Energy systems transformation and the political economy of climate change

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Abstract

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Climate change mitigation requires immediate and enduring cuts to greenhouse gas emissions, achievable only through the transformation of today's fossil fuel energy systems. Those systems today provide high-quality, inexpensive, and dependable energy to industrial societies. The low-emissions renewable energy systems that would replace them are, as of 2013, still more expensive, more complex, and unproven.

This combination of factors makes the political economy of climate change mitigation immensely difficult. Achieving real emissions reduction will impose very large material costs powerful interests, in pursuit of distant–if potentially massive–environmental benefits. These conditions are not auspicious for adopting, much less sustaining, effective climate policy.

Yet an increasingly large number of countries have taken explicit or implicit action to reduce greenhouse gas emissions. These actions include emissions pricing schemes, renewable energy research and development, energy efficiency mandates, technological research and development, and a host of other policies. The list of states pursuing such policy is as diverse as the policies themselves: the European Union, South Korea, India, and even China have adopted some or all of the provisions outlined above.

This dissertation addresses how states have overcome the apparently sizable barriers to climate change mitigation. It argues that successful states have made progress

by choosing policies that target environmental ends with economic gains. Those gains comes through benefits derived from the transformation of national energy systems–transformations that improve energy security, increase economic competitiveness, improve technological leadership, or target other opportunities and challenges in the legacy energy infrastructure. By targeting such areas explicitly, these policies create new constituents with a material stake in long-term policy stability. Those constituents act as valuable political allies in the political fight over the scale and distribution of costs for emissions reduction.

But while such policy strategies have proven successful to date, they do not resolve the underlying problem of cost that has plagued climate change mitigation to date. Massive emissions reduction still poses net economic costs, even if it yields huge positive environmental benefits. The benefits created by a low-emissions energy systems transformation can offset those costs, and if targeted can create supportive economic constituents. But the low-emissions energy systems of the future still do not, as of this writing, offer any novel economic or technological improvements over the reliably and ubiquitous energy we enjoy today. Hence these policies remain at risk of disruption from outside forces. The recent policy stagnation in the United States and Europe point to the risks posed by this inherent policy vulnerability.

For Emily

There at the beginning, the end, and forever

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I was also lucky to have had a dissertation committee that embraced what was a slightly odd take on a political science dissertation. Alison Post reliably asked more pointed versions of the nagging questions I had about my own work; and provided a sympathetic ear for bemoaning the disinterest that much of political science has in the technical nuances of industrial infrastructure that so often shape policy in more ways than we know. Paul Pierson embraced my interest in the practical details of politics. Finally, Michael Hanemann noted in my prospectus defense that he wasn't a political scientist and so wasn't quite sure how he should contribute; but then proceeded to point out all sorts of parallels to my own argument that later came to enrich the dissertation and my own thinking immensely. Moreover, everyone was immensely helpful in my pursuit of academic job market, and even more supportive of my choice to ultimately depart it.

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who put up with the neurosis-inducing process that is academic hiring, and who endured more conversations about renewable energy than she likely every expected. Our future lies in the west.

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1 Introduction: Climate politics and energy systems

Addressing the threat of global climate change will require significant, long-term reductions of greenhouse gas emissions by industrial economies. Those emissions result, primarily, from fossil fuel energy. Short of rapid progress on highly risky technologies like nuclear fusion or emissions sequestration, taking emissions out of the energy supply will require the large-scale adoption of wind, solar, geothermal, and biomass-based energy. While we can imagine how this shift to renewable energy sources might occur, in many cases the technologies required are nonexistent or relatively new, and experience in operating them limited. They are, as a rule, more expensive than the fossil fuels they replace. Moreover, the industrial economies and their citizens expect that the switch in energy sources will occur without disrupting the economic and social activities that depend on reliable, ubiquitous, and relatively cheap energy.

Hence climate change mitigation poses a political and economic problem of the highest complexity. But while the motivation is new, the nature of the change itself is not. Since the start of the industrial age, the world has seen a series of new energy sources emerge to find their place in the global economy. Coal replaced wood starting around 1600. Oil later supplanted coal, particularly for transportation, starting in the latter half of the 19th century. Natural gas and nuclear energy became major contributors to global energy consumption in the 20th century. Among all of these, however, electrification had perhaps the largest impact, not just on where energy came from but also on its ubiquity, reliability, and portability.

Climate change policy shares a logic of systems transformation with each of these earlier epochs. Prior changes in energy sources saw substantial reconfiguration of energy production, distribution, and use. Those reconfigurations required not only technological innovation and investment, but also a host of changes to how energy markets were regulated, and the behavioral and social patterns of the society at large. And, while each of these earlier transformations occurred in large part because of the superiority of the new energy source, that superiority often proved insufficient on to drive adoption on its own. The state–as regulator, financier, landowner, and policeman–played important roles in each.

But climate change departs significantly from earlier energy systems transformations in two vitally important ways. First, the benefits offered by the new energy source are, for the most part, distant and tangential to the economy. Avoiding the worst ravages of climate change will require immediate action to avoid damages far in the future. If successful, the benefits from climate change mitigation will arrive mostly in the form of costs avoided, rather than improvements gained. And the beneficiaries of action will be the children and grandchildren of those who must pay for it. Thus the primary motivation for this transformation provides only weak incentives for the actions required to initiate and sustain it.

Second, the new low-emissions energy sources offer few obvious advantages compared with the fossil fuels they must displace. Indeed, climate change mitigation will require significant investment to ensure that the natural variability of solar, wind, tidal, and other sources of renewable power does not disrupt economies dependent on reliable, constant supplies of power. And despite these potential–if entirely manageable–

shortcomings, renewable energy will, in the near term, cost more than fossil fuels. These differences mean a transformation that, in human terms, stands in stark contrast to the experience of someone born in 1880, who grew up with gas light and coal heat, but died in the age of electricity, television, and radio.

This dissertation considers the resulting political economy of a low-carbon energy systems transformation. Chapter 2 introduces the problem of climate change and demonstrates the necessity of significant changes to the energy system in order to confront it. Like earlier transformations, decarbonization of the energy supply will require a series of parallel and complementary changes in how we produce, distribute, and use energy. Technologically, that means a directed set of innovations and investments ultimately capable of providing the reliable, ubiquitous, and reasonably-priced energy on which modern economies rely. Economically, that means a range of changes to the markets that frame investments in energy infrastructure, markets for energy supply and demand, and incentives for energy conservation. And socially, it implies changes in the structural characteristics of social organization that dictate much of how individual citizens and firms use energy in daily life.

Building on this foundation, 3 lays out a theory of the political economy of climate change. The necessity of a low-carbon energy systems transformation poses significant challenges to sustained climate policy. It has the potential to impose acute costs on powerful and well-organized industrial and energy sector interests, and to generate acrimony among citizens resistant to higher energy prices. But, conceived as emissions reduction alone, systems transformation offers few immediate or tangible benefits to offset those costs. A low-carbon energy systems transformation also forces the state to navigate the always-complex terrain of technological innovation. It must influence the direction, pace and compatibility of technological development without straying too far into the kind of top-down direction of technological change that has failed so often in the past.

These challenges tempt us to favor the cheapest, most arms-length policy possible: cheap, to minimize the pain; and arms-length, to minimize the state's opportunity for error. That logic underpins the conventional wisdom that an emissions price constitutes the best policy approach to emissions reduction. States, so the argument goes, must merely set a price on greenhouse gas emissions, and then step back to let the market discover the most economically efficient path to emissions reduction.

But this logic is deeply flawed. Politically, carbon pricing imposes obvious and immediate costs on powerful interests, while generating few politically viable means of compensating losers. Advocates of emissions pricing argue that it must be "high, ubiquitous, and reliable" to be effective (Nordhaus, 2010), but provide few means to ensure that a high price doesn't generate a political backlash that renders it unreliable or prone to rent-seeking by powerful interests. This is an increasingly familiar critique, as in Victor (2011). But the problems go beyond these political concerns: technologically, it's unclear how pricing alone will deliver the parallel, complementary innovations and investments required to generate a viable low-emissions energy system. This is especially true for the somewhat more price-insensitive energy transmission and distribution markets, whose large, long-term investments mute the incentives of carbon pricing. Thus the dream of an arms-length approach wherein the state sets an emissions price and the market does the rest will likely prove a chimera.

Chapter 3 introduces an alternative logic. I argue that viable climate policy will emerge in situations where emissions reduction can be tied to progress on other policy domains that generate material near-term improvements. Those improvements serve two purposes: first, they create beneficiaries that support policy continuity; and second, they provide surpluses that can be diverted to compensate compensate losers. The institutionalization of emissions policy that emerges from this pattern of benefits and compensation will improve the effectiveness of climate policy itself, by increasing the credibility that the policy regime will survive over the long term. But the policies most likely to succeed at accomplishing this process will necessarily be multifaceted, complementing emissions pricing with a range of policy instruments that resemble more closely the traditional tools of industrial policy. Framing this as a choice between an optimal first-best policy and some regrettable but necessary second-best solution does not, I argue, enlighten. Rather, we must choose between the second-best and nothing at all.

Can such a strategy succeed everywhere? Likely not. Consistent with the political science literature on similar kinds of cross-cutting strategies–strategies broadly termed "issue linkage"–the potential for this kind of policy bargain will vary widely. In this case, I show that the structure of domestic energy systems will play a powerful determining role in the opportunities available for effective issue linkage. As networked technological systems, energy systems structure how the costs and benefits of a limited set of climate-focused changes will cascade through the network to affect firms and citizens throughout the economy. That structure depends on a historically-contingent process of technological, regulatory, and infrastructure development. Consequently, though the technologies underpinning electrification or transport today vary little, the broader systems in which they exist vary tremendously across countries. This suggest that domestic variation in energy systems frustrate attempts to transfer policy models across national energy and political systems.

Chapters 4-5 turn to how the European Union has managed this politics of issue linkage in crafting its comprehensive climate and energy policy regime. The EU presents a particularly hard test of a theory of linkage-driven climate and energy policy. The EU would surely lead the list of polities we might expect to succeed at overcoming economic concerns to pursue environmental goals. As Vogel

(2012) has shown, the EU has adhered more strictly to a precautionary principle when making policy for environmental and consumer protection. Furthermore, Europe is also presumed to have stronger, better-organized environmental actors. The European Parliament, ineffectual in many ways, has historically been an effective advocate for environmental policy (Burns, 2005; Burns and Carter, 2010; Burns et al., 2012). The stronger member states have either strong Green parties (Germany) or environmentally-motivated parties (Scandinavia). And many European citizens are thought to have "postmodern" preferences–willingly giving up marginal material improvements for non-material social or environmental gains (Kitschelt, 1994).

Hence we might expect–and others have certainly argued–that climate policy would be simply another instance of this precautionary bias. In that world, Europeans might willingly accept the costs of emissions pricing as a precaution against the threat of unchecked climate change.

Yet I argue that neither the design of Europe's climate and energy policy suite, nor the political history of that policy itself, conform to a view of politics dominated by environmental interests and precautionary biases. Instead, even so environmentally-conscious a polity as the EU still relies on economic and industrial benefits, rather than environmental motivations, to stabilize support for climate change mitigation. This is clear from the consistency between European policy strategy and European economic interests, as shown in chapter 6. And it is doubly clear in the political process by which that strategy was translated into policy. As chapter 5 shows, the Parliament–Europe's environmental advocate–has consistently failed to make policy more environmentally aggressive, and less economically pliant. Instead, the European Commission has yoked industrial support for emissions reduction to progress on more immediate and tangible goals in the energy sector. In doing so, the Commission has sought to reduce the vulnerability of climate policy to erosion by powerful economic interests.

In doing so, the Commission has made choices contingent on the particular structure of the European energy system. But the principles that underpin the European bargain–linkage between the long-term environmental goal and the material returns to the tasks necessary to achieve that goal–appear to hold in other contexts as well. As chapter 7 discusses, both relatively recent successes–like South Korea's pursuit of "green growth"–and persistent failures–like the American efforts to pass a cap-and-trade program–illustrate the role played by the energy system in structuring the possible outcomes of climate policy formation. The Koreans, by explicitly tying environmental goals to industrial restructuring, gained the support of Korea's politically powerful industrial sector and succeeded *despite* the lack of support from environmental interests. In contrast, the United States, with its well-funded and organized environmental groups, has consistently been unable to make the connection between environmental goals and industrial returns. As Skocpol (2013) has argued, American environmental reformers remain mired in a mindset where public opinion on climate change matters, and where managing the cost of emissions reduction–rather than identifying its economic benefits–is the critical policy strategy. But whether these reformers can succeed if they merely switch to an industrial policy strategy is unclear. In particular, the structure of the American energy system has far fewer opportunities for real material gains than its European or South Korean counterparts, restricting the options for environmental policymakers even if they decide to explicitly pursue linkage politics.

Stepping back from the climate issue, the dissertation makes a more general argument for treating climate change as a problem of comparative political economy, rather than environmental politics. Though its motivations are environmental, climate change mitigation poses a fundamentally different set of problems, at a very different scale, than almost any other environmental problem. Many environmental problems merited solutions that *modified* social and economic behavior. Resolving acid rain required power plant operators to switch fuel sources and clean their stack effluent, but not stop using coal (Hanemann, 2009). Reducing groundwater pollution required factories to contain or purify their waste water, not end production altogether.[1] Only the most aggressive environmental organizations have taken the position that true environmental protection requires humanity to simply *stop* doing something.[2]

In contrast, climate change requires root-and-branch changes in how we produce, distribute, and use energy. Barring either wholesale adoption of nuclear energy, or successful carbon emissions sequestration, renewable energy is the only option for permanent emissions reduction. That in turn implies, as we've said, a range of other social, political, technical, and economic changes. Those changes will cut to the heart of industrial economies, economic growth, employment, and development. It may represent the most fundamental change in how we organize industrial societies since the second industrial revolution. As such, the more focused perspective of environmental politics–on interest group formation, local impacts, mass public opinion, and scientific persuasion–will likely miss the forest for the trees. Instead, we need new approaches to studying interest group formation, legislative behavior, and the behavior of economic actors at the scale of the energy system itself. Chapters 6 and 5 propose new approaches for surveying both firm and legislator behavior that may make such systems-level research tractable and scale-able.

[1]This statement might raise the objection that production did in fact stop: companies simply shut down production and moved it to a new, unregulated locale. While true, that's an economic consequence. There was no reason those factories couldn't have kept producing. They simply chose not to.

[2]Note that this position is in the limit defensible. But it belies the fact that most major environmental improvements over the last half-century have come through modifications of existing behaviors that were largely painless to end users.

2 A low-carbon energy systems transformation: tasks, precedents, and complications

2.1 Introduction

Climate policy is energy policy. Any serious attempt to avoid the consequences of unchecked climate change will require significant absolute reductions in greenhouse gas emissions over the course of the 21st century. Approximately 65% of those emissions come from today's fossil fuel-based energy systems, the largest contribution of any single sector. Reducing those emissions implies substantial changes to the energy system to enable it to continue to provide abundant and reliable energy without imposing large environmental costs.

This chapter argues that these changes constitute an energy systems transformation, understood as a set of parallel and complementary changes to energy production, distribution, and use. Low-emissions energy sources have very different operating characteristics than the fossil fuels they replace. They are more variable, less dense, and more geographically diffuse than fossil fuels. Accommodating these differences in the character of energy production will require a set of corresponding changes in energy distribution and use. In particular, the power grid will require substantial new capital investment to service distributed power generation and manage intermittent power; and energy demand will shift from being an exogenous given, over which operators have little control, to being another variable that can be managed to ensure the stability of the energy system. These technical changes will require, in turn, changes to markets for energy investment and sale.

This scale of change is consistent with earlier instances of energy systems transformation. Like Smil (2011a), I argue that the primary lesson to be drawn from these earlier changes is the inherent slowness of change in large-scale networked systems. But in comparison to earlier transformations, a low-carbon energy systems transformation offers more challenges and fewer tangible benefits. This lack of benefits complicates the politics of designing and implementing policy to accomplish the technical tasks required of a low-emissions energy systems transformation.

Hence climate policy formation must be understood as both a technical and political task. The long duration, expense, and complexity of serious emissions reduction will require implementing measures that build and sustain supportive political coalitions for the duration. As the following chapter argues, doing so will require policy to generate real material benefits in the process of transformation. Such benefits will help create acute support for specific policy regimes, which over time can build new constituencies in favor of policy continuity. But the variegated nature of legacy energy systems and the economic actors that operate within them inform against any expectation of universal policy solution. Instead, we should expect policies whose idiosyncrasies are dictated by the structure of the legacy energy system, the material opportunities and challenges it embodies, and the potential to address these issues with instruments that serve longer-term climate goals.

2.2 The climate / energy nexus

Climate change refers to observed environmental changes resulting from increasing average atmospheric temperatures. Average surface temperatures have increased by approximately 0.74°C over the course of the 20th century. On a geologic timescale, the planet has seen such changes before. But the rate of change and the complex vulnerabilities of human society now amplify the potential damages from unchecked climate change. Furthermore, substantial evidence points to human activity as the predominate cause of this increase, and greenhouse gasses as the primary instrument.(Solomon et al., 2007)

Greenhouse gasses constitute a class of compounds that trap infra-red radiation reflected from the earth's surface. Increased concentrations of greenhouse gasses in the atmosphere change the equilibrium radiation flux, trapping heat energy in the earth's atmosphere. Carbon dioxide is perhaps the best-known greenhouse gas, but is also the weakest. As table 2.1 shows, methane, sulfur hexaflouride, and other gasses have much stronger greenhouse effects on a per-weight basis. But what carbon dioxide lacks in power it makes up in volume and persistence. Present atmospheric concentrations of CO_2 stand at approximately 390ppm, 3-6 orders of magnitude higher than other greenhouse gasses. That CO_2 will remain with us long after more potent gasses like methane have decomposed.

