their resulting value chains create challenges, opportunities, and constraints for relationships between actors (see table 3.3). These can, in turn, translate into transborder coalitions able to trump officially declared state energy policies.

TABLE 3.3
Distinct Energy Value Chains, Distinct Challenges: Effects on Actors' Behavior Through Typical Ways of Dealing with These Challenges

Type of Energy	Typical Characteristics	Materiality Issues Affecting Typical Value Chain Challenges	Typical Challenges (from Producers' Perspective)	Typical Ways of Dealing with These Challenges
Natural gas	Low value per unit of volume, gaseous, limited transportation options	Gaseous form requires more technology and energy for pipeline transportation; leads to higher transportation and infrastructure costs as compared with oil	Sunk costs related to high-cost, dedicated transportation infrastructure	Contractual: long-term contracts; destination clauses; take-or-pay clauses
	Gaseous substance requiring active pressure management to keep system in physical balance	High networkness requires high investments, close coordination to maintain working pressure	Risk of stranded assets (in case a different route or source of energy is chosen)	Contractual: long-term contracts
		Risks higher than in the case of oil due to higher cost of infrastructure	Sunk costs	
Oil	High value per unit of volume, liquid, many transportation options	Due to its physical characteristics, can be refined almost anywhere, adding to issue of coordination with processing actors	Coordination of midstream processing	Vertical integration and control of midstream (processing) and downstream distribution to keep more value added within producer firm
			Risks due to price volatility	Outsourcing
			Risk of stranded assets due to importers' ability to access crude oil via multiple transportation options	Risk-hedging through diversified economic activities and futures trading

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oal	Low value per unit of volume, solid "bulk cargo," relatively limited transportation options	Solid nature requires more human involvement and transshipment coordination	Coordination between large numbers of stakeholders	Vertical integration
		Typical low value per volume leads to less resources available for weatherproof storage	Risk of physical loss of the coal mass, or energy value loss from degradation in transit	
		Wide variety in thermal value and other qualities	Difficult standardization due to wide variety in thermal value and other qualities	(Multiple submarkets for different grades)

CONCLUSION

This chapter's discussion has shown how the physical features of various types of energy (e.g., physical state, homogeneity, energy density, CO_2 profile, and ubiquity) come to affect further characteristics of their typical supply and value chains (e.g., transportability, type of markets and processing, ability for cartelization, investment patterns, substitutability, role in nonenergy value chains, and networkness), all of which, in turn, will affect relationships between actors.

We have also seen how these materiality differences affect both external and domestic relationships. Thus, for example, issues such as an energy good's physical state, along with its degree of within-good homogeneity and related commodificability will affect its transportability and marketability, in turn affecting external energy relations. These characteristics will also affect transparency (or the lack thereof) in pricing, affecting possible arbitrage gains. We also saw how the different ways in which natural gas, oil, and coal value chains interact with the value chains of nonenergy products have important implications for the ability of specific players to gain power, not only or not necessarily in terms of their "power over" others, but first and foremost by becoming socially constituted and empowered to take on increasingly prominent roles ("power to") at a variety of levels, ranging from informal economic groups to firms to political actors. These roles become especially important because, for example, coking coal-dependent metallurgy in Ukraine and Russia constitutes one of the largest sources of export revenue for these countries and has consistently produced some of their wealthiest and most influential business actors. Energy-good-specific rents contributed to the emergence of important political players and groupings, to their increased power, and to their ability to influence policymaking.

Paying attention to materiality also helps us better understand the relationship between the external and domestic levels: by creating opportunities and constraints for relationships between actors, materiality characteristics can also affect the nature of transborder coalitions, to the point that these may be able to trump officially declared state energy policies or challenge the applicability of otherwise seemingly reasonable policies. To give but a preview, let us consider the long-standing issue of the Nord Stream pipeline bringing Russian natural gas to Germany directly, and the issue of compliance with the European Union's regulations requiring gas pipelines in EU territory to offer third-party access (and to have the spare capacity to back it) to other suppliers and banning pipeline owners from also being the providers of the gas carried by the pipeline.[85] In the case of the OPAL pipeline—connecting Nord Stream's end point, Lubmin, with Olbernhau on the German-Czech border—it is not possible to offer this capacity, because there is no other possible source of natural gas for this pipeline, which was built specifically to transport natural gas imported via Nord Stream. At the same time, the materiality characteristics of natural gas as a physical substance create important constraints: being lighter than air, natural gas easily dissipates if not contained, and thus must be under a certain minimum amount of pressure in order to travel through the pipeline. What this means in practice is that certain minimum volumes need to be maintained for the pipeline to be functional, making use of the pipeline at low capacity not an option. In this way, introducing materiality considerations into our analysis makes us look at issues such as the European Union's spare capacity requirements in a new light.

Looking at materiality and at the physical, material chain linking the various stages of energy production and use provides a different perspective compared with the one you would get by just looking at energy as an abstract concept and a political instrument. The subsequent case study chapters illustrate how such an approach can be used to understand long-standing issues in a new way.

PART TWO

Hydrocarbon Chains and Political Power