

Resisting change? : the transnational dynamics of European energy regimes

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4 Resisting Change?

The Transnational Dynamics of European Energy Regimes

Erik van der Vleuten and Per Högselius

4.1 INTRODUCTION

Numerous scholars, policy makers, civil society organizations and entrepreneurs have observed that changing present-day energy systems is difficult. This difficulty persists despite increasing political and public support for a sustainable energy transition, aiming to reduce such vulnerabilities as the depletion of fuel reserves, geopolitical energy dependencies, electricity blackouts, climate change and other forms of environmental degradation. Moreover, present-day prospects for solar, wind, hydro and geothermal power—and some would add nuclear power, biomass or ‘clean’ fossil fuel usage and conversion—seem to make a more sustainable energy supply technically possible (Pacala and Solocow, 2004). So is energy saving. If modern energy systems are difficult to change, it is not for a lack of imagination or practical options.

To examine the difficulties of energy system change, a number of innovation scholars shifted their gaze from new energy options to the persistence of the incumbent energy sector. Apparently existing energy systems resist radical change due to historical legacies of sluggishness, path-dependency and lock-in on conventional key technologies, and vested interests (e.g., Kaijser, Mogren and Steen, 1991; Islas, 1997; Van Santen, Khoe and Vermeer, 2007). In more general terms, the analytical focus shifted from isolated energy innovations and measures to the dynamics of incumbent socio-technical energy *systems* (Hughes, 1983, 1986, 1987; for a review, see Van der Vleuten, 2006), *complexes* (Unruh, 2000, 2002; Unruh and Carrillo-Hermosille, 2006), or *regimes* (Kemp, 1994; Rip and Kemp, 1998; Kemp, Schot and Hoogma, 1998; for a review, see Geels and Schot, 2010). Although differing in emphasis, these notions converge in foregrounding that incumbent energy systems are difficult to change because they are constituted by historically shaped alignments of many technical and non-technical components. Such heterogeneous components as fuel extraction, conversion and transport technologies, standards, consumer desires and habits, stakeholder interests, employment and government regulation were mutually adjusted and aligned into a stable and working socio-technical

energy constellation. This constellation today makes available immense volumes of energy, in a variety of forms, to millions of users. The flip side of the coin, however, is that these historically aligned components interlock and keep each other and the entire constellation in place, thus producing—in theory—a resistance to radical change.

The present chapter follows up on this line of research. In the terminology of the Multi-Level Perspective on sustainability transitions that informs this book, it examines the dynamics of stability and change of incumbent energy regimes. Scrutinizing if and how such regimes resist change, we make theoretical as well as empirical contributions. We start with a theoretical consideration of the notion of regime that constitutes our unit of analysis, and propose several amendments to existing practices of regime analysis. In particular, we call for symmetrical analysis of regime stability and change; make a case for a *transnational* perspective on transitions, and on regime dynamics in particular; and explore landscape-regime interactions as a site for negotiating transnational regime stability and change.

Then follows an empirical examination of the long-term dynamics of two important transnational energy regimes: electricity and natural gas. These regimes are at the heart of present-day energy problematiques. The 2007 energy balance of the European Union (EU-27), for instance, features an energy input (domestic production plus imports) of about 1848 million tons of oil equivalent (European Commission, 2010: 41). Some 20 percent, mostly oil, is used for transport purposes, and another 6 percent constitutes non-energy use of oil and gas as feedstock in the chemical industry. Of the remaining 74 percent the bulk is transported as natural gas, or after conversion as electricity, to agricultural, industrial, service and household users. Although this figure includes huge conversion losses, electricity and natural gas regimes clearly are key to any European energy transition.¹

Our empirical examination takes the form of a structured historical narrative. After all we engage with a line of transition theory that is a process theory, appreciating and capturing the role of historical contingencies and path dependencies in unfolding transition dynamics (Geels and Schot, 2010: 95–101). We first analyze the historical shaping of incumbent electricity and natural gas regimes. Against this background, we discuss more recent and ongoing regime dynamics and their sustainability implications. Finally, we briefly reflect on our theoretical and empirical findings.

4.2 SOCIO-TECHNICAL REGIME THEORY

The sustainability transitions literature is somewhat confusing on terms such as socio-technical system, complex and regime, which appear in several different meanings and relationships.² In this chapter we derive our understanding of the notion of ‘socio-technical regimes’ from the Multi-Level Perspective on transitions (Geels, 2002; compare the introduction to

this book). Regimes here stand for relatively stable, incumbent socio-technical energy constellations. They constitute a meso-level analytically distinct from the micro-level of technological niches, where actors experiment with radical innovation such as renewable energy technologies that may challenge dominant regime practices (Raven, this volume); and the macro-processes and events in the socio-technical landscape, which by definition are beyond the influence of niche and regime actors yet may destabilize dominant regimes, e.g., oil crises, the Kyoto Protocol, terrorist attacks, nuclear accidents, or financial crises. In this three-level perspective on transitions, our meso-level regime concept thus needs to capture the entire dynamics of the incumbent energy system, unlike more 'narrow' traditions of regime analysis studying either governance structures and rules of the game (Thue, 1995; Kaijser, 1996) or paradigmatic R&D search heuristics (Nelson and Winter, 1982; Van den Belt and Rip, 1987; Lee and Lim, 2001).

Given this broad focus on the dynamics of incumbent energy sectors, the important connotation of the socio-technical regime concept for us is that multiple technical and non-technical elements (power plants, legislation, company strategies, consumer appliances and habits etc) are interrelated in a common logic. Because this common logic is crucial for processes of regime stability and change, these elements should not be studied in isolation, as studies of technological, political, economic or cultural 'factors' in energy transitions tend to do. Having said that, different authors emphasize different mechanisms to account for this common logic. Several transition scholars argue that socio-technical regimes gain their coherence from meta-organization by 'rules': such mental (guiding ideas, beliefs and expectations on technological innovation; norms and values) and regulatory (laws, standards) constructs provide the 'grammar' of the regime (Rip and Kemp, 1998; Geels, 2002, 2004; Geels and Schot, 2010). By contrast, studies of socio-technical systems often locate this logic in the process of 'system building': individuals or organizations manipulate and align heterogeneous components such as technological infrastructure, institutional arrangements and rules into a workable socio-technical whole. This process may be centrally coordinated (Hughes, 1983, 1987) or distributed and contested (Kaijser, 2002; Disco and Van der Vleuten, 2002). Finally, yet another stream of energy regime analysis foregrounds the role of institutions, organization and governance structures that interact with technological systems (Thue, 1995; Kaijser, 1999, 2003).

Most of these authors, however, agree that technological infrastructure, actors and organizations, and guiding ideas and rules mutually constitute and reinforce each other, and that—theoretically—these interlockings give incumbent energy systems their stability and resistance to external transformation pressures. Vested stakeholder interests, deeply entrenched consumer habits, regulation may counteract the introduction of a radically novel technology that comes with new market players, consumer practices and legislation. In this chapter we study socio-technical energy

regimes in terms of these three interacting dimensions, with one minor adaptation: Taking 'formal rules' out of the 'rules' category and grouping them with 'actors and organizations' into a category of 'institutions', we study the material (technological infrastructure), institutional (actors, organizations, formal rules), and discursive (soft rules: guiding ideas, expectations) features of energy regimes, without a priori privileging any of these dimensions as the chief force of stability or change (cf. Verbong and Van der Vleuten, 2002; Van der Vleuten and Raven, 2006; Van der Vleuten et al., 2007).