The intensification of greenhouse gas emissions is inseparable from industrialization. Prior to industrialization, photosynthetic energy provided the vast majority of available energy inputs for economic and social activity. Thermal energy came largely from wood and crop residues. Mechanical power from draft animals required food inputs that were either purpose-grown feed or pasture. The dependence on photosynthesis kept society into a greenhouse gas equilibrium. Photosynthesis turns water and carbon dioxide into carbohydrates and oxygen. Burning or metabolizing

Gas	**GWP**	**Atmospheric half-life (years)**
CO_2	1	100
CH_4	21	12
N_2O	310	114
HFC-23	11,700	270
HFC-32	650	4.9
HFC-125	2,800	29
HFC-134a	1,300	14
HFC-143a	3,800	52
HFC-152a	140	1.4
HFC-227ea	2,900	34.2
HFC-236fa	6,300	240
HFC-4310mee	1,300	15.9
CF_4	6,500	50,000
C_2F_6	9,200	10,000
C_4F_{10}	7,000	2,600
C_6F_{14}	7,400	3,200
SF_6	23,900	3200

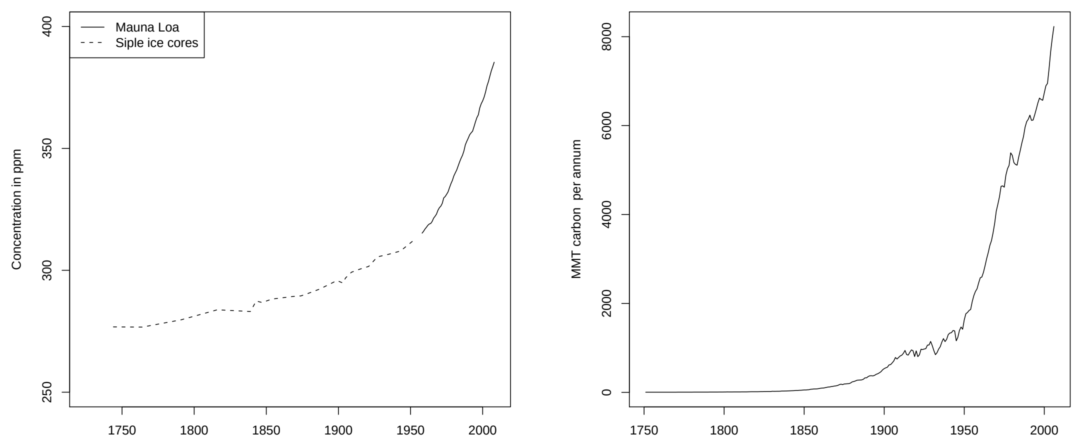
Table 2.1: Global warming potentials (GWP) for different greenhouse gasses, relative to CO_2. 100-year time horizon. Source: GWP taken from (EPA, 2011, ES-3). Half-lives taken from (Solomon et al., 2007, table 2.14).

the carbon-based energy in plant matter consumes oxygen and carbohydrates, and generates energy and CO_2 as a byproduct. Once returned to the atmosphere, CO_2 re-entered the photosynthetic cycle. The closed nature of this energy system, and the limited energy potential of plant matter, meant that near-term over-consumption of primary energy sources eventually ran into medium-term limits on the productivity of forests, grassland, and farmland.

Industrialization marked a departure from this equilibrium. Capital-driven productivity improvements depended on the availability of cheap, plentiful supplies of energy.[1] From the point of industrialization on, production required greater energy inputs than could be captured from self-renewing processes like photosynthesis. Coal, and later oil and natural gas, provided an escape from these constraints via what Sieferle (2001) called a "subterranean forest" of millions of years of accumulated photosynthetic energy.

Harvesting and burning that subterranean forest meant a departure from greenhouse gas equilibrium. As figure 2.1 shows, the atmospheric concentration of greenhouse gasses began to increase at about the same point in industrial development at which large-scale industrialization–and the co-commitant combustion of fossil fuels for steam power and heating–began in Europe. In the late 20th and early 21st centuries, the intensification of economic development, and hence energy consumption, in countries like China and India has caused a further acceleration in both demand for energy resources and flows of greenhouse gas emissions. As of 2007, China surpassed the United States as the largest single greenhouse gas emitter, though its per-capita emissions remained a fraction of that of the advanced industrial economies (Vidal and Adam, 2007).

[1] Both Nef (1932) and Landes (2003) place great weight on coal energy in driving the industrial revolution. Flinn (1984) and Clark and Jacks (2007) both dispute this argument, particularly in the English case, suggesting that water power was more important to the primary productivity increases in textiles. But this dispute does not affect the later importance of coal to the intensification of steel production or the second industrial revolution of the late 19th century.



(a) Atmospheric CO_2 concentration since the 18th century. Source: Data from 1750-1953 come from the Siple ice core samples. Data after 1958 come from the Mauna Loa observatory monthy record.

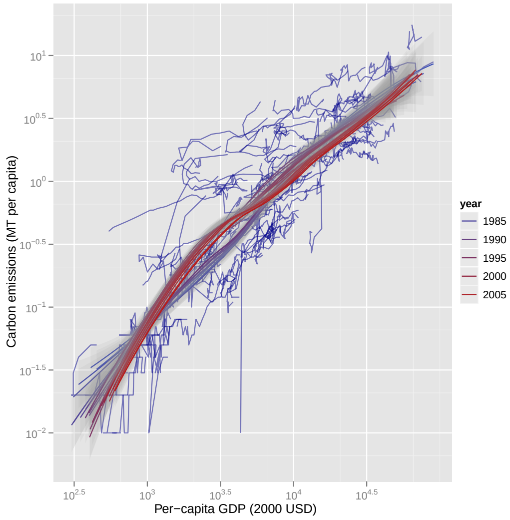
(b) Global annual emissions of CO_2. All data from Boden et al. (2009).

Figure 2.1: Global concentration and emissions of carbon dioxide.

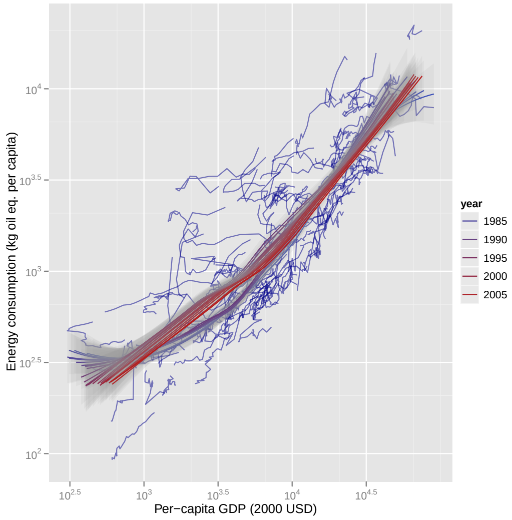
Attempts to decouple industrial growth from energy demand have generated limited returns.[2] Increasing energy efficiency and the greater weight of services have caused emissions per unit GDP to fall across the developed economies. But with rare exceptions–notably Denmark–the greenhouse gas emissions of the advanced industrial economies have continued to increase. Moreover, falling emissions per unit GDP in developed economies reflects, in most cases, the transition from a manufacturing-led economy to a services-led economy. That transition has suppressed the growth in emissions intensity of production, but has not displaced demand for emissions-intensive goods. Moving emissions-intensive production like steel, cement, or heavy manufacturing from one country to another only displaces the origin of emissions in the accounting, not the importance of those emissions to the climate.[3]

[2] Raupach et al. (2007) note that there's little evidence of *any* region actively decarbonizing their energy supply.

[3] In the G7, energy intensity per unit GDP declined 19.7% between 1991, the year after the Kyoto Protocol's 1990 baseline, and 2007. Despite this gain, energy use per capita grew 4% on average,



(a) Correlation of per-capita GDP with carbon emissions. Emissions represented as metric tons of carbon per person. Period: 1960-2007. Carbon emissions taken from Boden et al. (2009).



(b) Correlation of per-capita GDP with per-capita energy consumption in kilograms oil equivalent. Period: 1970-2007. Energy consumption taken from the World Bank World Development Indicators database.

Figure 2.2: Correlation of per-capita GDP with energy consumption and carbon emissions. 107 countries represented. GDP represented in constant 2005 dollars per capita, calculated from nominal GDP deflated with the NIPA GDP deflator. Smoothed lines generated from loess regression. Individual paths show country-specific timeseries within the data.

2.3 Energy options for climate change mitigation

Reducing greenhouse gas emissions therefore requires severing the link between economic prosperity and growth, and emissions. Given that 60% of all emissions come from fossil fuel-based energy, that will require a much lower emissions footprint for energy consumption. In macroscopic terms, states have three levers with which to

and total energy consumption 14%. Total energy consumption declined only in Germany and the United Kingdom, 1% and 0.65%, respectively. But German success in particular came at a price: the dismantling of the East German industrial base after reunification, and the widespread East German unemployment that followed. The collapse of British manufacturing during and after the Thatcher period is well-documented. These are, obviously, not viable or reproducible strategies. Denmark has been somewhat more successful over this period, increasing GDP by nearly 40% while keeping aggregate energy use constant. For information on global energy consumption, see "Total Primary Energy Consumption" and its variants, in Energy Information Administration (2009), updated regularly at http://www.eia.doe.gov/emeu/international/contents.html. GDP data taken from the OECD for 1990 and 2007 at constant PPP.

accomplish this goal: the intensity of energy demand (the amount of energy required for a given activity), the emissions footprint of that energy, and the amount of economic activity. But given political unacceptability of economic stagnation, only two of these levers are really viable strategies.

The rate at which emissions can come down depends on the relationship between the rate of improvement in energy and carbon intensity on the one hand, and the rate of economic growth on the other. More formally, we can express energy-related emissions as a function of the degree of economic activity Y in a country, the energy intensity E of that activity, and the emissions footprint f of the energy supply.[4]

Writing this formally and differentiating, we see that:

$$M = fEY \tag{2.1}$$

$$dM = EYdf + fYdE + fEdY \tag{2.2}$$

Emissions reduction implies $dM < 0$. Rewriting 2.2 to reflect this gives us:

$$EYdf + fYdE + fEdY < 0 \tag{2.3}$$

$$fYdE + fEdY < -EYdf \tag{2.4}$$

$$\frac{df}{f} + \frac{dE}{E} < \frac{-dY}{Y} \tag{2.5}$$

Hence we face three options for long-term stabilization of greenhouse gas concentrations:

1. Reduce the emissions footprint f of the energy supply

[4] What follows here is a variant on the Kaya Identity (Kaya and Yokobori, 1997), treating the role of population growth as implicit in economic activity.

2. Reduce the energy footprint E of economic production

3. Reduce our living standard as measured by GDP Y

Evidence suggests that neither developing nor developed economies can long support the stagnation or retreat of GDP growth. Since the start of industrialization, periods of extended economic stagnation have coincided with political instability and the retreat of liberal politics.[5] This experience suggests that politically-viable approaches to dealing with climate change will treat $\frac{dY}{Y}$ as a stubbornly positive quantity, in which the choice to pursue emissions reduction is conditional on very low or nonexistent opportunity costs to economic growth.[6] That leaves energy efficiency and energy supply decarbonization as the primary options at the hands of policymakers. But for emissions to fall, those must combine to reduce the emissions footprint of the energy system at a rate faster than GDP growth. Whether this can occur depends on our expectations for improvements in energy efficiency and for abatement of emissions from the energy sector.

2.3.1 Efficiency

Improved energy efficiency has a demonstrated history of effective moderation of both energy demand and emissions. As figure 2.2 shows, the correlation between per-capita income and emissions has remained positive for the last thirty years. But

[5]The Great Depression provided the most extreme instance of growth driving illiberal politics. Lesser examples include the prolonged period of stagflation in the 1970s; and the slow recovery after the 2008-2009 financial crisis. In all cases, the inability of national economies to generate broad-based economic growth led to a zero-sum competition for resources among economic interests and between political factions. See in particular Gourevitch (1987).

[6]This is not to say that such proposals have no following. Both mainstream organizations like the European Green Party and more fringe environmental groups have advocated for "green growth" policies that explicitly endorse a relative stagnation in living standards as a way to improve overall environmental sustainability.(European Greens Party, 2009; Schepelmann et al., 2009) Such a transformation of the implicit postwar settlement–alleviation of distributional conflict via equitably distributed economic growth–would mark a much more fundamental shift in political and economic governance than anything currently under serious discussion. None of these policies have achieved significant political traction.

the underlying country behaviors show significant diversity. Denmark's GDP has growth 40% over this era even as its energy consumption has remained flat. China's GDP grew fourfold over the period 1980-2010, but energy consumption merely doubled. Within the advanced industrial economies, energy intensity varies dramatically. The United States consumes approximately twice as much energy per capita as the Euro-area average. But this spectrum of differences appears to have little relationship to prosperity among the advanced countries. Per-capita GDP across the major industrialized economies varies little compared with rates of per-capita energy consumption.

Instead, most of the differences have to do with structural choices that influence energy consumption. Europeans in general, and northern Europeans in particular, tend to drive smaller cars, use mass transit more frequently, and live in smaller and better-insulated homes in denser communities. In many countries, these structural advantages are augmented by the use of highly efficient methods to heat and power buildings. Combined Heat and Power (CHP), used across Denmark and in many European cities, uses the residual heat in steam generated for electricity production to supply district steam heating systems. Thus, although Denmark continues to consume substantial amounts of coal for electricity generation and heat, it gets approximately twice as much useful energy from a unit of coal as the most efficient coal-fired power plants in the United States. These choices emerge in part from structural factors–the greater density of European populations–but also represent policy choices about regulatory and economic incentives for energy use and conservation.

Improvements in energy efficiency reduce the energy demands from economic production and implicitly the greenhouse gas emissions intensity of production. But while these improvements can complement energy systems decarbonization, they are not a substitute for it. Empirically, improvements in energy efficiency for household durable goods like washing machines and air conditioners appear to reach about 0.5-2.5% per annum (Newell et al., 1999), while the stock of household appliances turns over at a rate of perhaps 1% per year. The building stock in the EU is refreshed at a similar rate. Given that the advanced industrial economies have grown at a trend of approximately 2-3% over the last three decades, it does not appear that energy efficiency alone can offset emissions growth from rising GDP.

Furthermore, improvements to energy efficiency ($\frac{dE}{E} < 0$) are bounded by the constraint that $E > 0$: economic activity requires energy inputs. Thus energy efficiency alone will not deliver emissions reductions in the limit. So while energy efficiency measures make emissions reductions easier by loosening the constraints on decarbonization of the energy supply, they do not eliminate it altogether.

Moreover, energy efficiency improvements have potentially large transaction costs relative to changes in energy production and distribution.[7] Most energy efficiency efforts involve widespread, diffuse, very small changes to building codes, building retrofits, appliance standards, and other individually small but collectively large sources of energy demand. Thus widespread, rapid improvements in energy efficiency require a very large number of very small changes, posing coordination problems and transaction costs for regulators.

Finally, most countries that have successfully moderated energy consumption without harming GDP have also undergone industrial restructuring. This has usually meant a transition from energy-intensive heavy industry to less-energy-intensive manufacturing and services. But this has not meant a change in demand for outputs from heavy industry, such as steel (in the form of cars or household goods or building materials) or cement or other goods. Rather, it has merely moved the source of emissions from one country to another.[8] With climate change a global environmental goods

[7] Ed Barbier has pointed this out in a number of publications.

[8] South Korea has explicitly embarked on this shift as of 2011. Its green growth strategy contains an array of changes to urban planning, energy production, and other aspects of the economy. But it

problem, national solutions of this form do little to solve the problem.

2.3.2 Decarbonization

Energy efficiency therefore constitutes an important but incomplete lever for emissions reduction. Over time, permanent absolute reductions in greenhouse gas emissions will require the decarbonization of the energy system. Changing the process of energy production to reduce carbon emissions per unit energy can occur via one of two ways. Either the energy production process itself can be decarbonized, by replacing today's fossil fuel-based energy production infrastructure with zero-emissions sources; or the greenhouse gas emissions from the use of fossil fuels can be captured and stored or otherwise rendered harmless.

Capturing and storing emissions from fossil fuel power plants has become a conceptually popular but empirically elusive strategy. If successful, carbon capture and sequestration (CCS) technology would allow the continued unaltered use of fossil fuels, their elaborate and expensive capital infrastructure, and the industrial and economic processes that depend on them. This has made CCS attractive to both fossil fuel sectors and other energy-intensive economic interests.

CCS solutions come under criticism for three potential problems: first, they are incredibly energy-intensive, reducing the usable energy output of a plant by as much as 50% and increasing overall fossil fuel demand accordingly; second, they all sequester the captured carbon dioxide in underground geologic formations–the stability and durability of which are questioned, and the capacity of which to absorb the amount of greenhouse gasses required for serious mitigation is doubted[9]; and third, CCS has

also specifically mentions a shift towards a greater share of services in its economy, which changes the incidence of emissions production but not the demand for emissions-generating products (O'Donnell, 2011).

[9] See here Smil (2011b), who suggests that sequestration of today's carbon dioxide output would require an industry of the scale and complexity of the global petroleum industry, capable of handling annual volumes 50% larger than the annual production of petroleum from all global sources.

faced political resistance from citizens and civil society groups concerned about unforeseen problems in storing large volumes of potentially poisonous gas for very long periods.

CCS has only recently entered the trial phase, and technical experience is limited. Both the United States and the European Union have run long-term and expensive carbon capture and sequestration (CCS) research programs. In the US case, the FutureGen program was shut down after failing to produce a viable pilot plant despite billions of dollars invested. In the European case, several iterations of the Strategic Energy Technology plan have yet to yield a test plant, though the Scandinavian firm Vattenfall began the commissioning of a commercial plant in 2008.[10] Other alternatives for CCS have been proposed, including capturing carbon dioxide emissions via photosynthetic algae that then produce biodiesel fuel oil.[11] But these all remain in the proof of concept phase.

In contrast to CCS, zero-emissions strategies would replace most fossil fuel-based energy production with non-emitting alternatives like wind, solar, geothermal, hydro, or nuclear power. Of these, only hydro and nuclear power have been proven at scale. Hydropower is naturally limited to countries with suitable rivers. Nuclear power has proven extraordinarily successful in a few countries, most notably France, where 80% of electricity comes from nuclear plants. But that success has not been replicated elsewhere, because of combination of social opposition to nuclear energy and the enormous up-front capital cost of nuclear power.[12] And only a few countries today generate more than 10%-20% of their electricity demand from non-nuclear,

[10] See, for instance `http://www.vattenfall.com/en/ccs/pilot-plant.htm`. Last accessed 27 February 2013.

[11] For more detail, see `EERE biofuel algae roadmap`

[12] This problem became particularly acute in early 2011 after the post-tsunami meltdown of the Japanese nuclear reactors at Fukushima. Germany, which had planned on extending the lifetime of its nuclear plants by a decade, decided shortly thereafter to phase out all nuclear power by 2020. Italy voted against new nuclear power plant construction in a referendum held in June 2011. How either country plans to meet both its emissions obligations under the European emissions cap, and its power demand, remains unclear.

non-hydro zero-emissions or renewable sources.