In addition to these preliminary delineations, we wish to raise a few additional concerns regarding regime analysis.

First, a regime analysis of the kind that we have just described should not take for granted the 'conservative' nature of regimes and their resistance to major change. Theoretically, we may expect that the interaction and alignment of many technical and non-technical components constituting the regime may resist radical change, because a change in one component will be counteracted by the others. Yet by the same token of interconnectedness, hypothetically the change of one component may trigger a chain reaction that ultimately reshapes the entire regime. Several studies provide hints in this direction. It has been observed that regimes may produce radical, next to incremental and regime-conserving, innovation (Godoe, 2000; Van de Poel, 2003). Also 'closed systems' or regimes may open up and reconfigure due to external as well as internal processes, such as congestion, 'negative externalities' as pollution, or changing competitive advantages (Summerton, 1994; Markard and Truffer, 2006). Indeed 'transition pathways' may originate inside or outside incumbent regimes (Smith, Stirling and Berkhout, 2005; Geels and Schot, 2007, 2010). To complicate matters even more, in periods of regime transition some components might be preserved (say the technological infrastructure), while others are subject to radical change (say ideologies or formal rules); lock-in and change may co-exist in one and the same regime process (Van der Vleuten and Raven, 2006). These insights suggest that in order to comprehend regime dynamics, we need to study regimes with an open mind and search for internal stability as well as change. In other words, we call for a symmetrical analysis of regime stability and change (cf. Pinch and Bijker, 1984, on symmetrical analysis).

Second, in this chapter we make a case for a *transnational* perspective on transitions, and on regime dynamics in particular. In our reading, most transition research seems to tacitly and uncritically reproduce the nation-state as its presupposed core category of analysis. Such a priori nation-centered analysis includes nation-nation comparisons and nation-nation transfer studies, which equally frame transition dynamics in fundamental national boxes. In case of the Multi Level Perspective on transitions, the three constitutive levels of niche experiments, regime structures and exogenous landscape developments explicitly denote scales of structuration and stability, *not* spatial levels (Grin, Rotmans and Schot, 2010: 4). Yet in want

of explicit spatial conceptualization, here, too, a nation-centered format is easily reproduced. Niches and regimes are overwhelmingly framed as 'national' entities, say the Danish, Dutch, Swedish or German biomass, biofuels, wind energy or photovoltaics niches and ditto electric power or natural gas regimes. International dynamics tend to be analytically 'exogenized' to the macro-level of landscape developments; the international dimension of regime and niche organization fades from view.

A transnational perspective in transition studies may answer the call by Smith et al. (2010: 443) to start investigating the 'geography of transitions'. Notably, such transnational analysis is *not* about abandoning national analysis in favor of higher, say European or global, scale level (we strongly disagree with authors such as Robinson [2002]). Rather, it is about actively interrogating the configuration of transitions in terms of specific entanglements and intermeshings of local, national and international dynamics (Van der Vleuten, 2008). Whereas such a perspective may enrich landscape as well as niche analyses, it is particular important for regime analysis: We argue that transnational entanglements constitute an often missed arena mediating regime stability and change. Cross-border entanglements and interdependencies in terms of technological infrastructure, system operation, reliability management, financial investments, exchange contracts or organizational structures may counteract any power company or national government attempt to achieve radical change in isolation. And *vice versa*, in line with our first observation on symmetrical analysis of regime stability and change, such transnational entanglements may constitute an avenue for a radical change chain reaction.

A third consideration on regime analysis concerns the assumption of 'exogenous' landscape developments impacting on regime dynamics. As noted, the Multi-Level Perspective on transitions analytically carves up the transition process in landscape, regime and niche developments. The notion of socio-technical landscape primarily serves to draw into the analysis external pressures (e.g., oil crises, terrorist attacks, international law) that destabilize regimes, and hence provide a window of opportunity for niche-level radical innovation (Geels, 2002). Such landscape pressures by definition are beyond regime and niche actors influence; they impact and unsettle the regime from the outside (Geels and Schot, 2010: 23, 24).

This form of analysis poses two problems. Analytically, it obscures how phenomena analytically separated by 'landscape' and 'regime' classifications may connect and co-evolve. For instance, studying geopolitics as an exogenous landscape factor affecting the natural gas regime 'from the outside' would obscure the reverse relationship, i.e., actors using the construction of gas pipelines to change geopolitical relations (cf. Hugill, 1993, 1999; Van der Vleuten and Kaijser, 2006; Högselius et al., forthcoming). Second, there is a political caveat: the classification of phenomena as 'exogenous landscape factors' places them outside the sphere of regime actor-influence by definition, and thereby also outside the scope

of transition policy making; landscape-regime distinctions thus have policy implications and are politically laden (cf. Shove and Walker, 2007). For these two reasons, regime analysis should actively study the logic of regime-landscape interaction (compare the study of niche-regime interactions in Raven, this volume).

Following up on these theoretical observations, the next sections explore the long-term dynamics of the European electricity and natural gas regimes in terms of their material, institutional and discursive aspects. We search for stability as well as change, transnational dynamics and landscape-regime interactions. Notably this exercise has become empirically possible only recently: Energy histories, too, have long taken the form of nation-centered analysis. We here build on recent insights that follow on a transnational turn in the history of technology (Misa and Schot, 2005; Van der Vleuten, 2008) and historical studies of Large Technical Systems in particular (Van der Vleuten and Kaijser, 2005, 2006). It should be noted that the relative novelty of transnational energy historiography puts many constraints on our analysis. Most important, perhaps, is that we offer a supply-perspective on energy regimes; the role of demand is elaborated elsewhere in this volume (Shove, this volume).

4.3 BUILDING THE INCUMBENT ELECTRICITY SUPPLY REGIME

“These blackouts . . . are unacceptable. The EU needs an internal market based on the very highest levels of system security. These incidents show, once again, that events in one part of Europe impact on other parts and again confirm the need for a proper European energy policy. . . . I intend to . . . (i) propose that a formal European grouping of Transmission System Operators be created at EU level . . . , (ii) institute a mechanism to ensure that . . . standards are formally binding on network operators and (iii) propose a European Priority Interconnection Plan.” (European Commission, 2006a)

With these words Andris Piebalgs, then Energy Commissioner of the European Commission, the executive body of the European Union, reacted to the ‘European blackout’ of 4 November 2006 (Van der Vleuten and Lagendijk 2010a). This quote captures several vectors of regime change desired by the Commission, thereby revealing important aspects of the old, incumbent electricity supply regime that the Commission tried to get away from. *Institutionally*, a ‘proper European energy policy’ should transfer power grid governance from the power sector and national governments to the European Union level. *Materially*, the blackout spreading from Germany to Portugal suggests that Europe’s power grids were interconnected, yet the Commissioner desired additional interconnections to enhance reliability—and create a “true inner market,” as he stated elsewhere. *Discursively*, Piebalgs reframed Europe’s incumbent

electricity regime in terms of transboundary threats to European energy security, inner market building and ecological sustainability (absent in this particular quote; compare Piebalgs, 2009), all of which supposedly demand EU-led change. In line with EU cultural policy (Shore, 1993) the very term 'Europe' is rhetorically equated to EU territory and governance. Just a few years earlier, the Commission and the power sector alike still found decentralized organization secure, well-working and 'European' (Van der Vleuten and Lagendijk, 2010b).