2.4 Energy systems: structure and change

Given the pace of emissions reduction required for serious climate action, and the complexity of both options, climate policy suites will likely include both energy efficiency and low-emissions energy as complementary instruments. But simply stating that we will build a low-emissions economy obscures the challenges of adopting significant quantities of renewable energy in a system capable of supporting substantial improvements in energy efficiency. And it says nothing about the political issues at stake in using either lever effectively.

This section defines the parameters of a low-emissions energy systems transformation, as a prelude to elaborating a theory of the political economy of climate change in chapter 3. I argue that energy systems will be the focus of both the technical process of climate change mitigation, and of political contestation around whether and how to pursue emissions reduction. Energy systems provide the capital, technology, and market structures required to generate, transmit, and use energy in productive processes. Those systems may be as basic as a means of growing or gathering sufficient food to power human labor; or as complex as the modern electrical generation and distribution infrastructure. Though radically different in the details, the energy systems that have persisted at different times and places over industrial history share a common set of characteristics; and the historical pattern of energy systems transformation shows a set of distinct trends. Simply stating these changes suggest the scale of the challenge implicit in constructing a low-carbon energy system; and the historic trends that brought us the energy systems we enjoy today demonstrate the novelty and the political difficulty of attempting to reverse those trends.

2.4.1 Energy systems[13]

I define an energy system as the entire set of installed, operational technologies, markets, and institutions that make a given energy source a practical choice for fueling economic activity. This spans the production, distribution, and use of energy. For electrical systems, this breakdown becomes obvious: the power plant, the power grid, and the electrical appliances or plant of the end user, plus the power markets and the metering technologies and regulatory systems that give structure to these markets. Likewise, the liquid fuels industry that powers transportation consists of the oil and gas wells, the regulatory apparatus that governs them; the pipelines and shipping infrastructure that transports the oil; the refineries that transform it into useful fuels and industrial chemicals; a second distribution system that brings the fuels to the network of final points of sale; and the combustion technologies, automotive markets, and regulatory apparatus that promotes the use of automobiles.

These combinations of technologies, policies, and markets are systems in two senses. First, removal or significant alteration of any component would render all or part of the system inoperable or superfluous. For instance, United States oil refineries consume approximately fifteen million barrels of oil per week. Approximately 45% of this is refined into motor vehicle gasoline, which then is sold through a network of 161,000 gas stations throughout the country.[14] Firm decisions on how to allocate refinery time, purchase trucking and transport capacity, and franchise retail stations are driven by the presence of a large private motor vehicle fleet. Alteration of the fleet could, absent its replacement by a very similar technology with a similar demand structure, render much of this capacity superfluous. Likewise, the continued existence of the fleet is predicated on the presence of the system for production and

[13] This section was adapted from Huberty (2009)

[14] Total station count taken from *NPN MarketFacts 2008*, available in summary form at http://www.npnweb.com/ME2/dirmod.asp?sid=A79131211D8846B1A33169AF72F78511&type=gen&mod=Core+Pages&gid=CD6098BB12AF47B7AF6FFC9DF4DAE988.

distribution of retail gasoline. Imagining transformative technologies that only affect the automobile without affecting where its fuel comes from, how it is produced, and the market conditions under which firms and individuals make a host of purchasing decisions ignores the systemic nature of the industry in question. Moreover, the presence of the system creates powerful barriers to the entry of new technologies. Plug-in electric vehicles could operate much like existing cars, but without a dense network of recharging points analogous to the network of gas stations, they would be hobbled by short range.[15] Thus their widespread entry into the market is forestalled by the characteristics of the existing system.[16]

Second, energy systems contain logics of operation that influence future developments.[17] The existence of energy systems makes further innovation inside that system less costly and less risky than innovation outside it. As shown by Katz and Shapiro (1986), network externalities may prove large enough to reward the adoption of sub-optimal technologies compatible with the current system over optimal technologies that would require complementary changes in the rest of the system. Furthermore, the sheer cost of building a parallel system deprives consumers and firms of choices, cementing the dominance of networks long after the initial justification for their configuration has passed. Thus energy exhibits behavior similar to transportation, telecommunications, and other systems with significant economies of scale.

These forces push the energy system tends towards incremental innovation. In-

[15]This problem has led electric car manufacturer Tesla to start deploying its own network of rapid-charger stations. At present, that network has only been deployed in dense population areas like the Northeast corridor. See ().

[16]Note that this is not suggesting that such a system is necessarily a market distortion, or exists due to some form of private collusion, or governments "playing favorites." It only points out that systems of technology generate large positive network effects that influence the price structure and investment and purchasing decisions for any one part of the system as well as for the whole. Since deploying a new system all at once is nearly impossible to coordinate, this creates near-term barriers to entry for new technologies even without private collusion or public favoritism.

[17]This argument at the market level is similar to that made by Zysman (1994) at the national level.

cremental improvements may result from sophisticated technologies, and the firms that deploy those technologies can deliver jobs and prosperity. But they continue to exist within the same energy system, having not affected its whole, and as a result do not achieve the hoped-for reductions in total consumption or emissions. In contrast, technologies that are introduced from the outside, that do not fit well within the existing system, can find themselves marginalized, or face high barriers to entry from both the initial cost of entry–the cost of constructing a parallel energy system–and the marginal cost of operation. Unruh (2000, 2002) terms the resulting stasis "carbon lock-in."

Energy systems are therefore analogs to Hughes' arguments on the inter-relatedness of technological systems. His discussion of the electrification of New York City provides a typical example.(Hughes, 1979) He explains that Edison's development of an appropriate filament for the electric light bulb was not, as is sometimes portrayed, a random walk across several thousand different materials. Rather, evidence from Edison's laboratory notebooks shows that had a particular goal in mind, one tightly coupled to his plan to electrify Manhattan. The properties of the filament were set by the expected market demand for electric lighting, the electrical load that this demand would place on Edison's coal-fired dynamos, and the resulting resistivity required to match his ability to supply electricity to the physical properties of the demand system at a scale set by the market. Edison's filament design did not emerge in a vacuum; rather, in Hughes' argument, it emerged to complement the particular properties of the energy system he was trying to create. Take away the structure of market demand, the characteristics of the electric grid he had envisioned, or the capabilities of his power generators, and a very different filament may have resulted. Likewise, Hughes (1962) points out that electrification in Britain, despite enjoying access to the same technologies as the United States, and operating with the benefit of the American experience in power grid deployment, experienced serious shortcomings due to a mismatch between the technology and the financial and regulatory apparatus. In this case, treating electrical power just like municipal water and sewer programs ignored the different demands the former system placed on the legal, regulatory, and market apparatus in which it functioned.

2.4.2 Energy systems transformation: not the first time

A low-carbon energy systems transformation would be the fourth major such transformation in industrial history.[18] England began the switch from wood to coal staring around 1600.[19] The rest of Europe followed in the 18th and early 19th centuries. The adoption of oil began in the latter half of the 19th century and continued through the second World War. Electrification began with Thomas Edison's initial Pearl Street generating station in Manhattan in 1882, and was finally pushed in to most of Europe and the rural United States during the 1930s and 1940s.[20]

We should learn a few critical lessons from these earlier transformations. First, they took a long time: nearly 200 years for coal, 100 years for oil, and 75 years for electricity.

Second, each transformation took this long despite real and undeniable advantages offered by the new fuel: each new generation promised denser, more easily trans-

[18] Smil (2011a) treats each of these processes in elaborate technical detail. What follows concentrates on the primary features of these transformations and their political implications.

[19] The initial shift took place primarily in London. Hammersley (1957) argues that overall forest productivity in England was more than sufficient to support its population at that time. But he ignores the fact that the distribution system was incapable of bringing wood from much further away than 25km, or 5km in the case of charcoal. Thus the capabilities of energy production were not matched by sufficient abilities for energy distribution. Coal, which could be cheaply from Newcastle to London, supplanted wood in the capital city long before it did so in the rest of the country. See Nef (1932) and Flinn (1984) for a complete history of the English wood-to-coal transformation.

[20] Hughes (1983, 1979) notes that widespread electrification in Europe and the United States really began after the first world war. The combatant nations had built substantial electrical generation capacity to power munitions factories. With the end of hostilities, those plants were re-oriented to electrify cities and industrial production.

ported, and more universal sources of power than the last. As Perez (1985) notes, each of these changes also expanded the opportunities for value creation in industrial economies.

Third, each required wholesale changes not only to energy production–mining or drilling or steam turbines–but also to distribution and use. The English coal industry provides a wealth of examples. Energy production required not only the discovery of coal seams, but the development of the steam engine to drain water from the mines and push air through them. Those mines were in many cases poorly served by an energy distribution system designed around Stuart England's remaining forests. Thus an entirely new distribution system had to be built. Coastal shipping and inland canals provided the initial infrastructure, but the system was only truly complete with the construction of the railroads in the mid-19th century. Finally, effective use of coal required a range of new combustion technologies even for the most basic tasks. Allen (2009) notes that the adoption of coal in London required both the replacement of fireplaces (wood-burning hearths were incapable of the concentrated airflow required to burn coal efficiently), and stoves and chimneys (to exhaust highly toxic coal smoke and prevent it from coming in contact with food). These basic innovations emerged alongside more complex developments in covered crucibles for firing glass and other materials (Robert Mansell, c. 1615), blast furnaces (Abraham Darby, c. 1709), and steam engines (Newcomen, c. 1712, and Watt, c. 1770).

These patterns repeat themselves in later transformations. Oil required a whole series of new engine designs, and a new transportation infrastructure to bring it often significant distances. The widespread use of oil for transportation is closely tied to massive investment in road networks and interstate highway systems whose scale was unnecessary in a pre-automobile world. Electrification required massive investment not only in new plants, but also in new power grids, home appliances, machinery, lighting, and a range of other technologies. In each case, mere substitution of one energy source for another was only the first of a wide range of steps needed to effect the transformation of the energy system.

In all cases, the motivations for these myriad parallel changes were multi-factorial. For coal, oil, and electricity, the natural advantages of the new energy source over the old provided powerful incentives to overcome the systemic barriers to use. In the case of the wood to coal transition, that motivation was complemented in England in particular by near-term shortages of firewood in and around London, which had reached the natural limits of its regional energy system. But the state also played a powerful role. Warde (2006) provides a fascinating account of the role of the state in imposing modern forestry practices on 15th-century forests, to ensure the adequacy of supplies of both fuel and material. The English crown forbade the use of wood in glassworks in 1615 out of concern that it was driving wood shortages; a series of innovations and shifts in the location of production for glass had to occur as a result.(Nef, 1932; Hartshorne, 1897) Uncertainty about technology standards for the new electrical power grids in the United States diminished rapidly after the New York State Legislature chose an Alternating Current solution for the new Niagra Falls generation station, amidst fierce lobbying from both Thomas Edison and Nikola Tesla.[21] The politics of oil are, of course, well-trod ground; suffice to say that access to reliable supplies of oil is closely tied up in the legacy of 19th and 20th-century geopolitics, and that the highway systems that made oil-powered personal transportation viable constitute some of the largest state-led infrastructure projects in history.

[21] See Hughes (1976). Edison invented the electric chair at the time to drum up public fears of the dangers of alternating current.

2.5 Harder than last time: Novel challenges for the coming transformation

While climate change mitigation will require an energy systems transformation of a form common in industrial history, historical examples capture only a part of the complexity of the problem. Earlier transformations tended to move the energy system from lower to higher geographic and energy density; towards greater flexibility of the final energy carrier; and towards greater reliability of supply. These benefits have been powerful drivers of long-term energy systems transformation, and provided the means by which these transformations could occur in the absence of a concerted effort of the state.

In contrast, the technical characteristics of low-emissions renewable energy sources pose additional, novel challenges. In brief, decarbonization based on renewable energy will move the energy system *from* a system of highly concentrated and geographically dense generation of constant power to supply exogenous low-density demand; *to* a system of low-density and geographically diffuse generation of intermittent power to supply endogenous demand. These characteristics thus run contrary to the characteristics of earlier transformations, and impose higher barriers to change than were faced in the past.

This section shows that the changes required by a low-emissions transformation run opposite the direction of the major historical transformations: from higher density to lower, from greater reliability to less, and with no improvement in the flexibility of the final energy carrier.[22] These qualities should compound the complexity of this energy systems transformation relative to prior examples. They will put substantial limits on the degree to which the energy systems transformation can be

[22] I will pay particular attention here to the electricity sector, where these changes are most pronounced. But similar challenges–for storage, convenience, reliability, transportability, and density–pertain to transportation as well.

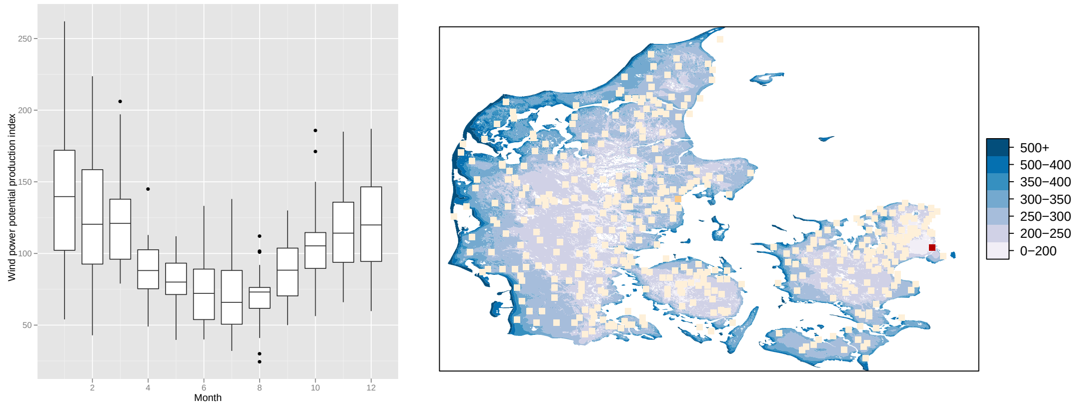
self-sustaining, while simultaneously raising the cost and complexity of the transformation itself. In particular, compensating for these differences will require substantial changes not just in the technical infrastructure of the system, but in the markets that set the framework under which that infrastructure is built and operated. As we shall see in the following chapter, that poses real challenges to the political economy of this energy transformation, and thus to the viability of climate change mitigation.

2.5.1 From constant to intermittent

Fossil fuel-based energy production is organized around a system of baseload and peaking generation. Baseload generation–usually coal, gas, or nuclear-fired steam turbine generation–provides constant, always-on energy supply. Peaking power–usually fast-starting natural turbine power–supplements baseload power in order to follow the peaks and troughs of the daily cycle of energy demand.

This system is predicated on the assumption that the operator has complete control over the timing and scale of energy production. That assumption is supported by a series of long-term contracts for power generation, futures markets that provide price-smoothing mechanisms, and spot markets that provide short-term mechanisms to match supply to demand. Within these markets, price-based power dispatching ensures that cheaper baseload power is consumed prior to more expensive peaking power.

Zero-emissions renewable energy violates most of these assumptions. By its nature, renewable energy depends on flows, such as wind speed or solar intensity, over which the operators have no control. These flows may be intermittent on a variety of timescales–from minor fluctuations in the 15-minute range to larger fluctuations in the hour range, to major fluctuations from year to year based on variation in climate and weather conditions. Figure 2.3 provides a sense of those fluctuations in Denmark, a high-wind-capacity market, over the last thirty years.



(a) Wind power potential index by month. Baseline = 100.

(b) Geographic distribution of wind power potential, in W / m^2. Population centers overlaid; darker points indicate larger population.

Figure 2.3: Intertemporal and geospatial variability in wind power production potential, Denmark. Intertemporal data represent averages over the period January 1979 - March 2011 across all geographic areas. Geospatial data reflect measurements as of 1999. Source: Wind potential data provided by EMD Corporation, at http://www.emd.dk/Documentation/DK%20Wind%20Resource%20Map/. Intertemporal data provided by Vindstat, Denmark, at http://www.vindstat.dk/. Population center data provided by the Socioeconomic Data and Applications Center Gridded Population dataset, at http://sedac.ciesin.columbia.edu/gpw/index.jsp

Managing intermittency in an energy system with significant renewable energy capacity will require changes to both the technical infrastructure and market superstructure of the energy system.

Infrastructure issues for intermittency management

Technically, both engineering estimates and experience suggest that an energy system can tolerate up to 20% generation from intermittent sources before the intermittency interferes with the stability of the electrical grid.(Integration of Variable Generation Task Force, 2009) Beyond that point, the fluctuations in power production can interfere with the electrical stability of the grid and compromise its ability to deliver power on demand. In the limit, unmanaged fluctuation can cause unexpected brownouts, as for example when sudden drops in power inputs cannot be met by other generation assets.

Market issues for intermittency management

Economically, the introduction of significant intermittent resources–particularly wind energy–into power grids can affect markets for both the sale of electrical power and investment in sufficient generation capacity to ensure systems stability. Electricity sale is complicated by the potential for renewable resources to invert the price structure of electricity markets, while provision of sufficient capacity is complicated by the realignment of market incentives necessary to drive adoption of significant amounts of renewable energy.

Power markets structure power consumption based on the marginal cost of generation. Historically, this has meant that the markets construct a dispatch order–the order at which different generation sources are fed into the power grid–that first consumes cheap baseload power and only later more expensive peaking power.

However, renewable energy power sources like wind, though more expensive on an average-cost basis than most fossil fuels, are often cheaper on a marginal cost basis. Once generating capacity is installed, the variable cost of production is almost zero. Wind farm operators, for instance, thus face strong incentives to produce whenever the wind blows. On particularly windy days, this can lead to near-zero marginal power prices as large amounts of effectively free wind power are offered to the market. This can both disrupt system stability and dilute incentives to invest in baseload power resources. This problem became severe enough in the Scandinavian power market that Nordpool introduced a €-200 / MWh penalty on wind farm operators who do not reduce production at times of system overcapacity.(Nord Pool Spot, 2009)

This realignment of market incentives is closely related to the problem of capacity. Incentives to adopt significant amounts of renewable energy simultaneously reduce the incentives to invest in fossil fuel generation, and increase the need for investment in the kinds of flexible generation capacity that fossil fuels excel at, and which is required to compensate for renewable power intermittency. Because that flexibility may be needed only irregularly, investors face uncertainty about when and how they will earn returns on their investments.

Solving intermittency: available options and political implications

The intermittency of renewable energy is thus disruptive to both the technical stability of the power grid and the economic incentives in power markets. The problems created by changes in the structure of power generation aren't insurmountable. But, as has been emphasized above, dealing with these issues requires downstream changes to the structure of energy markets and energy distribution. And those changes will require both technological innovation and policy choices.