In the following, we first portray the contours of the incumbent electricity regime that had stabilized by the 1970s. On this basis we discuss how this regime engaged with recent and ongoing landscape pressures for radical change. Unless otherwise noted, we build on detailed historiographical examination published elsewhere (Lagendijk, 2008; Van der Vleuten and Lagendijk, 2010a, 2010b; Lagendijk and Van der Vleuten, forthcoming).

Institutional Make-up

We start with the institutional make-up of Europe's incumbent electricity supply regime. This institutional make-up, in which we include social structures for building, operating and regulating electric power systems, emerged and stabilized in the post-World War II decades. However, to comprehend its logic, we need to briefly revisit pre-war developments.

On the eve of World War I, commercial companies, municipalities and other lower governments, and rural cooperatives had been the key players in European electricity supply. They owned power stations that were predominantly located near consumers in cities and villages, and which were mostly operated in isolation from other power plants. The First World War brought fuel shortages and economic nationalism. With these came state government interventions and support for national *power pools*, interconnecting different power plants—in particular distant hydropower and thermal power plants based on coal and lignite—into one system with an allegedly superior fuel economy. A bit later, the boom in ideologies and movements for European Union promoted ideas of a supranational Pan-European power pool, supported by such intergovernmental organizations as the *League of Nations* and the *International Labor Organization*. In terms of Hughes's (1983) classic analysis, exogenous 'landscape' developments (fuel shortages, economic nationalism, Europeanism) broke the momentum of the pre-war electricity regime (isolated, decentralized plants run by a variety of local actors) and enabled regime change (integration in power pools and the entry of new powerful actors). However, we may also make the opposite case: Power pool advocates sought to promote ongoing regime developments (power pool integration) by highlighting its possibilities for national and European economic integration and luring state governments and international organizations into action. In this interpretation, regime developments provided leverage for economic nationalism and Europeanism.

Already here we may speak of landscape-regime interaction rather than one-sided impact.

The repeated confrontation of these forces ultimately produced the incumbent electricity regime that we are searching for. In the 1930s existing utilities and nation states teamed up as the main players in electrification: Power companies identified the company and country levels as the most promising in terms of markets, financing and regulation. States offered protection of (vertically integrated) company monopolies in return for their electrification efforts. Europeanist politicians were isolated, and the prospects for a supranationally owned and financed power system faded away. After the Second World War these alliances between power companies and states successfully thwarted American Marshall Planners pushing a supranational power system, and further strengthened their own position.

The resulting dominance of state-protected, sometimes state-owned, power company monopolies was complemented by new structures for international collaboration focusing on coordination and standards rather than financing, ownership, construction or management. The *Union for the Coordination of Production and Transmission of Electricity* UCPTE was established in 1951 by representatives of Austrian, Belgian, Dutch, French, Italian, Luxembourg, German, Swiss power companies to facilitate and coordinate cross-border electricity flows. After 1960 similar organizations emerged in Scandinavia (NORDEL), Southern Europe (UFIPTe and SUDEL, which merged with the UCPTE a few decades later), and Central Eastern and Eastern Europe (CDO-IPS). These organizations helped align national or company systems into a transnational pool by promoting innovation trajectories, setting voluntary standards, fostering a common identity, promoting interconnection and synchronization of member power grids, coordinating cross-border electricity trade, and successfully lobbying for liberalization—which in the 1950s meant abolishing national restrictions on cross-border electricity trade (Lagendijk, 2010). Power companies in the UCPTE zone started synchronous cooperation, meaning that all electromechanical machines in the pool move in tune irrespective of national borders, in 1957.

In this multi-layered model of transnational organization, the company-state axis remained central. All international organizations except the socialist CDO-IPS exclusively used soft power as voluntary, non-governmental associations of power company representatives. Individual power companies kept full autonomy in construction, production and supply, as well as cross-border power exchanges. Furthermore, the prominence of the state-company axis was mirrored by the development of a European patchwork of nationally specific institutional arrangements within the loose international frame (Kaijser, 1996, 1999; Van der Vleuten, 1999; Millward, 2005). This national institutional embedding of the incumbent power regime took many visible and hidden forms. By the late 1980s the European Commission started to criticize this model but found it difficult

to change. For it was kept firmly in place by interlocking aspects such as nationally specific ownership and operation; fiscal and financial treatment (tax deductibility, asset evaluation and depreciation policies, capital market access); standards and administrative constraints (technical standards, environmental and security standards, land use policies, fuel policies); monopolies and exclusive rights; and intransparent deals with very large consumers (European Commission, 1988).

Technological and Discursive Embedding

This short analysis suggests that the incumbent electricity supply regime's institutionalization co-evolved with its technological infrastructure. Accordingly, transnational power grids, too, gained a multi-layered and—from an all-European perspective—decentralized character. By the mid-1970s electric power grids had transcontinental, meso-regional, national and sub-national layers. Transcontinental electrical integration existed but was extremely weak in terms of power lines and lack of synchronized operation at a common frequency. Meso-regional integration (in the UCTE, NORDEL, CDO blocks etc.) was stronger, hosting more frequent power exchanges in synchronously operated power pools where all electromechanical machines operated in tune. However, electric integration was still stronger within individual countries. By 2000 Germany and France had an import capacity below 10 percent of their domestic production capacity, while the corresponding figure for Italy, Greece, Spain and Portugal did not even reach 5 percent (Verbong, 2006). Finally, while some countries possessed state-run national power pools, others were characterized by even further decentralization. In Germany, the Netherlands, or Denmark at the eve of the neoliberal era, single company systems were organizational and technical gravity centers even within national power grids (Van der Vleuten, 1999; Eberlein, 2000).

This decentralized character of the incumbent transnational electricity regime was also reflected in choices of power sources and generation. Attempts by the European Communities to establish a common energy policy since the late 1950s failed over and over again, leaving power company concerns and state government pressures for supporting domestic coal industries, hydropower resources or nuclear power as key determinants of fuel selection. Hydropower dominated in Switzerland and Austria (91 percent and 69 percent of the generation capacity in 1970), domestic natural gas in the Netherlands (74 percent in 1980), coal in the UK (63 percent in 1980) and, increasingly, nuclear power in France (53 percent in 1990) (Eurelectric, 2005).

This multi-layered transnational power regime was also discursively embedded—it became part and parcel of the power sector's self-understanding and legitimation. For instance, in the 1950s and 1960s UCPTE spokespersons developed a rhetoric repertoire linking up European collaboration, economic and reliability advantages of transnational power

pools, and—again from a European perspective—decentralized organization. This constellation was widely accepted by national governments and European Union spokespersons until quite recently.

In this discursive constellation political ideals of European integration were present, yet weak components. At celebrations spokespersons might highlight the historic importance of electricity's remarkable contribution to the ideal of a 'United Europe' (UCPTE, 1971: 1), and websites might foreground the integration of some 450 million people "from Portugal to Poland and from Belgium to Romania" at a joint "electrical heartbeat" of 50 Hertz.³ Organizational statutes and internal debates, however, lacked such European integration references. Instead they emphasized power sector advantages of cross-border collaboration: Economically, a transnational power pool enabled a rational mix of power stations, and should in particular help eliminate losses of excess hydropower in post-war Europe. In a synchronously operated pool, all available water could be led through the turbines, fed into the common pool, and reduce fuel costs elsewhere in the system. Such hydropower wastes had largely been eliminated in the UCPTE system by 1970. As for reliability, in a synchronously operated power pool generator failures would be instantaneously compensated by other generators in the pool. The larger the pool, the more generators to stabilize the common frequency: "all production units in the synchronous system jointly counterbalance the disturbance of one power station, regardless if this power station is located in Lisbon, Palermo or Hamburg, Le Havre or Vienna" (UCPTE, 1976: 167).

Importantly, these economic and high reliability arguments explicitly connected to the choice for decentralized management and operation. Over and over, UCPTE spokespersons stressed that "decentralization is indispensable for economy, security and continuity of supply" (UCPTE, 1976: 153). As for economy, already in the late 1940s the future founders of the UCPTE and its sister organizations held that "in Europe the major advantages are to be gained *within* national frontiers" (OEEC, 1950: 24, emphasis added). Additional cross-border power exchanges were welcome extra's, but should be judged on their profitability on a case-by-case basis. With this argument US Marshall Plan funds were diverted from its international power program to national projects. As for security, in the 1950s and 1960s the UCPTE and its sister organizations in other parts of Europe developed a decentralized approach to security management, based on anticipation and restoration of failures by partners in their own supply areas (Van der Vleuten and Lagendijk, 2010b). UCPTE spokespersons argued that individual power companies knew the particulars of their situation best, and a decentralized response to failures and disturbances would do a much better job than central coordination. Indeed, "the lack of a [decentralized] grid operator's empowerment and independence could be identified as a potential security risk" (UCTE, 2003: 10). A reliable system demanded decentralized management.

4.4 ELECTRICITY REGIMES IN TRANSITION

How did Europe's incumbent electricity regime, with its mutually reinforcing institutional, material and discursive components, engage with external landscape pressures for radical change? We distinguish two major waves of pressure for such radical change. In the late 1960s, 1970s and 1980s landscape-level factors such as counterculture values, environmentalism and the oil crises challenged the internal momentum of electricity supply as well as other large technical systems (Hughes, 1989, 1998). More recently (neo)liberalization, the climate change debate, fears of terrorism and widespread security obsessions, and Europeanization did the same. Here we shall briefly discuss electricity regime dynamics in the context of such pressures.

Stability and Change I: The Case of Acid Rain

To capture some of the dynamics of regime stability and change during the first wave of challenges, we will take a closer look at the case of 'acid rain'. Acid rain, largely caused by sulfur dioxide (SO₂) emissions from power stations and heavy industry that transform into acid during atmospheric transport, counts as the first major example of long-range air pollution. Causing widespread anxiety and indignation decades ago, today it figures as a European success story in emission reduction (Menz and Seip, 2004; Vestreng et al., 2007; Kaijser, 2010).

Most studies cast this story as, in conventional transition theory terms, external international landscape pressure followed by national energy regime adaptation. In brief, environmentally engaged soil and forest scientists brought 'acid rain' to the media, capturing public and political imagination with British and German sulfur emissions killing fish in Scandinavia in the 1960s and 1970s, and killing forests in Germany and Czechoslovakia in the early 1980s. Acid rain became symbolic for a global environmental crisis. Later the *dying forests* hypothesis proved a tremendous exaggeration challenging the credibility of the environmental sciences, but sulfuric damage to human health took its place (Alm, 1998; Menz and Seip, 2004; Hajer, 2005; Vestereng, 2007; Horeis, 2009). Next, this widespread public and political anxiety produced unprecedented intergovernmental environmental policy action: Especially the 1979 *Convention on Long-Range Transboundary Air Pollution* (LRTAP), targeting the protection of humankind against air pollution, was followed by explicit international emission reduction targets. Later, European Community directives followed. Next such international agreements were imposed on national industry and electric power regimes, implementing a range of desulfurization and low-sulfur technologies. European anthropogenic sulfur dioxide emissions then decreased by 73 percent between 1980 and 2004 (Vestreng et al., 2007).

A closer look, however, may turn this quasi-linear interpretation of landscape-regime impacts upside down. Levy (1995) and others have shown how ongoing incumbent regime dynamics produced international environmental politics, rather than the other way around. The initiators of the LRTAP Convention, the Russian and Norwegian governments, supported their domestic energy sectors embarking on natural gas export; international sulfur reduction agreements could support this low-sulfur energy path. Likewise French, Belgian and Swedish energy sectors were introducing (sulfur-free) nuclear power and found additional legitimation in international sulfur reduction agreements. Simultaneously these and other governments negotiated domestic emission reduction plans with their domestic power sectors and *subsequently* engaged in intergovernmental politics to change *foreign state* behavior (and, in the German case, to promote desulfurization technology exports). None used international legal instruments to enforce emission reductions at home. Instead domestic regime concerns stimulated international legislation. The relationship between landscape dynamics and regime changes, again, was intimate and complex.

In the end, the incumbent electricity regime hardly changed. *Institutionally*, new environmental policies produced an additional legislative layer, but did not fundamentally alter the centrality of the power companies, their international associations and close collaboration with national governments. Even the oft-cited ‘politically imposed’ German emission reduction success story is misleading: In fact German emission reduction legislation stemmed from a government-power sector consensus and mutual benefits, leading to voluntary implementation by the power sector beyond the legal targets. The costs could simply be transferred to consumers as long as the state guaranteed utility monopolies (Wätzold, 2004). *Materially* power grids were unaffected. The acid rain controversy supported fuel trends towards natural gas and nuclear power that were already happening. Desulfurization technology was added as a ‘technological fix’ largely solving the sulfur problem, but despite much grass-roots effort renewable energy technologies hardly came of the ground. *Discursively*, power plants did become a popular symbol for environmental pollution and lost their overwhelmingly positive connotations. Yet widespread appreciation of power sector economics and high reliability remained center stage. Europe’s multi-layered transnational electricity regime still was firmly in place.

Stability and Change II: The Dynamics of Electric EU-ropeanization

We conclude this section on Europe’s electricity supply regime with a brief interpretation of recent and current dynamics. In the 1990s and 2000s, many authors agree, new landscape pressures *did* coincide with a number of significant electricity regime changes that are still ongoing. Electricity sectors and markets currently seem to stand at ‘something of a crossroad’

(Pollitt, 2008: 64). This ongoing transition seems to connect to intertwining landscape-level phenomena such as neoliberalism and re-regulation (Rider, 1999; Sioshansi, 2001; Ringel, 2003; Markard and Truffer, 2006; Verbong and Geels, 2007), security and criticality concerns that skyrocketed after 9/11 (Gheorge et al., 2006, 2007; Van der Vleuten and Lagendijk, 2010b), and ecological anxieties following the climate change debate (Gan et al., 2007; Pollitt, 2008; Stenzel and Frenzel, 2008). Interestingly, all of these in turn intertwined with the increasing self-assertion of the European Union, which gave the other landscape developments weight and direction. We therefore take EU-led Europeanization as the entry point for our interpretation.

As in the cases of Interwar power pools and post-war acid rain, the story of electrical Europeanization is easily told in a linear format of (international) landscape pressure and subsequent (national) regime adaptation. From the mid-1980s European Communities policy entrepreneurs translated emerging concepts of (neo)liberalization and an Internal Market into the 1986 Single European Act, including a common liberalized electricity market. After several postponements EU directives 96/92/EC and 2003/54/EC aimed at administrative and legal unbundling of vertically integrated electric power monopolies into separate generation and grid companies; free (third party) access of electricity suppliers to grid; and, as a result, free consumer choice between competing power suppliers using the same 'impartial' grid.⁴ EU directives were implemented in national legislation and produced radical regime change, albeit in different forms and speeds in different countries (Sioshani, 2001; Padgett, 2003; Ringel, 2003; Meeus et al., 2005).