The various aspects of this problem can be solved in a variety of ways:

1. Expansion of the scope of the energy system via robust interconnection to other power markets, so that overproduction in one region can be redistributed to other regions (and vice-versa when local conditions for renewable energy are unfavorable)

2. Incorporation of storage capacity into the power grid, that is charged at periods of over-production and discharged at periods of high demand

3. Introduction of capacity markets that incentivize investment in rarely-used but occasionally crucial generation capacity to fill in for sustained under-production of renewable energy

Expansion of markets requires both the construction of new electricity generation infrastructure to connect those markets and establishment of the necessary regulatory and market institutions to govern cross-border power trading. The planning and construction process for electrical infrastructure takes a very long time, and represents a massive capital expenditure. Interviews with European transmission network operators in the fall of 2010 suggested a 10-year planning horizon from initial identification of new transmission needs to the start of operations on new lines. Costs for new lines run upwards of $1 million per kilometer of new transmissions capacity, depending on technology and whether more expensive but aesthetically more pleasing and thus politically more viable underground cabling is required.[23]

Other solutions, including integration of significant storage capacity and maintenance of flexible fossil fuel capacity, may require entirely new markets for power capacity, rather than simply power.[24] Capacity markets provide income streams to investors that reward the existence of capacity, rather than simply its use. This can provide the necessary incentives to invest in capacity that may be used at unpredictable intervals and at uncertain prices. Cailliau et al. (2011) provides a primer on these issues, and shows that multiple potential solutions exist, the viability of each depending on both the technical and regulatory structure of the energy system. In short, and consistent with a long-understood argument from political economy, the

[23]The California Independent Systems Operator (CAISO) estimates that long-distance 230kV overhead transmissions lines cost anywhere from $1.1-$1.8 million per mile, or $680,000-$1.1 million per km. That assumes flat land and does not include the cost of acquiring territorial rights. See Ng (2009). Smil (2011a) suggests that $2 million per kilometer is a more accurate cost. Underground lines are more expensive because of the greater technical complexity involved. Direct-current cables are more expensive because of their greater technical complexity and the need for AC-DC conversion at either end of the cable. This has limited their use to very long distances, where the greater efficiency of DC transmission outweighs the higher up-front capital cost.

[24]Joskow (2006) provides a formal justification for capacity markets. In perfect electricity markets with freely floating prices, investors in capacity would be rewarded for intermittent use of their assets by very high prices–as in periods where the system was operating above normal capacity. But because those periods (1) usually threaten serious system instability and (2) threaten politically unpalatable power prices, they usually trigger either ad hoc or statutory regulatory intervention to contain prices and maintain stability. Thus dependence on very high prices for returns is unwarranted, creating the need for alternative means for rewarding capacity investment.

solution to the intermittency problems created by renewable energy will require a range of political and regulatory choices that will shape the development and use of new technologies.

2.5.2 From concentrated to distributed

Modern electricity systems are based almost entirely on alternating-current (AC) generation technology. That choice emerged in part from the potentially greater efficiency of AC power transmission, and in part from political choices about power systems standardization. As Hughes (1976) has shown, the choice of AC instead of direct-current (DC) technology was ultimately political–made by the New York State legislature at a time of severe uncertainty about which system would ultimately prove best for electrification. But that choice is ultimately dictated a range of engineering decisions.

At the time of the decision, DC power could not be easily transmitted over long distances due to severe line losses.[25] Nikola Tesla's AC systems, which became the model for most systems worldwide, did not have this problem: the use of transformers makes it easy to use high voltages for efficient long-distance transmission and the step down the voltage close to the point of energy use.[26]

The ease of long-distance transmission resulted in an energy system reliant on highly concentrated energy production. Coal-fired power plants in the United States have an average generation capacity of 230MW. Most of those plants are located rela-

[25]This remains the case for short distances, but the efficiency of modern DC transmission technology now surpasses AC transmission at sufficiently long distances.

[26]This result emerges naturally from Joule's first law. The transmitted power of an electrical signal with voltage V and current i flowing through a line goes as $P = iV$. But the resistive heating in that line goes as $P_{heat} = i^2R$. Thus for a given power P^*, a higher voltage produces a proportionately lower current but reduces heat loss by the square of the change in voltage. Given US wall voltages of 120V AC, but transmission voltages at 100kV AC, this implies a nearly 700,000-fold increase in transmission efficiency. Higher voltages also allow for serving both industrial and residential customers from the same generation and transmission infrastructure.

tively far from population centers, and may be co-located with coal mines or other fossil fuel input sources. Those plants are tied into the energy system via long-distance, high-voltage transmission lines that supply local distribution grids. This pattern is widely repeated in other advanced industrial economies.

Renewable energy looks completely different. With the exception of hydropower, renewable energy is dependent on relatively diffuse energy sources.[27] Renewable energy generation capacity cannot be concentrated independent of finding geographically concentrated renewable energy resources. This, in turn, means that the transmission infrastructure for renewable energy must evolve from a system designed to move power from high-concentration producers to a system designed to collect and concentrate power from low-density producers. Thus capital investment in renewable energy requires both brand-new generation assets and significant new electricity transmission infrastructure.

Some geographic concentration of generation is possible if suitable concentrations of wind or solar resources can be found. Leading candidates here include offshore wind energy in places like the North Sea and off the Irish coast; and solar power in desert areas like the American southwest or the Sahara desert. But these regions tend to be far from population centers and far from pre-existing transmission infrastructure. Thus these options also represent a significant geographic reorganization of the transmission infrastructure, with the attendant capital costs and regulatory challenges. Both those costs, and who should pay them (the transmission systems operator, or the owner of the new generation plant) have proven politically contentious.

[27]This is transparently apparent on observation of Denmark. There, onshore wind farms are spread over the entire country at a density of 2-10 windmills (6-30MW assuming the largest and most efficient modern 3MW turbines) per farm.

2.5.3 From high-density to low-density

Prior energy systems transformations in the industrial era pushed the system towards greater densities in two senses. Chemically, each new energy source contained more energy per unit weight than its predecessors. Geographically, each new energy source allowed for greater energy production per unit area than its predecessors. Renewable energy, in contrast, reverses both these trends: physical energy sources like biofuels are energetically no denser, and often less dense, than fossil fuels; and renewable electricity is much less geographically concentrated than any fossil fuel-based power generation alternative.

Replacements for thermal energy–combustion–are particularly problematic. The only carbon-neutral option is purpose-grown biomass or crop residues. On a per-weight basis, biomass is half as energy-dense as coal, and four times less dense than natural gas. Thus a switch back to biomass crops and residues means a switch to less-dense energy sources, with correspondingly more complicated logistics for concentrating the energy source for final use. Ongoing work on bioengineered crops may improve these densities somewhat, but a doubling of the energy per unit weight of biomass appears ambitious at best and unlikely at worst.

Renewable energy is geographically less dense as well.(Smil, 2010) Coal fired power plants deliver power at a spatial density, in W/m^2, 2-3 orders of magnitude higher than either solar or wind-based energy. That means a much larger overall geographic area dedicated to energy production than we have in today's energy system. Not only does that imply a much different geographic structure for the energy system, as discussed in section 2.5.2, but it also suggests a reallocation of land from one set of uses to another. Some of that reallocation is marginal–as in the co-location of agriculture and wind turbines. But other forms–increased use of land for biofuel cultivation, for instance–may displace other uses.

Reallocation of land use poses a range of political questions, of which two have already proven highly salient. First it may take land away from other productive activity. This has been particularly controversial in the case of biofuels, where land use reallocation has moved arable land from food crops to fuel crops; or, as in Brazil, led to deforestation in order to grow sugarcane for use as an ethanol feedstock.

Second, land use reallocation generates both environmental and aesthetic concerns as previously undeveloped land is brought into the energy system. These concerns can delay or prevent the construction of new energy production and transmission infrastructure. This has been a consistent problem for new transmission infrastructure in much of northwest Europe, where the timeline for planning and development of new infrastructure now lasts about 10 years. It has also delayed construction of new wind farms in the American northeast, where coastal residents have objected to the aesthetic impacts.[28]

Finally, the spatial reorganization of the energy system implies the potential abandonment of otherwise viable transmission infrastructure and its replacement, at significant capital expense, with new infrastructure designed to service new and more diffuse geographies. The capital losses implicit in writing off otherwise viable infrastructure must be added to the cost of new infrastructure in any appraisal of the cost. Moreover, since that capital infrastructure depreciates over very long timescales–American powerplants average about 50 years in age, transmission lines 30-40–the natural depreciation and replacement of these assets may not occur in a timeframe compatible with rapid decarbonization of the energy system. Hence not only must major energy producers invest substantially in new infrastructure, but they may also face losses from the writeoff of existing infrastructure.

[28]The Cape Wind project off the shores of Massachusetts has been in development since 2001. As of 2013, it may finally receive approval to move forward. For a comprehensive review of the project, its opponents, and the challenges of offshore wind development in the United States, see Jr. (2013).

2.5.4 From exogenous to endogenous demand

Today's energy system gives operators little control over consumer behavior. Most residential consumers rarely see prices that reflect actually supply conditions; and lack the tools to observe and react to those prices even if the data were available. This is both a technical accident and a political choice: an accident, insofar as the transmission and distribution system was never built to accommodate real-time pricing; and a choice, insofar as public regulators have pushed utilities towards the pricing models currently in use.[29]

Deprived of responsive demand, systems operators depend on long-term investment and capacity planning, and short-term wholesale market operations, to maintain systems stability. Markets have evolved accordingly, with long-term power contracts designed around average demand profiles, and supplemented with day-ahead and spot markets to match final supply to final demand. These complementary features of energy production, transmission, and sale reflect a system that assumes absolutely no control over demand, and makes investments targeted at an energy supply flexible enough to meet that demand under almost any circumstance.

Because decarbonization implies a move away from constant and flexible power sources, it has led to the hope that demand can be managed against supply to ensure systems adequacy at all times. In many cases, this will require dynamic demand management. For instance, on peak power days in the middle of the summer, a difference of a few degrees in temperature settings on the air conditioners in apartments across a city could mean the difference between stable power supplies and brownouts. One version of a "smart grid" would enable this kind of dynamic demand management

[29] Even attempts at reforming these pricing models run into problems. California attempted to deregulate both wholesale and retail electricity pricing in the 1990s. An unexpected (and likely temporary) electricity price spike shortly after deregulation generated pressure to discontinue real-time demand pricing. The subsequent price mismatch between wholesale and retail markets contributed to the 2000-2001 electricity crisis. See Sweeney (2002).

at the systems level, treating both supply and demand as variable in the process of equilibrating the two.

This of course would represent a radical break with today's energy paradigm. It would require significant investment in new energy infrastructure to provide the information and control systems necessary for such a system to operate. And, as indicated discussed further in section 2.5.1, it would also raise a long series of regulatory and market design questions about how to price the service that energy consumers are offering to the energy system (implicitly, stabilization services) and who owned what rights to the information generated as a result.[30]

2.5.5 Substitution, not complementarity

Finally, earlier energy systems transformations introduced new sources that in most cases became complements to, rather than substitutes for, pre-existing sources. Smil (2011a) provides substantial evidence to the effect that earlier energy systems transformations showed long-lived co-existence of parallel energy sources in different domains of the energy system. New energy sources would establish themselves in niche applications before broader adoption took hold. Warde (2007) provides similar evidence for the history of energy consumption in England and Wales from the middle ages onward. The widespread adoption of oil did not replace coal; indeed, most oil is now used for transportation and as a chemical input. Meanwhile, coal remains the most significant fossil fuel input to electricity production.

Because each new system could emerge alongside the old, the new system had enormous latitude to experiment in a period before it became central to any major economic or social process. This latitude enabled widespread experimentation with

[30]The information question is potentially substantial. Given that it's reasonably possible to infer daily patterns of human behavior from their energy consumption profile, gathering daily consumption data from a significant proportion of households poses serious concerns.

the properties of the new energy system, properties that only later settled into standards and manifested the kinds of economies of scale that have characterized the inertia in networked systems.

But, as shown in section 2.3, this strategy may not suffice in the limit for the transformation to a low-carbon energy system. Actual absolute emissions reduction will require the replacement, rather than modification, of the energy infrastructure. And that will, in turn, mean that the new energy system must replace the old without substantial disruption of the downstream patterns of economic and social behavior that have come to depend on it.

2.6 Synthesis: The energy system as a policy constraint

The history of energy systems transformations illustrates the need for a series of *complementary* changes across the energy system to make a new energy source a viable means of fueling economic and social activity. In the past, those changes were driven in part by the inherent advantages of the new fuel, in part by limitations and supply constraints in the existing systems, and in part by state action to to either force change (in the case of English concerns about wood fuel exhaustion) or stabilize the environment for the massive investments required for construction of a new energy system. All these factors suggest the complexity and difficulty of substantially increasing the efficiency of modern energy systems while radically cutting their carbon intensity. They also suggest the diversity of political and economic approaches required to induce and sustain the transformation.

This technical interlude has sought to locate the climate policy problem in the context of the energy systems transformation required to solve it. The political choices about whether and how to pursue energy systems decarbonization and energy efficiency improvements will occur in a context framed by the the opportunities and constraints of these systems. As such, the question of how interests will form for and against this transformation becomes much more complex. A full theory of the political economy of climate change mitigation requires that we account for these constraints and opportunities. As the next chapter will argue, while the impacts to the narrow economic interests of the fossil fuel sector are usually quite clear, the broader pattern of interest formation is by no means pre-determined. Rather, because the energy system provides a range of interdependent services to the economy, it may create possibilities for balancing costs in one area with gains in another. Those kinds of tradeoffs may permit a political consensus in favor of climate change mitigation to form, even in the face of significant potential costs to some sectors. But we cannot understand the potential for this kind of issue linkage without considering the nature of the energy system in detail.

3 The political economy of climate change reconsidered

3.1 Introduction

With the technical background from chapter 2 in hand, we turn back to the political problem of emissions reduction. A global, binding agreement on climate change mitigation has proven ephemeral. In its absence, unilateral state action on emissions reduction should be highly improbable. Climate change mitigation imposes potentially large costs, faces acute technological uncertainty, and delivers benefits largely in the form of global public goods. The resulting incentives for free-riding on the actions of others should provide few incentives for individual state action, even as it also interferes with attempts to bind the major emitters into a common framework.

Nevertheless, individual states or small groups of states have adopted a variety of climate policy measures in spite of the lack of a global climate treaty. These range from incremental efforts like research and development on low-emissions technologies, to comprehensive emissions control regimes. The states pursuing these measures include both advanced industrial democracies and developing economies: The European Union has a comprehensive emissions control regime; South Korea has published a wide-ranging "green growth" economic development strategy; China is the world's largest market for renewable energy goods; India has an ambitious solar electricity program; Brazil operates the world's largest fleet of alternative-fuel vehicles, run on ethanol produced very efficiently from sugarcane. Surprisingly, many of these efforts were redoubled after 2008, despite the onset of the worst global economic crisis since the Great Depression.

Unilateral state action in spite of weak or nonexistent global coordination defies a view of climate change that emphasizes the creation of global public goods via the resolution of negative environmental externalities. Yet we've little evidence for a sudden turn towards altruism or virtue. Resolving this dilemma poses two questions for political science. First, *when* would we expect states to act in the absence of a global framework; and second, *how* would we expect states to implement an emissions control regime? The first question asks why states would take action that apparently risks the growth and competitiveness of their domestic economies relative to free-riding competitor states; and the second questions how they would do so given the politically difficult task of imposing acute costs on powerful economic interests.

This chapter presents a theoretical framework for the political economy of climate change mitigation that resolves the apparent contradiction of state action in the face of very large incentives for political stasis and free-riding. It argues that the pattern of individual state action on climate change depends on whether states can link emissions policy to other energy policy domains that produce near-term, tangible, private benefits to action. Those benefits provide the means of securing a policy bargain among major economic actors, assist in resolving the distributional conflicts that arise from significant emissions reduction, and generate new interests in favor of long-term policy continuity.[1]

[1] Urpelainen (2012a) presents a parallel model of a "technology fund" in which developed-country actors provide subsidies to developing countries to buy low-emissions technologies, as an implicit subsidy to developed-country technology firms. Participation among multiple developed countries may be secured, he notes, though linkage across technologies rather than issue areas. Here, I argue that absent such a fund, a multiplicity of climate policy instruments may accomplish the same ends

Whether states can find viable issue linkages depends, as chapter 2 argued, on the the structure of national energy systems and the corresponding tasks required to shift the energy system to a low-emissions trajectory. Fossil fuel use generates nearly 70% of global emissions even as it also provides the foundation of modern industrial economies. The physical, economic, and regulatory structure of legacy energy systems thus shapes the costs and benefits of emissions policies for the entire economy. As such, it influences whether those policies can offset the costs of emissions reduction through the generation of benefits from other energy-related domains like energy security, economic competitiveness, or high-technology innovation.

Treating climate change mitigation as a problem of energy systems transformation provides substantially more analytic leverage over the politics of climate action than more traditional approaches based in environmental politics. As 2 discussed in detail, the complexity, cost, and uncertainty surrounding the transition to a low-emissions economy are unlike anything encountered in other environmental issues to date. While the environmental movement has been vital to publicizing the issue of climate change, social movement dynamics and public opinion are poorly suited to the maintenance of long-term and potentially costly policy. Instead, viable emissions policy will require a durable coalition of industry and labor, similar to that of large-scale industrial policy measures. Understanding whether and how that coalition may emerge amidst legacy structures for energy production, distribution, and use in industrial economies provides a vital contribution to the analysis of climate policy action.

This chapter proceeds in three steps. I first summarize the conventional wisdom surrounding the politics of climate change, and illustrate its shortcomings for understanding state policy choices. I then present a model of when and how individual states or regions would embark on a low-emissions energy systems transformation in

through different means.

the absence of a binding global emissions deal. I show that this model helps explain today's pattern of action and inaction on climate change, and offers analytic leverage on the question of how state action will evolve in the future. Subsequently, chapters 4–5 provide empirical evidence from the European Union, home to the world's most comprehensive climate change policy regime, that supports validity of this model. Finally, chapter 7 suggests that the model also provides insight outside the EU, providing insights into both instances of policy success like South Korea; and policy failure, as in the United States.