Security and sustainability concerns were later integrated in these EU policies. The terrorist attacks of 9/11 2001, Madrid 2004 and London 2005 boosted a European Union 'security identity' and 'security policy space' targeting transboundary threats from counter-terrorism to food safety and avian influenza (Boin, Ekengren and Rhinard, 2006). After large transnational blackouts in 2003 and 2006, electricity supply security was prominently added to the list, followed by plans for an EU electricity infrastructure regulatory agency, a reorganization of the sector's international organizations and a new EU interconnection priority plan (Van der Vleuten and Lagendijk, 2010b). Regarding climate change the 1992 *UN Framework Convention on Climate Change* and the 1997 *Kyoto protocol* were addressed in the 2001 EU sustainable development strategy and renewable energy directive. Only after the rejection of the European Constitution by French and Dutch voters in 2005, however, did the new EU charm offensive give climate change a central role: "Europe must lead the world into ... the development of a low-carbon economy... We need new policies to face a new reality."⁵ EU leaders then agreed the 20–20–20 targets of 20 percent CO₂ emission reduction, 20 percent renewable energy and 20 percent energy efficiency improvements

by 2020. Implementation measures are currently under way. Meanwhile liberalization, security and sustainability concerns were explicitly juxtaposed in the *European Strategy for Sustainable, Competitive and Secure Energy* (European Commission, 2006b).

Again, closer scrutiny of these events complicates this linear, top-down narrative. First, neoliberalization was not simply a top-down process (Meeus et al., 2005: 25) that ‘initiated a fundamental restructuring’ (Markard and Truffer, 2006: 609) of the electricity supply regime. Instead, after having successfully displaced a common EEC energy policy with international sector organizations in the 1950s, 1960s and 1970s (Van der Vleuten and Lagendijk, 2010b), and having lobbied against the initial EU liberalization attempts in the late 1980s (Högselius and Kaijser, 2010), several powerful state-sector alliances in the incumbent electricity regime identified liberalization advantages and started to push new national and EU legislation. In Germany and Sweden, large power companies saw EU-driven liberalization as an opportunity to make inroads in local monopolies of small utilities, halt local public interference and enable foreign expansion. Liberalization then facilitated the subsequent domestic and foreign expansion of major power producers such as E.ON, RWE and *Vattenfall* (Eberlein, 2000; Högselius, 2009). After an initial protective reflex, the French government and *Électricité de France*, too, captured the possibility for foreign expansion, while hampering the intrusion of foreign players on the domestic market (Padgett, 2003). Belgian power generators established *Electrabel* to reach similar goals. In different countries, different ongoing sector dynamics interacted with EU liberalization policy processes and produced different outcomes (McGowan and Thomas, 1992).

Similar landscape-regime interactions played out in the security and sustainability policy fields. For instance, British and Spanish electric utilities proactively shaped their environmental legislation, although UK players did so to keep out new entrants, while Spanish incumbents saw new business opportunities, promoted subsidy schemes and massively engaged in wind and solar energy. Analysts interpret this case as a “co-evolution of firm capabilities and institutional environment” (Stenzel and Frenzel, 2008: 2655). Such bottom-up dynamics, finally, were strengthened through the international sector organization UCPTE and the newly founded industry group EURELECTRIC negotiating with the European Commission to accommodate power sector concerns in EU liberalization policies (Lagendijk, 2010).

These combined efforts for change clearly affected Europe’s incumbent electricity regime. *Institutionally*, neoliberal policies—irrespective of support from key regime players—often triggered painful break-up processes of power company production and transport activities. The state-company axis was weakened by an increasingly assertive EU, strengthening its bond with national governments by, for example,

uniting national energy regulators in an organization dedicated to implementing EU legislation (the *European Regulators Group for Electricity and Gas* established in 2003). In the wake of the large 2003 and 2006 transnational blackouts, EU and power sector organizations clashed about the interpretation of these events and the necessary changes. The EU set up a new EU-wide regulator for power grids (ACER) and pushed the reorganization of international collaboration of transmission companies. After half a century of undisturbed work, the UCTE and NORDEL were replaced by the EU-wide *European Network of Transmission System Operators for Electricity* (ENTSO-E). Throughout these vivid changes, however, key incumbent players—Électricité de France, Vattenfall, Electrabel, RWE—retained prominent positions and they continue to be supported by their respective governments wherever possible.

These processes came with a number of *discursive* changes. The incumbent sector identity combining economic benefits, high reliability and sector-run decentralized governance was increasingly challenged. From the mid-1980s EU reports referred to trade barriers as ‘the costs of non-Europe’; in electricity as well as other sectors, decentralized organization was condemned as economically disadvantageous. Furthermore, after the large transnational blackout of 2003 EU spokespersons suddenly cast European electricity supply as ‘insecure’ as long as its decentralized organization persisted, even though power grid experts question this interpretation (Van der Vleuten and Lagendijk, 2010b). Finally, the power sector prominently figures amongst the bad guys in climate change debates. The power sector now is constantly struggling to reconstruct a convincing image of economy, reliability and sustainability.

The *material* implications of this ongoing transition process, finally, remain to be seen as various scenarios remain possible (Verbong and Geels, this volume). Incumbent regime players and the EU alike have high expectations of low-carbon technologies that fit the current infrastructure and institutional setup, such as nuclear power or de-carbonization technologies such as coal, oil and gas decarbonization and end-of-pipe Carbon Capture and Storage (Vergragt, this volume). If successful, this low-carbon path, much like the low-sulfur path that preceded it, may keep much of the existing infrastructure in place. Competing zero-carbon options such as solar power, wind power and biomass originated as small scale, distributed generation that might reconfigure the material infrastructure completely; yet incumbent players have become leading investors, up-scaling these energy alternatives to large scale production sites that could more easily be integrated in the existing material framework, thereby raising the discussion whether one may justifiably talk of radical regime change (Hirsh and Serchuk, 1996; Heymann, 1999). Power grids, finally, are the target of much thought and research working for higher transport capacities and smart integration of distributed generation and unstable energy sources such as wind power into European

energy systems. All these innovation trajectories receive massive R&D funding, but their integration in Europe's incumbent electricity regime remains to be seen.

4.5 The Making Of A European Natural Gas Regime

We now turn our attention to Europe's natural gas supply regime, which is younger than the electricity regime. Up to around 1960, natural gas played a negligible role in European energy supply, accounting for some 3 percent of Europe's primary energy. In the late 1950s and early 1960s, however, new vast natural gas fields were discovered in several regions in Europe and beyond, with the northern Netherlands, the Sahara, eastern Ukraine, Central Asia and northwestern Siberia emerging as particularly promising regions. The North Sea was later added as a further key area. In the course of the following decades, natural gas grew to become one of the most important fuels in Europe. Presently the share of natural gas in primary energy supply amounts to 25 percent on average in the EU and up to 50 percent in the Netherlands, the United Kingdom and Russia (United Nations, 2006; IEA, 2008).

Transnational gas history remains a largely uncharted field; unless otherwise stated, we here build our analysis on Högselius, Åberg and Kaijser (forthcoming).

Institutional Make-Up

The rise of natural gas had two antecedents: oil and manufactured (i.e., non-natural) gas. From the perspective of distribution and use, the rise of natural gas was understood as a transition from coal and coke gas to natural gas. From a producer perspective, it was treated as an extension of the oil business, since oil and gas finds were often co-located. As a result, the organizational structure of the natural gas industry that took shape was dominated by two actor categories: distributors with roots in the manufactured gas industry, and producers whose main business was in oil.