3.2 Towards a political economy of low-carbon energy systems transformation

Recounting the conclusions from chapter 2: Emissions reduction via energy systems transformation poses very significant barriers to policy action. It lacks the natural incentives that earlier energy system transformations enjoyed. It faces profound technological uncertainty. The changes required must occur though highly networked, monopolistic, and inertia-prone markets. And the interests displaced by emissions reduction are wealthy and well-connected, and stand to benefit from the sympathies of many energy consumers dissatisfied by higher energy prices. Meanwhile, the primary benefits from climate change mitigation arrive far in the future, and in the form of largely intangible global public goods that accrue to everyone regardless of their contribution to emissions reduction. This pattern of costs and benefits has regularly forestalled coordinated global action on climate change, and offers little reason to expect unilateral action.

Empirically, however, some states have adopted emissions reduction measures of varying degrees of ambition and comprehensiveness: In 2010, South Korea adopted a "green growth" strategy that included emissions targets and renewable energy promotion measures; Colorado adopted significant subsidies and other regulatory changes favoring renewable energy; California has pursued both renewable energy and emissions control via its AB32 legislation; China has become a major market for renewable energy; and the European Union, considered in much greater detail later in this book, has adopted a wide-ranging climate and energy policy strategy.

State action in the face of apparently overwhelming incentives to the contrary poses two questions that cut to the core of the comparative political economy of climate change mitigation:

1. When should we expect states to institutionalize climate change action?

2. How should we expect states to institutionalize a policy framework for climate change action?

3. What would have to occur to fundamentally change the answers to (1) and (2)?

This section provides a framework for answering these questions, grounded in a theory of the political economy of energy systems transformation. I show that while alternative explanations for state action reliant on public opinion, party structures, or bureaucratic entrepreneurship provide some insight into state action, their predictive value is limited in both time and space. Resolving the contradiction between action on emissions reduction and the problem of global public goods requires looking beyond political processes to the way in which domestic energy systems structure and distribute the costs and benefits of climate change mitigation.

3.2.1 Why might states act? Postmodernism, greens, and bureaucratic ambition

Theoretically, the literature has suggested three explanations for variation in individual state willingness to adopt and institutionalize greenhouse gas emissions reduction. The "post-modern politics" thesis suggests that non-material goods have taken precedence over ever-growing material prosperity in sufficiently wealthy countries. In this view, emissions reduction represents a kind of consumption good attractive to citizens in wealthy advanced industrial economies.[2]

A second argument has suggested that this preference for non-material goods is particularly well-expressed where green parties have established themselves and provided single-issue representation in national parliaments. Jacobsson and Lauber (2006) pursue that notion in their explanation of Germany's transition towards a favorable environment for renewable energy adoption. They argue that German adoption of renewable energy emerged as a fight between the Energy ministry, allied to the fossil fuel sector, and the Environment ministry, backed by an increasingly powerful green party. Green parties in this argument embody a particular desire for environmental goods that may be willing to make explicit trade-offs of material consumption for improved environmental outcomes.

Finally, scholars have pointed to bureaucratic entrepreneurship in seeking issues to exploit for institutional gain. The high profile of the international climate change negotiations provided a potential venue for bureaucrats to exercise additional power

[2]The existence and strength of a "postmodernist" effect on attitudes towards environmental protection goods was confirmed by Diekmann and Franzen (1999), contrary to the results of Dunlap and Mertig (1995) and related work. Bättig and Bernauer (2009) find evidence that democracy increases citizens' expressed commitment to climate change mitigation, though that commitment rarely translates into actual changes in emissions levels. Gerhards and Lengfeld (2008) find that the relatively wealthier countries of the EU-15 support EU climate policy at higher rates than citizens of the new member states. The debate tracks with the left-libertarian realignment of European politics proposed by Kitschelt (1994), who argues that high levels of socioeconomic welfare have led disputes over non-economic goods to reassert their influence over late 20th-century European party identification.

outside domestic economies, or to establish new international roles. Promoting climate change mitigation at home may thus provide credibility for bureaucrats hoping to exercise power or autonomy abroad. Schreurs and Tiberghien (2007) suggest that this played an important role in the EU, where the European Commission sought a defining issue for its new foreign policy role after the passage of the Lisbon Treaty.

In practice, however, these three explanations offer an incomplete explanation for empirical patterns of climate change action. The new member states in Eastern Europe display far more conventional political preferences than their postmodern western European counterparts, yet those states supported the 2008 Climate and Energy package. China and India are relatively poor and have weak or nonexistent green parties, yet both have ambitious goals for renewable energy adoption. South Korea, a successful middle-income, heavy industrial developmental state, has adopted an ambitious green growth policy. The United States, as Skocpol (2013) points out, has very well-organized environmental lobbies who have spent very large sums on public persuasion and political lobbying, but to no effect. Finally, EU policy entrepreneurship proved disastrous at the Copenhagen climate talks, where the EU was largely shut out of final negotiations. But the EU has shown few signs of changing its long-term approach to climate and energy policy at home.

Furthermore, these explanations offer relatively few predictions of what states will do in the future. Victor (2011) has characterized today's landscape as one of "enthusiastic" and "reluctant" states. In the language of postmodern altruism and wealth, that typology should at least include a "skeptical" category for countries like the US, who have the wealth to act but not the will; and "vulnerable" for those whose susceptibility to climate damage makes them desperate for action even as they lack resources or international influence to promote or force it. Given the variation in postmodern altruism and the resources to do something in response, that implies a landscape something like figure 3.1.

But this typology, like the factors that underpin it, says little about how states will evolve over time. Will China, India, and Brazil become more like the US or the EU as they climb the income ladder? China has, for instance, become rather less recalcitrant in international negotiations over time, without either developing green parties or displaying much in the way of post-materialist values. Likewise, a framework based solely on political values and party relations provides little insight as to whether the present American reluctance to act on climate change is a product of momentary political spasms, or of deeper American economic and environmental interests.

Finally, on a more practical note, these explanations offer limited guidance as to how policy could be implemented or sustained in light of the barriers and setbacks observed to date. Even in rich, liberal states, preferences for climate change policy have proven volatile, often for reasons wholly unrelated to the climate change problem itself. For instance, Egan and Mullin (2011) provide evidence that extreme weather events, which individually provide no information on long-term climate trends, may significantly affect citizens' attitudes towards climate change policy. Likewise, the US has consistently failed to adopt climate policy despite periods of significant political support. Climate policy dependent on the postmodern altruism of rich, liberal countries would thus appear to offer little promise of gaining or sustaining much traction in the face of its potential costs and risks.

The range of observed variation within the group of ostensibly "enthusiastic" states suggests the limits to hypotheses reliant on public opinion and party structures. Likewise, the range of policy action observed across "enthusiastic" and "reluctant" states suggests the limits to these categories themselves both now and in the future. Explaining both why states have acted, and how they have chosen to act, needs to look beyond these factors and categories to understand interest group formation and behavior vis a vis emissions reduction.

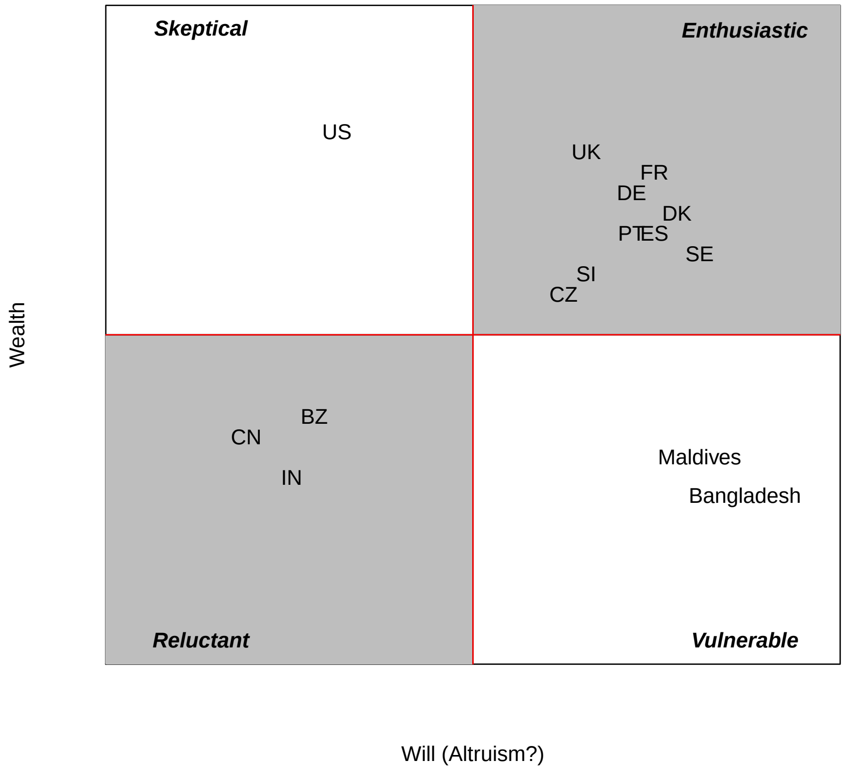


Figure 3.1: The conventional model of climate action, supposing that the choice to act is driven by a combination of altruism and wealth. "Enthusiasm" and "Reluctance" are based on the analysis by Victor (2011). "Vulnerable" states are those for whom climate change poses massive risks: the Maldives, for instance, is only 0.5m above sea level and is presently seeking new territory in anticipation of rising sea levels.

3.2.2 Beyond wealth and altruism: issue linkage and energy systems transformation

In contrast to these explanations for action and inaction, I posit that countries will institutionalize emissions reductions when the changes required of the energy system generate ancillary benefits elsewhere that can be used to justify the costs of emissions reduction[3]. Those benefits provide the means for two politically important tasks: first, to compensate losers who might otherwise have diluted or blocked progress on emissions reduction; and second, to create new interests allied to emissions reduction because of the acute benefits it brings, rather than a diffuse desire for environmental goods. The energy system thus frames whether and how emissions reduction can generate private as well as public goods; and whether those private goods can help stabilize improve outcomes for both the winners and losers from emissions reduction. Moreover, an explanation grounded in a careful analysis of energy systems can provide testable implications for the behavior of countries currently unaddressed by theories reliant on postmodern political preferences or green interests and parties.

Making enthusiasts of the nations? The promise and shortcomings of issue linkage

I propose that the connection between long-term environmental goals and the near-term material returns to systems transformation can be thought of as an instance of issue linkage. Traditionally, the study of issue linkage has emphasized inter-state relations and the terms under which states would cooperate in an otherwise anarchic world. There, the notion of issue linkage has been studied empirically in joint negotiation of economic and security issues (Davis, 2009), trade liberalization across sectors (Davis, 2004), European integration (Huelshoff, 1994; Moravcsik, 1993; Moravcsik and Nicolaïdis, 1999), European Community policymaking (Weber and Wiesmeth, 1991), and trade sanctions (Lacy and Niou, 2004).

Issue linkage has often been proposed as a solution to overcoming the incentives to free-ride at the heart of the emissions problem. As modeled by Tollison and Willett

[3] Urpelainen (2009) suggests that a similar dynamic may take place at the sub-national level. He presents a model wherein local politicians act despite national inaction on the basis of superior private information about near-term economic or political benefits. He then suggests that acting reveals information to national politicians, who may then act themselves. This section suggests that those benefits do not scale, and so can only form part of a multifaceted political deal.

(1979), issue linkage proposes that coupling progress in one domain to progress in another can create new equilibria that improve negotiation outcomes for both parties. This is principally true, as in Sebenius (1983), if the pattern of costs and benefits in the two issue areas are asymmetric among the negotiators. If progress on an issue that principally benefits one party can be coupled to another issue that benefits the other negotiating partner, both may find reasons to accept a resolution to the issue area that they do less well at.

In the international negotiations on climate change, however, issue linkage has not lived up to its promise. The Kyoto Protocol contained provisions for two programs, the Clean Development Mechanism (CDM) and Joint Implementation (JI), that provide a case in point. Both were intended to align developed and developing country interests. Traditionally, developing countries had demanded compensation for participation in emissions mitigation. But pure cash compensation was not acceptable to the developed economies. Instead, CDM and JI were intended to provide implicit side-payments from developed to developing countries. For CDM in particular, developed countries would gain emissions reduction credits by investing in low-emissions development projects in the developing world. Since those projects would in general be cheaper than equivalent emissions reduction in the developed world, the rich countries could benefit from cheaper emissions abatement options. Meanwhile, the poor countries would get the capital they wanted, and a high-tech infrastructure base to boot. In practice, however, these assumptions proved unworkable. Neither CDM nor JI delivered very much in the way of emissions reduction, and the development projects proved vulnerable to corruption, abuse, and various other problems.(Wara and Victor, 2008; Schneider, 2008)

More recently, the 2001 departure of the US from the Kyoto Protocol renewed interest in issue linkage strategies. Tying American access to economic negotiations in trade or technology sharing to its resumption of its Kyoto Protocol obligations seemed a promising way to rein in the world's largest greenhouse gas emitter (Kemfert, 2004; Buchner et al., 2005). But Hovi and Skodvin (2008) show that these proposals would probably fail and do serious damage to international economic institutions along the way. In particular, they lack the two precursors for effective linkage: a realistic link between two negotiating areas, and a credible means of enforcing that link. Advocates for issue linkage presumed that the US would desire trade liberalization enough to return to the Kyoto framework. But that implies that the rest of the world had the power to deny the US–the world's largest economy and holder of the global reserve currency–participation in trade negotiations. There's little credible reason that the US should expect this to occur; and hence little reason to think that issue linkage would work to bring the US back into global negotiations on emissions reduction.

Issue linkage through the energy system: assets and credible commitment

These actual and potential failures of issue linkage in climate change policy arguably stemmed from the choice of issue areas and the ensuing lack of reasons to take the linkage seriously. The size and importance of the US economy weakens any threat to cut it out of global markets. Likewise, the CDM and JI mechanisms depended on the assumption that rich economies counted climate change benefits as real and tangible, and would thus readily trade real cash for poor countries' participation. In practice, the rich countries ran into real limits to both will and wealth.

Instead, I argue that successful issue linkage will emerge from the problems and opportunities created by national energy systems. The complementary nature of the energy system means that changes to reduce emissions will necessarily impact a range of other functions that system performs. As chapter 2 showed, that complementarity complicates the process of systems transformation. But it also raises the potential to generate real, tangible, and near-term benefits. If states can use energy systems transformation to solve problems created by their legacy energy systems, or to pursue new opportunities, they may find real, credible, and even physical reasons to tie emissions reduction to other energy policy domains.

Moreover, because the benefits that underpin these linkages flow from the evolving physical assets and markets that make up the energy system, they should be more credible and thus stable than other attempts at issue linkage in climate policy. As chapter 2 pointed out, the need for complementary change is driven at its root by the technical needs of the energy system. Those needs, by their nature, have serious downside consequences if left unaddressed. Hence the credibility of the commitment to actually carry through on those changes may be larger than in other, failed instances of issue linkage, in large part because the downside risks are greater.

By implication, however, the potential for issue linkage via the energy system should be much higher *within* states than between them. The predominately national scope of energy systems limits the opportunity to use systems-mediated issue linkage to bring states together–except in cases like the EU, where substantial transnational political institutions already exist. Rather, the theory of issue linkage proposed here suggests that it will primarily involve coupling across interest areas within domestic or regional systems where emissions reduction can be tied to the creation of privatizable economic benefits ancillary to the climate problem itself. This does not discount the possibility that inter-state cooperation on systems transformation can display similar phenomena, particularly where energy system interests correlate strongly with state boundaries.

To support issue linkage, a low-emissions energy systems transformation offers three primary categories of ancillary benefits:[4]

1. Reduced risk to energy supply and price insecurity

   Energy security refers to the degree to which a country's energy system is exposed to either supply disruptions or price shocks and price volatility. Insecurity induces harm in two ways: supply disruptions interfere directly with the functioning of the energy system; and price shocks and volatility can adversely affect the competitiveness of domestic firms and their ability to engage in long-term production planning.

   Supply insecurity results from the origins and diversity of imported energy. Most countries depend in one form or another on imported energy for electricity generation and transportation. In many cases, those imports come from parts of the world that are geopolitically unstable or politically unpalatable (the Middle East), or with which the importing country has unstable relations (as with eastern Europe dependence on Russian gas). This instability has often resulted in supply disruptions, particularly if a country depends on one or a handful of countries for the majority of its energy supplies.

   In contrast, low-carbon energy is usually domestic energy.[5] The sources of renewable energy are ubiquitous, and can be exploited on domestic territory. As such, they offer (for electricity generation, in particular) the opportunity to reduce domestic dependence on imported fuel sources. To the extent that energy insecurity imposes negative externalities on economies, the improved security

[4]Several forms of benefit, including public health benefits from reduced pollution, are not mentioned here. While there is little doubt that these benefits do exist, they do not provide the kind of concentrated and privatizable returns necessary to offset the acute and tangible near-term costs imposed by emissions reduction.

[5]The DESERTEC project under consideration at the European Union is an exception. It anticipates building large solar farms in the Sahara, and linking them into the European power markets through long-distance undersea transmission cables. The cost/benefit profile of the project aside, political instability in north Africa in early 2011 has provided some cause for re-thinking the wisdom of this project as a solution to supply instability.

of domestically-generated renewable energy provides immediate benefits to domestic firms and citizens. There may also be a prospective justification for such investments, insofar as aggressive competition from emerging economies for preferential access to fossil fuel resources may signal future supply constraints and instability.

Price insecurity originates from a wholly different set of phenomena. Even if countries are unconcerned about potential instability of supply, they still confront impacts of fluctuating world prices for fossil fuel energy. Energy importers are mostly price-takers on world markets. Price fluctuations in domestic energy bills have important consequences for the balance of trade. In a floating currency regime, this translates into fluctuating exchange rates and downstream impacts on the price of domestic goods in export markets. Price fluctuations also impact the cost structure of domestic firms and may interfere with long-term production planning, or impose hedging costs on firms in order to mute the effects of world price volatility.

Reduced fossil fuel consumption can generate price stability benefits in two ways. First, on the assumption that fuel costs will continue to rise over time, it can provide relative improvements to the competitiveness of domestic firms compared to more energy-dependent foreign firms.[6] Second, to the extent that volatility itself–and not just the price level–imposes costs, the reduced exposure to price volatility that comes with reduced exposure to fossil fuel markets can generate real cost advantages there as well.[7]

[6]Interviews with senior policymakers in Denmark in early 2010 suggested that this motivation was well-understood. They viewed their greater energy efficiency as a contributor to increased Danish competitiveness amidst high and volatile fossil fuel prices. This interview evidence provides additional confirmation of the results in Urpelainen (2011). He provides evidence that export-oriented OECD countries with limited access to cheap energy face strong incentives for energy efficiency as a way to reduce input costs and protect comparative advantage.

[7]Wal-Mart is an interesting case in this regard. Given their sheer size, energy became a sizable cost center that had historically gone un-examined. Cooperation between Wal-Mart and the Nature Con-

2. Improved systems performance

   Both developed and developing economies may suffer from inadequate infrastructure relative to their energy needs. For developed economies, renewal of aging infrastructure to accommodate renewable energy may also reduce the instability of the system as a whole. That instability imposes real costs on economic performance: blackouts cost the United States an estimated () annually.

   For developing economies, renewable energy may simplify the process of building a new energy system. The ability generate power locally, without large and expensive transmission and distribution infrastructure, may mean that renewable energy provides new and valuable energy services. Coupled with energy security arguments in the context of rapidly increasing emerging-country demand for fossil fuels, renewable energy may offer tangible near-term benefits from improved energy services that would motivate the adoption of renewable energy over other alternatives. However, to date this appears to have meant adoption of renewable energy as a complement to, rather than substitute for, additional fossil fuel energy capacity.[8]

3. Employment and comparative advantage

   In contrast to energy security, which improves benefits through reduced risk exposure, low-emissions energy sources may also improve the economic prospects for existing and new sectors of domestic economies. These benefits can arise from technological advantages in new industrial sectors, or job creation in protected sectors.

servancy, among others, led to a corporate emphasis on energy efficiency. Wal-Mart subsequently used its buying power to bring down the cost to consumers of various energy efficiency goods. Wal-Mart is of course an outlier on both energy consumption and corporate size, but this case is at least indicative of the myriad challenges and opportunities for energy efficiency improvements. See Gunther (2006).

[8]See here, for instance, Asif and Muneer (2007) on Chinese adoption of renewable energy amidst indigenous reserve constraints; and Karekezi and Kithyoma (2002) on the potential for solar energy to improve rural electrification in Africa. **Also Joanna Lewis on China**.

A renewable energy will require a range of new innovations, technologies, and expertise. Delivering those requirements will on its own deliver significant, if short-term, economic returns to new constituencies of firms and workers. Furthermore, early adopters may enjoy additional returns through export-led growth. There is evidence that energy technologies benefit substantially from learning-by-doing effects: the knowledge required to successfully design, build, and deploy these assets at scale requires actually designing, building, and testing them in real-world environments.[9]

Under this set of assumptions, states that start early on energy systems transformation may benefit from spillover effects in the competitiveness of domestic industry that produces renewable energy sector goods. The potential, or reality, of such spillovers may be a motivating factor for states to engage in emissions reduction.

The benefits created through these new industries may improve policy sustainability as well as policy acceptability. The new industrial interests created by this process (namely, the renewable energy sector firms, their workers, and their supply chains) will have material reasons to support the continuation of emissions policy and offset the weight of interests that might lobby for moderation or discontinuation of the policy framework.

Improvements to the efficiency of domestic energy systems may also generate new sources of employment in protected sectors. Roland-Holst (2008) has shown that energy efficiency improvements can generate positive employment feedback in sectors protected from international trade. In brief, improvements to energy efficiency reduce demand for employees in the energy sector, but re-

[9] See, for instance, Heymann (1998) on the parallel development of the Danish, German, and American wind power industries; and Schneider and Azar (2001) on the justification for early investment in emissions reduction based on arguments over knowledge capital accumulation.

lease funds for uses other than energy purchases. Empirically, it appears that most of those funds go to buy output from more labor-intensive sectors than energy, leading to overall employment growth, much of which occurs in sectors insulated from international competition, such as services.

Thus, consistent with Jacobs (2008) and Patashnik (2003, 2008), climate policy may stabilize itself if it can create constituencies with a material stake in policy continuity. Growing these constituencies out of the near-term benefits of a low-emissions systems transformation would help offset opposition from those interests that lose most from the cost of emissions reduction. The exact configuration of these benefits will vary by country, but will ultimately be shaped by the structure of national energy systems. Whether states can choose policy configurations to improve energy security, enhance industrial competitiveness, or expand energy supply will depend on whether and how their energy system and the broader economy facilitate such choices. Regardless of exactly where they come from, however, the potential for generating such near-term, tangible, and privatizable gains offers the crucial possibility of creating and sustaining a bargain with industrial interests in favor of continued action.[10]

The potential for such ancillary benefits now or in the future provides better explanatory power for understanding why countries fall into the "enthusiastic", "reluctant", or "skeptical" categories outlined in figure 3.1. Unlike arguments built on the intersection of wealth and green parties, it provides for more specific predictions of the geometry of policy action, grounded in the need for long-term policy institutionalization and not just short-term policy action. Stated formally, the potential for ancillary benefits to secure political coalitions from issue linkage depends, as in Tol-

[10] Urpelainen (2012b) provides a formal model of this process in which excess profits from renewable energy mandates drive support for politicians who supported them. Since more stringent mandates provide larger profits, politicians may have greater incentives to deliver more stringent mandates over time.

lison and Willett (1979), on whether expanding the issue domain in the bargaining process brings in issue areas that have varied distributions of costs and benefits. In the case of climate change mitigation, the legacy structure of the energy system plays a powerful role in dictating whether and in what domains these linkages can occur.

Chapter 4 will provide empirical evidence for the role played by issue linkage in policy adoption in the EU. In brief, Europe's pursuit of climate change mitigation exploited emissions control to generate benefits from improved energy security, larger markets for domestic renewable energy firms, and reduced exposure to international energy price volatility. In contrast, the United States, which imports relatively little energy, has substantial domestic coal and gas resources, and where renewable energy goods industries have much less economic weight, has fewer opportunities to use energy systems transformation to offset the costs of climate change mitigation with near-tern benefits. Finally, China and India, if reluctant to sign on to significant international emissions reduction targets, nevertheless derive significant benefits from renewable energy adoption in the form of better energy security, and improved energy system, and comparative advantage in new industries. To the extent that the opportunities for those benefits persist, we may expect these countries to become more willing to adopt emissions reduction policies directly as they become wealthier.

3.2.3 How: second best solutions and the rise of green industrial policy

The motivation to act, as outlined in section 3.2.2, does not necessarily imply the will to adopt a pre-packaged set of policy solutions. In choosing policy instruments, states face the challenge of using issue linkage to create a coalition in favor of action. Once policy is adopted, however, that challenge shifts to sustaining climate change mitigation over a 50-75 year time frame. As Patashnik (2008) has pointed out, policies intended to serve general interests face long-term vulnerability even after passage, as the enthusiasm that helped pass them fades while opposition endures.

Consistent with Victor (2011), I argue that states will adopt policies that have the best chance of disguising the costs they impose, and provide the most opportunity for disguising transfers to losers from climate change. As Victor argues that implies that most emissions pricing regime will probably use cap-and-trade schemes instead of taxes to regulate emissions directly. As chapter 4 will show, the process of cap setting and permit allocation integral to a cap-and-trade scheme provides more and more implicit opportunities to structure side-payments among interest groups. Those payments, consistent with issue linkage in other domains, have proven to play important roles in overcoming opposition from otherwise recalcitrant actors.

Policy sustainability, however, will likely require states to adopt a multitude of instruments beyond emissions regulation. Sustaining emissions policy over a 50-75 year duration will require ongoing support for a low-emissions energy systems transformation that will impose large losses on owners of fossil fuel capital and resource assets. Shielding the policy regime from pressure to dilute or reverse it will require going beyond just muting the costs these interests will incur. Rather, policy must create a range of equally acute new interests and beneficiaries in favor of systems transformation.

Creating acute and salient interests in support of systems transformation can occur most easily via narrowly targeted policies that directly support outcomes like renewable energy adoption, energy efficiency improvements, and power grid reform. As section 3.3 will argue, this goes against conventional wisdom on "optimum" climate policy. Whether emissions pricing alone represents the most "efficient" climate policy may be open to debate. But it most definitely makes the costs of emissions reduction obvious to the narrow interests who incur them–indeed, that is the entire point of emissions pricing. Furthermore, as an intentionally hands-off form of emissions control, pricing also implies relatively little influence over the specific trajectory of the energy system, which may lead to emissions reduction that generates few ancillary benefits (by, for instance, replacing domestic coal consumption with imported natural gas at a 50% savings in emissions per unit energy, but a potential increase in price and supply risk). Acute costs, explicit subsidies, and diluted benefits threaten to make pricing, pursued in isolation, politically unstable and prone to reversal. Avoiding these outcomes thus requires moving beyond prescriptions for a one-size-fits-all carbon price.

Structured properly, a low-emissions energy systems transformation may eventually become self-sustaining as it alters the structure of the energy system and the interests of the actors within it. The largest initial losers from emissions reduction will be firms who control significant fossil fuel assets. Since those firms are long-lived utilities, however, the gradual replacement of their fossil fuel assets with non-emitting alternatives may change their preferences over time. Patashnik (2008) provides evidence this occurred under the United States' price-based acid rain emissions control regime. But in that case, alternative technologies were well-known and adoption occurred relatively quickly. In contrast, climate change policy must survive an initial period of technological uncertainty where adoption will occur slowly. Thus stabilizing emissions reduction by changing preferences within the energy system requires policies that can quickly generate interests to sustain it through that initial adjustment period before increasing returns from policy kick in.

The demands of both policy adoption and sustainability thus imply a highly fractured landscape of national emissions policy. The national character of energy systems that grew up in sovereign states with different technical, geological, and economic characteristics now generates very different problems and dilemmas for national economies. This, in turn, implies significant cross-national variation in where and how energy systems transformation may solve these problems and generate the benefits that enable and sustain emissions reduction. What works in a country that imports significant quantities of energy may not matter at all to a country with large domestic coal reserves. Likewise, highly industrialized countries with strong renewable energy goods sectors may view renewable energy investments differently than those without.

3.2.4 Exceptions: exiting from the constraints of systems transformation

Section 3.2.2 argued that state action on emissions reduction becomes more likely when the energy system permits emissions reduction to occur through policies that serve more immediate needs and generate more immediate benefits. Section 3.2.3 suggested that this will move policy away from politically nonviable emissions pricing and towards a range of so-called "second-best" options that increasingly look like industrial policy. If true, this would imply fairly binding constraints on the opportunities for action.

Nonetheless, several potential developments could occur that would change this set of constraints. The first, and most obvious, would be a range of technological developments that rendered low-emissions energy very cheap, very reliable, or both. If renewable energy really did become cheaper than fossil fuels, that may change the dynamic of energy systems transformation. In contrast to the argument put forth in section 3.2, it would mean that "green" electrons now had at least one absolute advantage over "brown" electrons. Alternatively, radical and transformative innovation like nuclear fusion could also change the cost / benefit framework of climate action and render the acute cost problem largely null and void.

Barring near-term outcomes like this, we should ask whether emissions policy could attain outcomes similar to those of industrial policy during the postwar era. Then, investment of deferred consumption translated into significantly improved long-term growth prospects in the advanced industrial economies. Policy sustained itself for the better part of twenty years on the grounds that it provided far greater benefits than the costs imposed.

The possibility of such "green growth" gained considerable currency in the aftermath of the 2008-2009 financial crisis and ensuing recession. The linkage between emissions reduction and other environmental goals on the one hand, and re-industrialization and employment on the other, was made explicitly by the U.S. administration, the European Union, the South Korean government, and several American states.(Barbier, 2010) Chapter 7 will discuss the potential for "green growth" in greater detail, particularly with regards to the European Union's stated objectives for leadership in this developing sector. But as Huberty et al. (2011) show, there are grounds for skepticism about the potential for many "green growth" proposals to serve both environmental and economic masters.

Finally, we should remember that earlier energy systems transformations often suffered from status quo bias that obscured potential benefits from the new energy source. Anecdotal evidence from late 16th-century England suggests that wealthy households disdained coal because of its soot and smell and regarded it as absolutely inferior to firewood and charcoal. Only a few decades later, Nef (1932) quotes well-born women in London praising the "sweet smell" of coal and mourning the shortage of their now-favored fuel. In the English case, this shift in preferences was aided, no doubt, by the unappealing alternative of freezing to death for lack of fuel. Climate change mitigation doesn't offer so plain a downside. Regardless, relieving status quo bias has some precedent in ameliorating social resistance to energy systems transformation via changes in the structure of energy demand.

3.2.5 Consequences for climate action

Returning to the core argument of this chapter, emissions policy-making must occur between, on the one hand, the distributional costs and barriers created by emissions reduction; and, on the other, the technical, economic, and regulatory requirements of a low-emissions energy systems transformation. The political economy of climate change mitigation thus requires a policy framework that can both mediate the distributional conflicts and costs of emissions reduction while accomplishing the multi-faceted changes required for systems transformation. And it must do so over a long time frame, to account for both the pace of change in complex technological systems, and the need for a durable emissions control regime.

Section 3.2.2 has argued that state decisions to act on climate change derive less from the supposed altruism of post-modern citizens than from the extent that the domestic energy system permits policy action to generate near-term benefits through solutions to ancillary problems like security, economic competitiveness, industrial policy, or–in the developing world–energy poverty. But those near-term benefits are not evenly distributed, nor confined to the "enthusiastic" countries. The idiosyncrasy of national energy systems will lead to a varied pattern of costs and benefits from energy systems transformation. This generates a correspondingly varied pattern of actions related to emissions reduction. We should consider what consequences such a theory of political economy would have for comparative patterns of policy choice and action. In principle, we should expect at least three outcomes:

1. Idiosyncrasy of policy adoption

   The degree to which states can access any of the ancillary benefits discussed above varies widely among the major emitters. Countries vary widely in their exposure to trade, their dependence on imported energy, their domestic fossil fuel resources, and their reliance on export income. Thus while energy security and balance-of-payments concerns have motivated Denmark to invest in domestic renewable energy since the 1970s, that argument has not proven very effective to date in motivating United States to do the same. Oil, largely for transportation fuels, constitutes the bulk of US energy imports. Replacing oil with anything other than direct gasoline substitutes would require significant downstream changes to the structure of energy distribution and use. But if those changes must occur anyway, the US could equally well adopt electric vehicles charged with electricity generated by coal-fired plants fueled from the abundant coal reserves of the American Midwest. Furthermore, as a relatively less trade-exposed country than, say, Denmark, the impact of balance of payments improvements from reduced oil imports on national welfare would be relatively modest. Thus the same incentive set doesn't apply, and hence the ancillary and offsetting benefits of emissions reduction experienced in the Danish case aren't good justifications for action in a country like the United States. This doesn't mean that other incentives might not exist–only that the motivations vary significantly by country.

2. Idiosyncrasy of instrument choice

   The idiosyncrasy in the organization of national energy systems, and the implied variation in ancillary motivations for energy systems transformation, suggests different sets of winners and losers across countries. If policy instruments must provide the means to transform the energy system, provide private benefits to new energy actors, and manage the inevitable distributional conflict among the ensuing losers and winners, then we should expect to see variation in the policy instruments chosen by different countries based on the varied interest groups they need to pacify or create.

3. Non-alignment of policy approaches across countries

   The resulting variability of policy choices across countries may conflict with the establishment of a global (or even large regional) policy framework. The UN process on global climate change has proceeded on the basis of a common framework for emissions control, within which nations could adapt internally as they saw fit. But that framework implied the assumption that national policy regimes would somehow be cross-compatible. The Kyoto process, moreover, set up a framework for international carbon emissions trading that assumed, implicitly, a global carbon price. But in practice, policy idiosyncrasy may render this kind of condominium difficult to achieve and sustain in the absence of serious political institutions capable of managing distributional outcomes across states. To date, few political entities exist to do such things.

3.3 Implications for policy adoption

These implications stand opposed to the dominant narrative on climate policy. Policy design recommendations from environmental economics have consistently approached the emissions problem as a negative externality first and foremost. Those who produce greenhouse gas emissions as byproducts of economic activity benefit from the activity, but don't pay for the damages those emissions cause. Without an incentive to minimize emissions, people and firms over-produce them. An optimally efficient response therefore requires a policy that prices the social cost of emissions into the private cost of production.

3.3.1 Policy design: price fundamentalism and its discontents

In practice, this policy proposal has come in the form of a price on emissions, via either a tax on emissions or a system of costly permits to emit.(Pigou and Aslanbeigui, 2001; Baumol, 1972) Theoretically, a price instrument like a tax should produce the same results as a quantity instrument like a cap-and-trade scheme.[11] Both provide incentives for firms and consumers to reduce their emissions so long as the marginal cost of emissions reduction is less than the cost of the emissions tax or permit. The tax or permit system thus provides the incentive for firms and consumers to invest in both energy efficiency goods and lower-carbon energy. Nordhaus (2010) has termed this approach "price fundamentalism" and argues that a credible, ubiquitous, and high carbon price, perhaps coupled to an R&D subsidy, should be sufficient to generate the necessary emissions-reducing activity.

Emissions pricing and its analogues are attractive for two primary reasons: the promise of low costs, and the liberation from the problem of choice. Low cost is attractive in a world where we all wish to do something about climate change, and quite sensibly prefer to do the cheapest thing that works. Liberation from choice is similarly attractive if we doubt the ability of public institutions–whether governments or utilities–to make sensible investments. Emissions pricing promises to deliver on both.

3.3.2 Policy reality: implications of energy systems transformation

As Victor (2011) has argued, this policy design is liable to fail on political grounds. An emissions tax or a pristine cap-and-trade system with fully-auctioned permits makes

[11] In practice, Weitzman (1974) has shown that this may not be the case when the social cost is discontinuous, and in the face of imperfect information about the cost of emissions mitigation or the damage from excess emissions. If, for instance, it's clear that the cost of environmental damages go up exponentially when emissions exceed some threshold, then it may be better to use a cap-and-trade system to ensure that threshold isn't exceeded.

the costs of emissions reduction acute and the subsidies to losers explicit. In doing so, it imposes very large costs on powerful interests while providing few mechanisms to offset those costs, or to develop equally acute and countervailing interests in favor of the policy regime. Thus the policy regime is highly unlikely to pass in the first place, and perpetually vulnerable to erosion or stagnation as attempts are made to raise the price or tighten the cap. Helm et al. (2003) argued that this problem could be solved via the creation of a technocratic body analogous to a central bank, which was institutionally insulated from rent-seeking pressures and which had a narrow mandate to implement the orderly reduction of emissions. But that solution seems highly unlikely. In that political context, it matters little whether emissions pricing does in fact constitute a first-best solution, as the political economy of emissions reduction will rarely if ever permit a solution that satisfies the Nordhaus (2010) criteria of a "credible, ubiquitous, high" carbon price.