Because only a few gas distribution companies had access to any major gas fields in their own vicinity, most of them had to secure access to natural gas by way of long-distance pipelines, which often crossed national borders. Such pipelines were extremely expensive to build. Both importers and exporters were keen to ensure the stability of import arrangements over a long period of time, and they therefore sought to make radical future changes impossible or at least very difficult. Natural gas supply, in short, was designed to resist change.

Very long term contracts constituted a key expression of this concern and formed the institutional foundation of the European natural gas regime. Gas contracts usually covered a period of 20–25 years. They

contained extensive paragraphs defining technical aspects such as gas quality and how it was to be measured, but the key features of the contracts concerned the gas price. Governments in importing countries took an active role in assuring a 'harmonious' entry of imported gas onto their fuel markets. Hence the gas price would have to be competitive, but not too low. To reduce the risk that the gas would outcompete or be outcompeted by other energy sources, it became important to adapt the gas price to the price of competing fuels, of which the most important was fuel oil. European gas markets thereby became linked to world market prices for oil (Davis, 1984; Estrada et al., 1988).

Notably, these contracts were nearly always bilateral rather than multilateral.⁶ There was no counterpart in the gas industry to the regional groupings in the European electricity industry such as the UCPTE and NORDEL. Only in a few instances did a group of gas companies form *ad hoc* customer consortia, the purpose of which was to increase their bargaining power vis-à-vis exporters. Repeated attempts to create a common market for natural gas within the EEC failed, mainly due to the widely differing interests of member states with and without large gas reserves. As a result, Europe's incumbent natural gas regime was institutionally dominated by national governments collaborating with (often international) oil and gas companies, and bilateral long-term contracts that defined the relations between them.

Technological Infrastructure

In contrast to the electricity case, but in accordance with the prominence of international institutional arrangements of natural gas supply, international pipelines dominated the material infrastructure. Without the emergence of a nearly transcontinental pipeline network, the use of natural gas in Europe would in most countries have been negligible: Today, import dependencies average on 90 percent (the major exporters excluded). For this reason, we take a closer look at international pipeline development.

The first of these pipelines were built between neighboring countries that shared a similar political and economic culture. Once the feasibility of long-distance trade had been demonstrated, however, actors proceeded to negotiate imports and create pipeline and liquefied natural gas (LNG) links tying North Africa and Siberia into Western Europe's energy geography. Both played only very minor roles in Western European gas supplies until the early 1980s, when positive experiences with early import projects produced a growing mutual trust. In 1982 Western European intra-trade still accounted for 67 percent of all imports. In 2005, however, this figure had fallen to 45 percent—despite the surge in North Sea gas production and Norwegian gas exports. Of the non-Western exporters, Russia provided 29 percent. In addition, transit countries became participants in Europe's expanding natural gas geography. Some transit routes—for example,

through Poland, the GDR and Morocco—were seen as more risky than others, which strongly influenced pipeline trajectory choices.

Moreover, importers regarded it problematic to have all gas supplied from one source only. The quest for diversification, with the double goal of increasing both security and competition, became a powerful force in further accelerating transnational pipeline-building and transnational gas trade agreements. As a result the European pipeline geography grew more complex and competition between producers increased. The natural gas regime differed considerably from the electricity regime in this regard.

The structure of gas use, as it evolved, differed between regions. In some parts of Europe natural gas was taken into use mainly for electricity production and for industrial purposes. It became an important source of fuel for branches of industry with a particularly high demand regarding the quality of heat, notably the metallurgical, glass and cement industries. It was also important in large parts of the chemical industry, where the gas was taken into use not only for heating purposes, but also as a feedstock in petrochemical processes, notably fertilizer production. Europe's industrial competitiveness on global markets thereby became bound up in a heavy reliance on large-scale access to natural gas. In several countries, governments also supported a transition to natural gas in space heating, replacing coal and fuel oil.

DISCURSIVE EMBEDDING

Discursively, the rise of natural gas was linked to several key developments and trends at the landscape level. Up to around 1960, there was disagreement as to whether a large-scale transition to natural gas was desirable. The coal industry, in particular, felt threatened by the prospects for a far-reaching and powerful natural gas regime, fearing that natural gas would outcompete coal on European markets. The coal interests could in this connection link up with the fear of vulnerability to import disruptions, which ever since World War II was a much discussed issue when elaborating on oil supply policies. Through the discovery of Groningen and North Sea gas, however, natural gas started to be viewed as a 'domestic' energy source in Western Europe as a whole. It was this availability of large intra-European gas reserves that made it politically acceptable to gradually turn to imports from what was considered less reliable sources further away. A greater reliance on natural gas was increasingly seen as a way of diversifying away from oil at a time of global uncertainties, price volatilities and political conflicts in the major oil-producing regions.

But proponents of a radically scaled-up use of natural gas also linked up discursively with another trend that was of increasing concern, particularly from the 1960s: the environmental problems related to coal and oil. Natural gas was identified as a much cleaner fossil fuel that did not have any

smell and which burnt completely, without leaving any ashes behind. As such it was extremely attractive for both industries and households.

Natural gas imports from the Soviet Union and North Africa were closely linked to Western Europe's overall relations with these countries. It was not a coincidence, for example, that the first import agreements with the Soviet Union were concluded at a time of relaxed East-West relations. Conversely, in the 1950s and 1980s, when the Cold War reached its extremes, ideological arguments were aimed to prevent further pipeline projects. But landscape-regime interaction was not a unidirectional process. For example, natural gas was used as a political tool in Willy Brandt's New Eastern Policy of the late 1960s and early 1970s, and the quest for Saharan natural gas decisively shaped French-Algerian relations in the post-colonial era. The European natural gas regime also contributed in a decisive way to shaping both economic and political affairs in the Netherlands and Norway.

4.6 THE EUROPEAN NATURAL GAS SYSTEM IN TRANSITION

If Europe's incumbent natural gas regime was constructed to resist radical change, how did it respond to major external landscape pressures for change? In the following we discuss a number of transformation pressures that we regard as crucial to the future of natural gas in Europe. We discern three major landscape-level pressures: climate change, market reform and depletion and security concerns. Taking into account both natural gas and the gradual emergence of *alternatives*, we will focus both on landscape-regime and on regime-niche interaction.

Stability and Change I: Exploiting and Responding to the Climate Threat

Because natural gas combustion produces CO₂, a phase-out of natural gas would be welcomed from a climate perspective. At the same time, since CO₂ emissions from natural gas combustion amount to only 56 and 71 percent of the corresponding emissions from coal and oil, respectively (EIA, 1999), a transition from coal (and oil) to gas would also be welcome. Accordingly, the pressure for change is highly contradictory and strongly dependent on interpretations in nationally and regionally specific settings. It appears likely that the dynamics of future system-building will be channeled to certain regions and links between regions where natural gas enjoys greater political and market support.

Seeking to exploit the *opportunities* arising from the climate debate, the gas industry has devoted intense efforts to opening up new gas markets. This concerns, for example, an accelerated R&D and marketing offensive aiming at a transition to natural gas in the transportation sector—a sector

where gaseous fuels, despite numerous attempts in the past, have remained negligible (e.g., Engerer and Horn, 2010). Other examples include a growing reliance on natural gas for electricity generation and industrial purposes, often linked to radical technologies such as the combined-cycle gas turbine and the use of natural gas for the direct reduction of iron in the steel industry (Islas, 1997; Smil, 2003; Markard and Truffer, 2006). In all cases, the trend towards an increased reliance on gas is discursively closely linked to the perceived role of natural gas as a solution rather than as a problem. Underlying this argument, however, is the momentum of the technological infrastructure: in the absence of an already well-developed, fine-meshed transnational pipeline grid that spans most of Europe, the current expansion into new market segments would hardly be possible.