Emissions cap-and-trade systems are thought to be more flexible than pure carbon prices. Because the control of permit allocation allows for permit auctions, free or subsidized permit grants, grandfathering, and other kinds of implicit transfers, it can smooth over distributional conflicts that an emissions tax might not. Nevertheless, we should ask whether this more politically viable form of emissions pricing will solve the myriad problems of energy systems transformation discussed above and in chapter 2. There are a range of good reasons to believe that it will not.

First, we should consider whether and why emissions pricing has worked in the past. Supporters of emissions pricing have cited the U.S. experience with acid rain mitigation as a case of radically successful price-based pollution policy. There, a tradeable permits scheme for sulfur and nitrous dioxides rapidly reduced emissions of these acid-rain-causing pollutants after 1990, at a cost nearly forty times less than originally projected.(EPA, 2005) Today, that program covers over three thousand power plants in the United States.

However, as Hanemann (2009) has argued, this past experience bears little resemblance to the problem of greenhouse gas emissions. For acid rain, the technologies required to reduce emissions were already well-developed and their costs and benefits apparent. Moreover, ancillary changes to the energy system–notably the deregulation of the railroads and the mining of low-sulfur coal in Wyoming–permitted rapid and cheap fuel switching that allowed emissions reductions even absent technology adoption. Finally, SO_x and NO_x emissions reduction on the part of power plants made absolutely no difference to the downstream energy system. In this context, the emissions price had only to nudge a fairly small set of emitters to select from a menu of well-known and relatively inexpensive emissions-reducing options. In the context of energy systems transformation, a range of non-price-based changes (discovery and exploitation of new coal sources, reform of the transportation and distribution network) enabled changes to energy production that did not require downstream changes to energy distribution or use.

As we have seen, serious greenhouse gas emissions reduction is quite different. Unlike acid rain emissions, greenhouse gas emissions are inseparable from the process of energy generation. Biomass is a highly imperfect substitute. Thus fuel switching isn't an option in the limit. Many of the technologies or processes required for large-scale emissions reduction or efficiency improvements don't exist. Changes to energy production will, consequence of intermittency and lower density, require downstream changes to (relatively price-insensitive) energy transmission and distribution. Finally, it's apparent that many of the end changes to energy use will require non-price instruments, such as regulatory reform or standards adoption, that were not required for acid rain emissions reduction.

Thus, in summary, emissions pricing (1) does not on its own support the stabilization of institutional frameworks for climate policy as described in section 3.2, and (2) does not solve the myriad problems implicit in energy systems transformation beyond price-sensitive markets: regulatory control of the energy market, monopoly behavior in the power grid, market failures for energy efficiency improvements, and the problem of learning-by-doing and the potential need for early investment.[12] On its own terms, then, emissions pricing as a standalone policy is probably politically unsustainable absent other means to buffer and constrain emissions prices, and may be quite functionally limited. Its claim to satisfy criteria for economic efficiency rests on a set of unsupported assumptions about the political economy of climate change and energy transitions; and the empirical evidence for prior successes suggests that the emissions pricing would face severe challenges in achieving emissions reduction even if those political challenges could be overcome.

3.4 Conclusions

This chapter has argued that the political economy of climate change will lead to a policy suite that looks unlike either the first-best recommendations of economics or the satisficing proposals of the environmental movement. Either of those options requires that states and citizens choose virtue–either directly, or by pricing themselves into it. But the terms of that choice confront serious problems of political economy that inform against believing that virtue will be embraced or preserved.

Rather, sustained emissions reduction will be most likely to occur when its costs and long-term time horizons can be balanced by forms of energy systems transfor-

[12]For a review of the innovation issues, see Zysman and Huberty (2010) and its companion articles on research choices for emissions reduction. For a summary of the debate on price-induced innovation, see Popp (2010); Popp et al. (2009). Acemoglu et al. (2009) provide evidence that regulatory incentives alone can induce innovation in a simple two-good model where firms choose between some generic innovation and an emissions-reducing innovation; but the industry (automobiles) and the data (patents) both have limited relevance to the core energy system and learning-by-doing forms of innovation.

mation that tie in other, more immediate policy goals capable of generating near-term and tangible economic benefits. The interests created by that kind of policy framework will help provide a bulwark against the opposition that emissions reduction stands to create among losers from climate change mitigation. That, in turn, will assist the institutionalization of climate change policy that will be required to sustain emissions reduction over a long time horizon.

This is not, of course, the first argument to use issue linkage to explain potential or actual choices for climate change mitigation. But in placing the energy system in the center of the climate policy problem, it helps explain both the relative failure of those earlier proposals and the potential for future success. Issue linkage within the structure of the energy system need not assume any particularly innate desire for emissions reduction as a vital outcome, nor does it require that states link costs and benefits across disparate policy domains. Rather, a low-emissions energy systems transformation may permit issue linkage between climate change and other energy-related issue areas because those policy domains are already tied together through the physical, economic, and regulatory structure of the energy system. That connection can help explain why both Denmark and China, for instance, have aggressively pursued low-emissions energy despite radically different positions on economic growth, wealth, and global climate action.

The next chapter turns to empirical evidence for this theory. The European Union operates the world's only comprehensive greenhouse gas abatement program. But alongside the Emissions Trading Scheme, it has also deployed a range of policies on energy efficiency, energy market integration, renewable energy adoption, and research and development. Aspects of this policy suite has been criticized for imposing a range of distortions on the European energy market. But, as chapter 4 will show, that criticism must be balanced against the evidence that the policy suite exploits the kinds of issue linkages theorized here, in order to sustain and institutionalize policy momentum amidst diverse and sometimes fractious interests on climate and energy policy.

4 Europe's low-carbon systems transformation: diverging interests and converging policy

4.1 Introduction

Chapters 2 and 3 presented a theory of how the problem of energy systems transformation shapes the political economy of climate change. Testing this theory poses a difficult empirical problem. Until 2005, most countries had no substantive climate policy. By 2012, this world has changed substantially: Australia implemented a carbon tax in 2012; South Korea, discussed further in chapter 7, adopted a green growth strategy in 2010; even the US had adopted a range of low-emissions R&D programs, and its Environmental Protection Agency threatened to regulate greenhouse gas emissions by fiat. But as they are so new, these cases offer little history to suggest how these policies will evolve over time; whether they will prove durable; and how they will shape the future politics of emissions control.

The European Union offers the one substantial contrasting case. Of all the major emitters, only the EU has succeeded in adopting and preserving a long-term policy on emissions control. Since 1996, the European Union has initiated the liberalization and integration of national gas and electricity systems, mandated the breakup of state gas and electricity monopolies, put a price on greenhouse gas emissions from electricity generation, established binding targets for renewable energy adoption, and sponsored the creation of EU-level regulatory bodies for trans-European energy infrastructure and markets. Most recently, the Europe 2020 program has established statutory targets for the integration, liberalization, and decarbonization of the European electricity supply system; and ambitious but aspirational targets in energy efficiency. This has all occurred despite an EU enlargement that made internal energy interests more diverse and more dependent on fossil fuels; and despite the withdrawal of the United States from the Kyoto Protocol and the subsequent paralysis in global climate negotiations.

The EU is also interesting because most explanations for the EU's climate policy success emphasize environmental ideas over industrial policy. The EU has developed a regulatory reputation for precaution when faced with environmental risks. Across a range of issues–genetically modified organisms, chemical disclosure, animal testing, and others–EU regulation is far more restrictive than in other advanced industrial economies. Furthermore, environmental interests tend to be very well represented. Both environmental interest groups and green parties are very strong in the EU. Green parties have played key roles in national government coalitions and Parliaments, and have a significant presence in the European Parliament. Finally, Europe is generally regarded as putting more weight on international negotiations and international obligations than the US.

I argue against the presumption that environmental interests play the primary role in shaping Europe's choice of either *whether* or *how* to act. Environmental interests no doubt help to shape the broad policy environment for climate action. But as this chapter shows, they leave unaddressed the specific choices that European policymakers have made in designing, implementing, and reforming its climate policy. Furthermore, I show that in many cases, the expressed interests of major environmental policy actors–both in party platforms, and in legislative processes–supported very policies very different from those ultimately chosen.

Instead, I argue that the EU has explicitly pursued a strategy of tying support for environmental goals to the realization of industrial gains. Furthermore, I offer evidence that this strategy hinges on the particular structure of Europe's legacy energy systems, and demands it placed on a low-emissions energy systems transformation. Europe's policy choices reflect, I argue, a strategy of using systems transformation to generate industrial benefits from renewable energy adoption, energy security, and technological innovation. These benefits help build and sustain material support for Europe's long-term climate goals. They also help mollify otherwise recalcitrant firms and member states. This specific strategy depends, critically, on how Europe's legacy energy system structured the costs and benefits of climate action. The resulting EU policy suite, which mixes emissions pricing with renewable energy mandates, regulatory reform, market integration, and R&D support, thus closely conforms to the predictions of the theory presented in chapter 3.

The chapter proceeds in five parts. Section 4.2 provides an overview of the EU climate and energy policy suite and the national context in which it exists. Section 4.3 then discusses prevailing arguments for EU policy action and their shortcomings. Section 4.4 then considers the problem of low-emissions energy systems transformation in the EU context and the specific tasks required to bring significant amounts of low-emissions energy into the system. Section 4.5 then reviews the evolution of European policy to serve those tasks. As section 4.6 shows, the distributional consequences of this policy evolution bind together member states and sectoral economic interests based on asymmetric patterns of costs and benefits created by the nature of national energy systems. Finally, section 4.7 argues that the underlying distributional logic of the EU policy suite should counter critics who see the EU's policy suite primarily as an inefficient and distortionary alternative to a well-designed emissions pricing regime. Instead, the EU's choice of how to implement emissions reduction rests on a political logic for overcoming large incentives for inaction. This holds important lessons for elsewhere: if emissions policy must survive fickle citizens, powerful opposition, and economic volatility in pursuit of substantial emissions reductions, then the politics of why countries persist in acting will prove inseparable from how they choose to act.

4.2 Climate and energy policy in the EU

Europe's climate and energy policy suite consists of four major initiatives:

1. The Emissions Trading Scheme (ETS), which sets a price on energy-derived carbon emissions for approximately 40% of the European economy via annual limits on emissions and a secondary market for emissions permits within those limits.

2. The Renewable Energy directive, which puts binding targets on member states to consume, as an EU average, 20% of their electricity from renewable sources by 2020.[1]

3. The Internal Energy Market directive, which mandates the breakup of vertically integrated national energy markets into separate domains of production, distribution, and retail; and which sets new terms for market competition in wholesale and retail energy provision.

[1]A non-binding target for a 20% improvement in energy efficiency accompanies this goal.

4. The Strategic Energy Technology (SET) Plan and Framework Programmes, which provide significant EU and member state funding for research, development, and deployment of new energy infrastructure and technologies.

EU policy thus provides an array of policy instruments that target emissions reduction, renewable energy adoption, technological innovation, regulatory reform, and market integration. Consistent with the energy systems perspective presented in chapter 3, these instruments perform much broader array of tasks than simply the retirement of fossil fuel energy. In brief, the policies together function to:

- Open vertically-integrated markets to price competition
- Equalize terms of access to the energy system for new entrants, notably renewable energy generators
- Enable state intervention in energy markets to incentivize renewable energy adoption
- Plan and fund cross-border electricity transmission infrastructure and market integration
- Provide financial incentives (the ETS) and impose binding targets (the renewable energy mandates) for energy systems decarbonization
- Fund R&D for the next generation of technologies required for energy systems transformation

Figure 4.12 shows that this policy suite did not arrive at once–rather, it evolved over time. Versions of each policy instrument had emerged independently starting in the mid-1990s. Justification for each policy varied widely. Energy market integration was portrayed as simply another phase of completing the Common Market. Renewable energy policy was thought to serve both environmental and industrial policy goals. Emissions trading had an explicit environmental justification–but was very quickly understood to bleed over into the rest of the economy. By 2008, the synthesis of these different domains into the 2008 climate and energy package represented a necessary evolution of these parallel policy tools into an integrated package with complementary consequences for energy, emissions, and economic redistribution.

An array of other changes occurred in this same period, however. Two stand out for particular importance in the context of EU climate policymaking. First, the United States withdrew from the Kyoto Protocol for global emissions reduction in 2001. The US had played a critical role in negotiating the protocol and in mandating the use of tradeable emissions permits as the central pillar of emissions control. But President Bill Clinton had never submitted the treaty to the United States Senate for ratification (where it faced almost certain rejection), and President George W. Bush formally withdrew the United States from the Protocol shortly after taking office. The withdrawal of the United States marked the departure of the EU's largest trading partner and strongest competitor among the advanced industrial economies.

Second, the European Union went through two major waves of eastward enlargement to incorporate the former Warsaw Treaty Organization states into the European polity. In 2004, ten states–the Visegrad states of central Europe, the Baltic states on the edge of the former Soviet Union, and Slovenia, Malta, and Cyprus–joined the Union. They were followed by Romania and Bulgaria in 2007. These additions to the EU marked a significant divergence in energy and emissions interests among the EU members. As figure 4.3 shows, each of these enlargements brought in new member states with more energy-intensive economies that produced higher emissions and relied more on fossil fuels. While the collapse and renovation of their Soviet-era economies had reduced greenhouse gas emissions from the new member states 24%

between 1990-2007, those emissions had risen 5.5% after 2000 consequence of economic growth and re-industrialization. Meanwhile, as figure 4.1 shows, emissions in the original EU-15 were essentially flat from 2000-2007. And as figure 4.2 shows, the new member states remained more energy- and emissions-intensive than the EU-15 as late as 2005.

These two developments stood to significantly increase the economic and political barriers to emissions reduction in the EU. Internationally, the withdrawal of the US would mean that the EU would bear more acutely the cost of adjustment, while its major competitors would not. Internally, the changing structure of member state energy demand meant that newer, poorer member states who relied more on fossil fuels would now have a strong voting presence in the EU institutions.

4.3 Postmodernist citizens, green parties, and international leadership

Scholars have pursued three explanations for the EU's aggressive pursuit of climate change mitigation in spite of these challenges and the free rider problem more generally. First, they credit a rising "postmaterialism" in EU electorates with a greater willingness to exchange income for non-material goods like climate protection. Second, they cite the increased visibility of green parties in government as providing an outlet for these voter preferences. And finally, they note that the EU itself had sought a high-profile foreign policy role for Brussels after the passage of the Lisbon Treaty, and thought that strong action at home would increase its influence and leverage at international negotiations abroad. But each of these explanations, while they offer some motivation for EU action, encounter difficulties when faced with the developments described above. They also provide very little insight into why the EU chose the policy instruments it did, rather than some other (potentially more efficient) policy framework. Given volatile public opinion, a changing mix of member state interests, and an increasingly unfavorable international environment, we need to look beyond public opinion and bureaucratic entrepreneurship in answering why the EU chose to act and what led it to adopt the specific policies it did.

Whether environmental concerns are the product of the increased prosperity of citizens in liberal polities has attracted significant attention both for climate change and beyond. Kitschelt (1994) argued that high material living standards had weakened the old left-right division of European politics. Diekmann and Franzen (1999) find, contra Dunlap and York (2008), that prioritization of environmental concerns correlates with per-capita wealth. Bättig and Bernauer (2009) posit that democracies are, net of income, more likely to express preferences for environmental goods than in other regime types. In this analysis, climate change and other environmental issues are a form of luxury good, available predominately to citizens in wealthy, liberal countries whose material needs are satisfied. Building on this analysis, Gerhards and Lengfeld (2008) find that support for EU climate and energy policy is stronger among the richer member states.

This changing pattern of public preference for environmental goods permitted, and was supported by, the rise of green parties. From a start as fringe opposition parties in the 1970s, green parties had by 2000 become much more mainstream, and offered real electoral alternatives to longer-established parties of the right and left.(Bomberg, 2002) This included a stint in government for the German Green Party, in coalition with the SPD, from 1998-2002; and, according to Jacobsson and Lauber (2006), acting as one of the primary contributors to a fundamental transformation in German renewable energy policies earlier in the 1990s. The pan-European Green Alliance is also well-represented in the European Parliament.

Finally, Schreurs and Tiberghien (2007) argue that these domestic developments dovetailed with Brussels' search for a new foreign policy role. The Lisbon Treaty, ratified in 2007, formally gave the European Union greater say in making all-European foreign policy. This left Brussels looking for a significant role to play in global politics. Climate leadership fit the bill. Brussels could build on the actions of more aggressive countries like Germany or Denmark to position the EU as a paradigmatic example of a rich, competitive economy willing to bear the cost of emissions reduction and provide global leadership for others to do the same. In doing so, the European Union could define a foreign policy identity separate from the individual member states and assert its newly-won powers in a prominent global venue.

In practice, each of these explanations for why the EU would act in spite of diverging domestic interests and an increasingly frustrating international environment encounter limits when faced with two related developments. First, measures of post-materialist value alignment are fairly volatile across space and time. The new member states, who now constitute 12 of 27 voting members of the EU, consistently poll as more focused on economic growth and less enthusiastic about environmental action. Attitudes towards climate change also rely on a range of volatile non-scientific, economic, and social factors (Leiserowitz, 2006), and respond to individually insignificant events like extreme weather conditions.(Egan and Mullin, 2011)

Volatility at the citizen level is matched by volatility at the party level. Climate policy progress has continued in both western Europe and at the EU despite fluctuations in green party popularity at the ballot box. The new Conservative government in the United Kingdom has maintained its commitment to emissions and energy policy despite unprecedented austerity measures in the wake of the 2008-2009 financial crisis.[2] The center-right Danish government's 2011 energy and climate package was so aggressive on emissions reduction that it surpassed even what the opposition party

[2]CITE

had planned for its own election manifesto (Danish Ministry of Climate and Energy, 2011).

Neither can green party preferences for climate action at the EU level explain the choice of policy instruments. The European Green Alliance's Green New Deal would have implemented a less market-based, more comprehensive program of emissions reduction and environmental sustainability.(Schepelmann et al., 2009; European Greens Party, 2009) But as of 2011, interviews with the European Commission and the Parliament provided little evidence that this agenda had attracted significant support in the mainstream European parties. Finally, even the Parliament as a whole, widely regarded as a strong environmental advocate, had relatively limited influence over the design of European policy. As chapter 5 demonstrates in detail, the Parliament's environmental ambitions for the 2008 climate and energy policy reforms were largely checked by the Commission in favor of industrial policy.