Responding to the overall *threats* of global warming, gas companies have at the same time started developing methods for decreasing greenhouse gas emissions from natural gas. This concerns both CO₂ and the main constituent of natural gas itself, methane. Methane emissions result from leaks in gas fields and pipelines, and they can therefore be counteracted through improved production and transmission technology (IEA, 2004). In addition, the gas industry has linked up with the overall efforts in the fossil fuel complex to develop a completely new infrastructure for Carbon Capture and Storage (CCS), although such a system may also increase the competitiveness of coal vis-à-vis gas (Kjärstad and Johnson, 2009; Osmundsen and Emhjellen, 2010; cf. Vergragt, this volume). Moreover, on the user side, the efficiency of gas burners and other equipment has improved markedly over the years in response to climate-related landscape pressures, thus supporting the image of natural gas as a 'green' fuel (Weiss et al., 2009).

The overall impression is that the rise of global warming as a major issue in European politics has served to boost the popularity of natural gas. Natural gas has remained extremely popular and is interpreted by an increasing number of actors as a very attractive fuel to which they would like to get and expand access. This unprecedented popularity contributes to an immense expansion and widening of the regime. Hence the IEA recently predicted that natural gas demand in the EU will increase from 532 bcm in 2006 to a level of around 680 bcm in 2030 (IEA, 2008; Söderbergh, 2010).

Turning to *pressure from niche developments*, the perhaps most interesting alternative to natural gas being debated, in the context of global warming, is the use of biogas. In contrast to natural gas, biogas is portrayed by its supporters as a climate-neutral fuel and a regenerative resource that may help solve the climate crisis (see Raven, this volume). There is at present only very limited competition between biogas and natural gas, with biogas being concentrated to niches that are very small from the perspective of the natural gas industry, notably the transportation sector and some segments of the heating business. In some countries, however, biogas is seen as a highly promising substitute for natural gas since it, in the eyes of the biogas

visionaries, could take over a significant part of the natural gas pipeline infrastructure (Fraunhofer UMSICHT, 2009; Swedish Government, 2009). Biogas has generally a lower calorific value than natural gas, but it can be upgraded to natural gas quality. A transition from natural gas to biogas, proponents argue, could thus take place by changing the source of supply only, without altering the overall regime. This aspect appears highly attractive for those who identify the systemic characteristics of the European gas regime as the most problematic feature when aiming for a phase-out of natural gas. The momentum of the system is thus interpreted not as an *obstacle* to, but rather as a *facilitator* of change. However, this argument is also used by the incumbent natural gas industry as a way of legitimizing more traditional new pipeline projects with a very long life expectancy (National Grid, 2009).

To most observers, though, the vision of fully utilizing the immense capacity of the trans-European natural gas pipeline network for biogas appears totally unrealistic, given the scarce—actual and potential—resources that could possibly be used for the production of biogas. Nevertheless, some governments have started to approve applications for new natural gas pipelines with the argument that these can later on be used for the transport of biogas. In the eyes of these stakeholders, natural gas, while not constituting a sustainable path on the long-term, is seen as a ‘bridge’ to a bright future (e.g., Swedish Government, 2009). This metaphor provides a powerful image of great importance for the incumbent gas industry.

Stability and Change II: Market Reforms and Europeanization

Another key development at the landscape level, in addition to the climate change debate, is the growing ambition to make effective use of *competitive mechanisms* in the energy sector. Within the EU, in particular, a major aim is to establish a common European market for natural gas.

As mentioned above, competition has always been an important issue in the natural gas regime. Transmission and distribution companies and, to a certain extent, major industrial gas users, have been able to select their supplier. End users, however, have been powerless in this respect. Since the mid-1980s, the EU Commission and national governments have increasingly interpreted this state of affairs as a source of inefficiency and have, accordingly, devoted much effort to further liberalizing and deregulating gas, much in the same way as in the electricity case (European Commission, 1988; European Parliament and Council of the European Union, 2003).

This trend, which remains subject to political controversy, has stimulated efforts to bring about a far-reaching transition away from one of the key elements of the gas regime, namely the overwhelming reliance on long-term contracts and the immediate linkage between oil and gas prices. Proponents of liberalization, particularly at the EU level, now interpret long-term contracts as inhibiting effective short-term competition, and

efforts are therefore channeled to enlarge international spot markets, a trend that in turn has provided new incentives for the construction and expansion of underground gas storage facilities while also giving rise to a reinterpretation of the purpose of LNG terminals (IEA, 2004). In practice, however, many characteristics of the older mode of governance remains in place. In particular, when new transnational pipelines are built, these continue to be based on very long-term contractual arrangements, for the same reasons as earlier.

Importantly, deregulatory reforms have made it more difficult for governments to directly support or oppose a certain source of energy such as natural gas, since it, in the paradigm of liberalization, is up to market actors rather than technocratic planners to make a choice of fuel. There is an obvious mismatch and a deep contradiction between the desire to liberalize energy markets and the ambition to 'govern' the energy transition, since the liberalization trend is linked to a belief in the market, not policy-makers, to alter the fundamental patterns of energy supply.

Instead, the most important actual effect of the neoliberal turn is probably that it has provided new incentives for raising the organizational and technical efficiency of the gas regime. Moreover, although the largest companies have been reluctant to accept liberalization, they have also gradually discovered ways of using it for their own purposes, for example, by requesting state and EU financial support for strengthening of the physical transmission grid, which is argued to be of key importance for the system to function in a truly competitive fashion (IEA, 2004). Both the EU and national governments have thus found themselves in a position where they de facto support a further strengthening of the existing material infrastructure and a path-dependent development of the natural gas regime.

Security and Change III: Responding to Depletion and Security Concerns

To the extent that a sustained or increased use of natural gas is desirable, the next challenge is to secure access to sufficiently large gas resources that can cover future needs. EU and North Sea gas resources are quickly being depleted. Gas production within the EU peaked in 1996 and has been in a phase of decline since around 2004. The International Energy Agency (IEA) expects gas production within the EU to decrease from 216 billion cubic meters (bcm) in 2006 to 90 bcm in 2030. Norwegian gas production will continue to increase from today's level of around 100 bcm, but not by more than 20–30 bcm, and a production peak will be reached within a decade or two (IEA, 2008; Söderbergh, 2010). Given the expected increase in natural gas demand, it is thus obvious that Western Europe will have to rely on gas resources from further away.

The main regime-internal alternative, according to most analysts, are increased imports of Russian natural gas. However, recent studies have

highlighted the difficulties expected for the Russians to actually increase and sustain their deliveries to Western and Central Europe. This has to do both with the gas fields available and with the pipeline infrastructure for bringing the gas over vast distances to the West. Whereas new pipelines are currently being planned and built for the purpose of meeting additional demand, old pipelines, which remain crucial for the stability of the regime, are often in a very poor state—both in Russia itself and key transit countries such as Ukraine and Belarus. This is one of the main reasons for both Gazprom and European players to seek control over transit companies and their networks (Goldthau, 2008). Even if sufficient Russian gas may be available for many decades, the system characteristics thus make it uncertain as to whether the supply will be sustainable.

The situation is complicated due to the strongly transnational character of the regime in combination with developments at the landscape level in terms of general political power struggles and the global economic crisis. Problems regarding gas transit became particularly critical during the four years of Viktor Yushchenko as Ukrainian President (2005–2009), characterized by extremely fierce relations between Ukraine and Russia and thereby repeatedly threatening Western Europe's gas security (Pirani et al., 2010).

Apart from seeking to improve the existing pipeline infrastructure in Russia and the rest of Europe, intense attempts are under way to expand import capacities from elsewhere, notably from Middle Eastern and African sources. Such diversification of gas imports are welcomed by those who fear that disruptions in deliveries from Russia may result not only from technical problems, but also from the potential attempt of Russia to use natural gas as an 'energy weapon', i.e., for foreign policy purposes. In this interpretation, natural gas makes it impossible for the EU to follow, should it wish to, a policy vis-à-vis Russia based on confrontation; instead, an EU foreign policy based on cooperation is necessary. The whole debate provides an obvious illustration of how the natural gas regime contributes to shaping developments at the landscape level in highly significant ways.

It is against this background that much-publicized projects such as the Nabucco pipeline from the Caucasus and possibly Iran through Turkey must be understood. Nabucco is actively supported by the EU, although EU in this context appears to be responding to system-building visions of the large gas companies rather than the other way round (see, e.g., Erdogdu, 2010). Natural gas from other resource-rich countries such as Nigeria, Qatar and Egypt have not yet seen its breakthrough in Europe, but is already of regional importance for some markets, notably Spain (United Nations, 2006). The Iberian Peninsula is of particular interest since it has very strong incentives to develop relations with such new suppliers, given their greater distance to Russian, Dutch and North Sea gas fields. A greater

reliance on LNG is widely perceived as a way of increasing importers' flexibility. The overall trend is towards an increased globalization of the natural gas regime.

Other efforts aimed at responding to the threat of depletion and import vulnerability include a focus on natural gas production from unconventional sources (e.g., tar sands) or new methods for the production of synthetic natural gas (SNG) on the basis of coal (e.g., Söderbergh et al., 2007).

All in all, there are no indications that Europe would be heading towards a phase-out or a decline in the use of natural gas. A major reason for this is the existence and momentum of a very large, pan-European technological infrastructure with no alternative use. The gas industry has been very successful in using this momentum of the existing system to its advantage, turning landscape pressures for change into major opportunities for further expansion of the regime without altering its fundamental configuration. The overall effect so far of recent and current landscape pressures has thus been an increased rather than a reduced European lock-in on natural gas.

4.7 CONCLUSIONS

In this chapter we discussed patterns in energy regime stability and change. Translating basic regime theory into empirical inquiry, we described the historical shaping of incumbent European electricity and natural gas supply regimes in terms of interacting material, institutional and discursive features. These well-aligned, interlocking features provided considerable regime stability by the 1980s.

Next we studied how these regimes engaged with such challenges as (neo)liberalization, climate change, energy security concerns and EU-driven Europeanization. Our findings challenge the dominant assumption in early transition research that incumbent regimes resist radical change. In line with more recent transition pathway studies (Smith, Stirling and Berkhout, 2005; Geels and Schot, 2007, 2010), we found a more complex picture. Incumbent regime actors might attempt to neutralize pressures for radical change: electricity regime actors responded to the acid rain challenge by means of a technological fix, and gas regime actors appropriated the climate change threat by diversifying their markets. But regime actors may also initiate or stimulate change processes: Contrary to conventional wisdom, incumbent regime actors—producers, users, regulators—at times actively pushed liberalization or environmental policies to support ongoing regime developments.⁷ Moreover, stability and change often co-existed in ongoing regime processes (cf. Van der Vleuten and Raven, 2006). Even during significant regime reconfiguration, important regime elements by and large stay in place, leaving a variety of

possible process outcomes for the extent and form of change (cf. Verbong and Geels, this volume).

These complex regime dynamics became analytically visible, we argue, because of three regime theory additions. Recent research agendas (Geels and Schot, 2010; Smith et al., 2010) hint at these, but in our view do not develop them sufficiently. First, despite several studies suggesting regime-internal capacity for change, by far most transition research continues to define and study regimes exclusively as a site of resistance to change that needs to be 'opened up' (Smith et al., 2010: 445). In order to scrutinize this assumption, we proposed a symmetrical analysis of regime *stability* and *change*. Transition research needs to investigate what changes and what stays the same, and why. After all, interaction between regime components is not a law-like property; their couplings are negotiable and can be tightened or loosened.

Second, in want of explicit spatial conceptualization much transition research implicitly frames its subject in national settings. Using a transnational analysis perspective, however, brings into view how regime processes reify and cross political borders. Transnational regime analysis brings into view the geography of transitions (Smith et al., 2010). In electricity, we found a incumbent regime geography with a particular extension (including and excluding countries) and densities (combining weak pan European, stronger meso-regional and pivotal national and company dimensions). In natural gas, we found international gas relations (international pipelines and bilateral long term contracts in particular) dominant as by far most countries are gas importers. Current dynamics challenge and partly modify these transnational constellations, not least because of a new alignment between European Union, national legislators and large power producers. Moreover, transnational analysis addresses the classic question of regime stability and change, which are not driven by companies or governance in isolation: companies, sector international organizations, national legislators and bilateral negotiations and treaties were entangled in one and the same transnational space where regime dynamics played out.

Third and finally, regime analysis needs to cross the analytical boundary between supposedly exogenous landscape developments and indigenous regime dynamics. Although in the multi-level perspective on transitions, transitions are believed to result from the *interaction* of regime, niche and landscape developments, only niche-regime interactions have been seriously studied (Smith et al., 2010: 443). We have demonstrated that landscape-regime interaction, too, is a crucial site for regime stability and change. The cases of international environmental legislation, neoliberalization and Europeanization were negotiated across this boundary in a complex and two-way process, which cannot be reduced to (international) landscape dynamics impacting on (national) regime dynamics.

NOTES

1. After conversion and transport losses, users receive merely 289 Mtoe of electricity and 269 Mtoe of natural gas (European Commission, 2010: 41).
2. Thus, for some, a system may contain several regimes (Markard and Truffer, 2006: 611); for others, socio-technical systems (including artifacts, infrastructure, markets, regulations) are a component of a socio-technical regime next to social networks and articulated rules (Geels, 2002; Geels and Schot, 2010: 19). The notion of regimes, furthermore, may refer to this interlocking of rules, organizations and institutions, and technology (see also Berkhout, Smith and Stirling, 2004), or specifically to refer to different kind of rules (Geels, 2004) or governance forms (Thue, 1996).
3. <http://www.ucte.org> (accessed 17 August 2004).
4. Although inspired by British, US and Norwegian examples, EU legislation is generally held decisive for the subsequent transformation of the European power sector except for the independent liberalizations in Sweden and Finland.
5. Commission president Jose Manuel Barroso cited in Associated Press, "Low-carbon economy proposed for Europe. Eyeing warming and volatility, EU leaders expected to approve it in March," 10 January 2007.
6. Multinational organizations such as the International Gas Union (IGU) and the Gas Working Group of the Economic Commission for Europe (UNECE) did exist, but did not take any direct influence on the institutional arrangements of pipeline construction or international gas trade.
7. This is also true for other sectors. Consider, for instance, the role of Europe's large companies gathered in the *European Roundtable of Industrialists* (established 1983), playing their regime role of large transport, telecommunication and energy users, in getting deregulation and infrastructure policies on the EU agenda (MacGowan 1993).