Finally, Europe's failure to leverage its domestic climate action into international leadership on climate change appears to have done little to damp its policy ambitions. Europe had gone into the 2009 COP-15 climate change negotiations confident of assuming a leadership role. But that role collapsed amidst disagreement among the world's major economies. It was left to China and the US to hammer out the final, and largely ineffectual, agreement. Nevertheless, ongoing inability to use EU policy ambitions to catalyze a global deal does not seem to have made a material difference to the long-term trajectory of European climate policy.

To date, then, analysis of EU climate and energy policy has tended to emphasize public opinion, party politics, and bureaucratic entrepreneurship. But while these factors undoubtedly influence the will to act, they have limited insight as to why the EU has persisted in its climate goals even as those factors have changed in quite substantial ways due to EU enlargement, electoral politics, and political stasis at the international level. Furthermore, these explanations do not point to why the EU picked the constellation of policies that it did. Indeed, given the near-unanimous conclusion that emissions pricing alone should suffice for the most cost-effective solution to climate emissions, we should wonder why we observe the potentially rather more expensive mix of pricing, mandates, subsidies, and other policy instruments that we do.

4.4 An energy systems transformation: the whys and wherefores of EU policy choice

A full understanding of how and why the EU was able to make progress on emissions needs to start with a closer understanding of the comparative pattern of energy and emissions intensity in the EU, and with the structure of the markets and infrastructure at the root of that pattern. The costs and benefits, and hence winners and losers, of emissions reductions are inseparable from the energy system through which those reductions must occur. Sustaining policy will require, as chapter 3 argued, support from economic actors with a material stake in a low-emissions future. Building such support requires policymakers to identify how tasks that serve long-term environmental goals may also deliver near-term tangible benefits. Because emissions reduction embraces the whole of the energy system, the scope of both these tasks and benefits encompasses the entire spectrum of energy production, distribution, and use. Understanding the political possibilities for climate policy must therefore begin with an understanding of the baseline conditions of domestic energy systems.

This section shows that the EU's pre-existing energy system provided an array of challenges and opportunities for EU energy policy. In the south and east, "energy islands" exposed some member states to supply insecurity even as their neighbors enjoyed surpluses. In the north and west, formerly abundant reserves of North Sea oil and natural gas began a decline that would have significant long-term impacts on energy exports and national trade balances. Except in Scandinavia, integrating regional gas and electricity markets remained a halting task, and national boundaries and energy markets persisted in the face of early efforts at market reform. Meanwhile, some countries had developed significant expertise in and export income from new renewable energy technologies. As section 4.5 will show, these varied patterns of energy markets and the interests that went with them created opportunities to engage in a systems transformation that served multiple masters. In doing so, it could provide implicit side-payments to different constituencies that permitted the EU to bridge the potentially divergent interests in fossil fuel-based energy. The system thus facilitated a particular form of issue linkage, from which a particular policy suite emerged.

4.4.1 Emissions

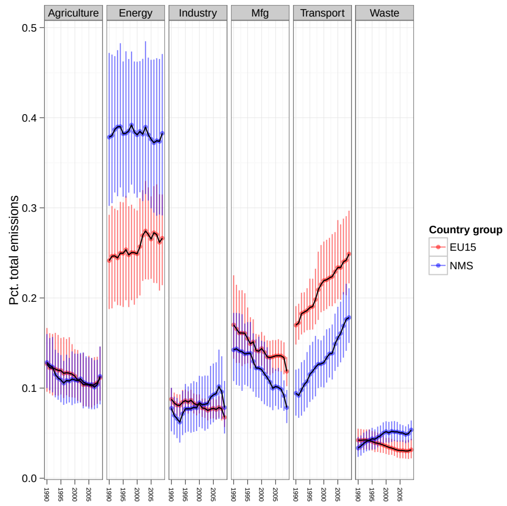
Europe's diverse regional and national economies show significant variation in both the intensity of emissions and the trajectory for emissions growth and reduction. In 2007, overall greenhouse gas emissions levels in the EU-27 stood 9.3% below 1990 levels.[3] That aggregate figure obscures some internal diversity. Among the EU-15, emissions fell 3% in the same period, while among the member states added after 2004, emissions fell 24%. But while emissions in the EU-15 were more or less flat from 2000-2007, emission in the new member states grew 5.5% as their economies reindustrialized. Figure 4.3 demonstrates that net of these changes, the economies of the new member states remain anywhere from 2-4 times more emissions- and energy-intensive than their EU-15 counterparts. This is due in part to a greater reliance on

[3] All calculations are based on data released by Eurostat for total and sectoral emissions in the EU member states. 2007 will be used as the latest year for comparison. The 2008-2009 financial crisis and ensuing recession has pushed emissions below trend due to depressed economic activity.

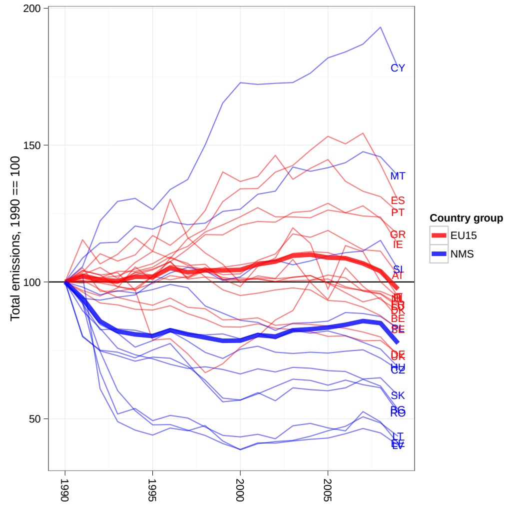
manufacturing compared with services; in part due to increased reliance on fossil fuels in some states, particularly Poland; and in part due to the persistence of inefficient Soviet-era capital stock.[4]

Within these broad trends, the composition of emissions has also changed substantially. Figure 4.1 shows that emissions from manufacturing industries have generally declined in all regions, while transportation has become a larger share of overall emissions. Other categories remained mostly flat. But the manufacturing trend in particular obscures the fact that this trend in the west is in large part due to deindustrialization and a parallel shift to an increased role for services, while in the new member states it reflects the decline (and partial replacement) of energy-inefficient industrial base. Despite these gains, however, figure 4.1 also suggests that the new member states are significantly less emissions-efficient in electricity and heat production than the EU-15.

[4]The EU does not provide integrated statistics on capital stock age. For comparison, BRE Bank Securities reports that 71% of Polish coal-fired power plans are 30 years or older. Poland depends on coal for about 83% of its primary energy production. In contrast, the average age of a coal-fired power plant in the United Kingdom as of 2012 was about 31 years; but the UK only derives about 7% of primary energy production from coal. Power plant data taken from Stoklosa (2010) (Poland) and (Department of Energy and Climate Change, 2011, table 5.11) (UK). Primary energy production data taken from Eurostat for all solid fuels (including all grades of coal, plus peat) for 2010.

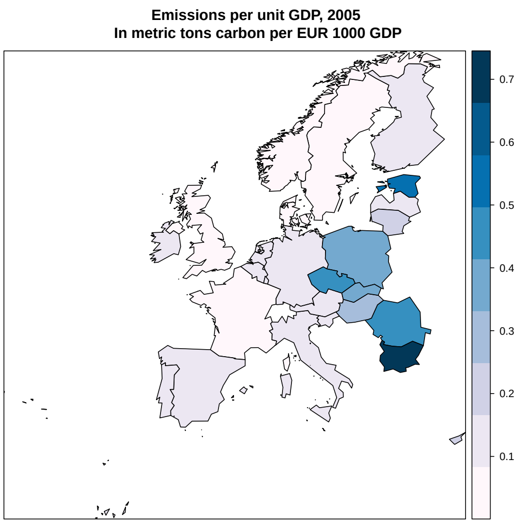


(a) Changes in emissions composition by sector, 1990-2009.

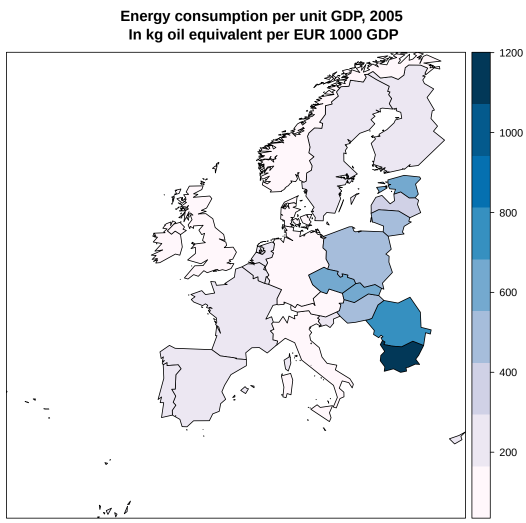


(b) Emissions levels by country, 1990 = 100. Dark lines indicated within-group averages.

Figure 4.1: EU-27 emissions trajectory, 1990-2009. All data from Eurostat. NMS = New Member States, including the ten new member states added in the 2004 enlargement, and Bulgaria and Romania.

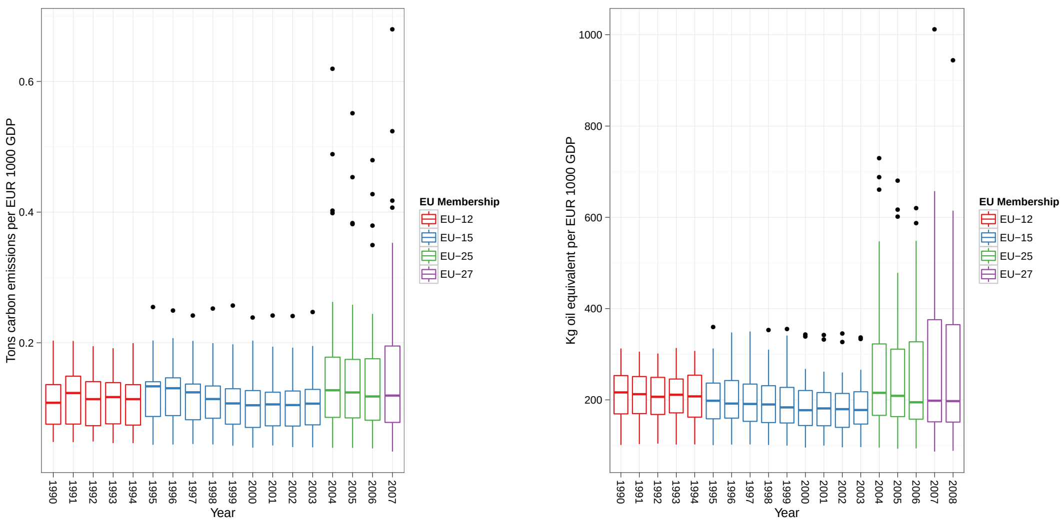


(a) Emissions intensity per unit GDP



(b) Energy intensity per unit GDP

Figure 4.2: Emissions and energy intensity in the EU-27 + Norway, 2005. Greece omitted due to lack of data. Energy intensity data from Eurostat. Emissions intensity data based on author's own calculations using GDP data from Eurostat and emissions data from the Carbon Dioxide Information Analysis Center at Oak Ridge National Lab.



(a) Emissions intensity per unit GDP

(b) Energy intensity per unit GDP

Figure 4.3: Emissions and energy intensity of economic activity in the EU across enlargements. Emissions data are expressed as metric tons carbon per constant €1000 in constant 2000 euros. Energy data are taken from Eurostat and are expressed as kg. oil equivalent per €1000. Emissions data are taken from the Carbon Dioxide Information Analysis center and are expressed in MT Carbon.

4.4.2 Energy

These emissions result, predominately, from the use of fossil fuels to generate electricity and power transportation. How that occurs depends on the structure of the energy systems in the EU–the assets, markets, and regulatory frameworks that govern how energy is produced, distributed, and used. In the context of a low-emissions energy systems transformation, four aspects of the European Union's energy system bear closer examination:

1. The historically national and monopolistic structure of EU energy markets reduced competition among energy firms and limited new firms from entering markets with new technology.

2. The national structure of markets has also led to the existence of "energy islands" with few or no connections to the larger EU energy market. Those islands, in turn, are often highly dependent on geopolitically unstable countries for energy supplies.

3. Decades of significant energy exports from the North Sea oil and gas reserves will probably end in the foreseeable future, with significant impacts for both energy security and national trade balances in northwestern Europe.

4. Adoption of significant quantities of renewable energy in some countries have forced those countries to confront the problems posed by intermittency for both physical and price stability in their energy systems.

Most of the EU member states experience one or more of these issues. But, as section 4.6 will show, variation in the specific patterns of market structure, energy security, and renewable energy adoption consequence of the structure of domestic energy systems has allowed for a particular structure of policies that fulfill both functional and distributive roles in stabilizing the political economy of energy systems transformation.

Market structure

Aside from the highly-integrated Scandinavian Nordpool market, the electricity markets of the European member states as of 2005 remained largely national and dominated by legacy, vertically-integrated state utilities that controlled production, distribution, and transmission. A study for the European Commission's Directorate General for Competition found that five of six major west European markets showed serious evidence of monopoly-driven price and market distortion in 2005, ten years after the first efforts at market liberalization had begun.(London Economics, 2007) As a consequence of market concentration at the national level, markets to manage intermittency and provide for reserve capacity remained anemic.

This situation had three practical consequences for the decarbonization of the energy system. First, vertically-concentrated control of the grid was thought to prevent entry of new technologies into the grid, particularly new low-emissions generation sources. Second, the lack of liquid markets for capacity made management of intermittent energy sources more costly. Finally, anemic competition for electricity customers in the context of regulated prices may have kept prices higher than they otherwise would have been. Pricing power in the presence of impending price increases due to emissions trading posed challenges for managing the costs and benefits of emissions reduction.

Energy islands and energy security

While all EU countries import significant quantities of energy, the structure of imports varies substantially by geography. In particular, the "energy islands" of the Baltic states and eastern Europe depend heavily on imports from Russia to satisfy demand for natural gas and, in some cases, electricity. This dependency led to severe supply disruptions in 2004-2005, 2006-2007, and 2008-2009, as a byproduct of geopolitical conflict between Russia and Ukraine. Notably, during these crises, western Europe maintained gas surpluses that could have been used to offset reduced Russian imports. But the lack of west-to-east transmission infrastructure prevented Europe from implementing this solution in full. The eastern European and Baltic member states remain acutely interested in diversifying their energy supplies.

Thus both northwestern and eastern Europe faced impending risks to energy security, either from decline of domestic resources or geopolitical uncertainties surrounding Russia's relationship with her former satellite states. These risks stand in addition to a general risk stemming from geopolitical uncertainty in Europe's primary sources for transport fuel.

Energy exports and reserve depletion

With several notable exceptions, the EU member states have few conventional domestic energy reserves and depend on imports for the bulk of their energy consumption. Figure 4.4 shows that imports as a percentage of total consumption and by fuel dominate nearly all countries' energy demand. But since the early 1970s, the Nordic countries, the Netherlands, and the United Kingdom have benefited from substantial oil and gas exports from the North Sea. At present, however, the anticipated remaining lifetime of those reserves is estimated on the order of 20-30 years.(British Petroleum, 2011, 43) Danish oil production fell 37% from 2009-2011 alone.(Danish Ministry of Climate and Energy, 2011, 45) Declining reserves pose long-term challenges for these countries' balance of payments and their incomes from natural resource exports.

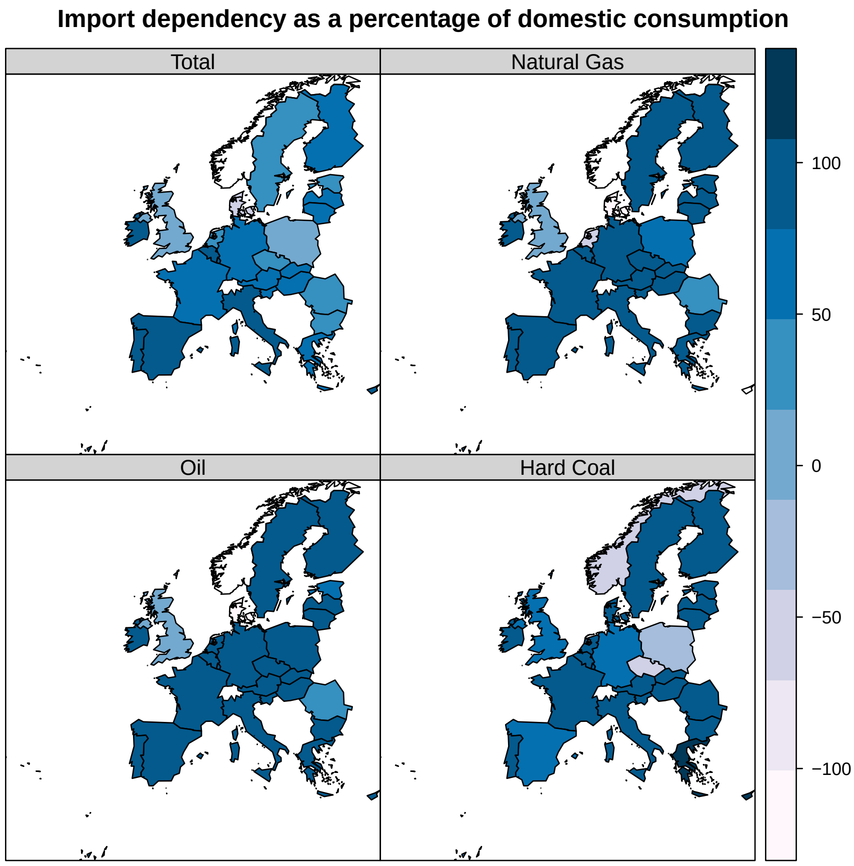


Figure 4.4: Import dependency by fuel for the EU-27 + Norway. Norway omitted for Petroleum, Gas, and Total to omit scaling distortion imposed by Norway's very large gas and oil exports. Data taken from the Energy Information Administration for 2005.

Systems stability and renewable intermittency

Finally, countries that have adopted significant amounts of non-hydro renewable resources have begun to encounter issues with systems instability stemming from renewable resource intermittency. The Nordpool market has been an early test case for this problem. Denmark, which obtains about 20% of its electricity from renewable sources, depends on cross-border trade in the Nordic region to buffer under- and over-production. In 2010, concerns about overproduction and its effects on systems stability led to the introduction of a €200 / MWh penalty tariff to discourage electricity production at times of overcapacity.(Nord Pool Spot, 2009) As other member states move to adopt significant renewable energy resources, maintaining systems stability will increase the demand for cross-border geographic averaging of electricity production.

4.5 Altering the system trajectories: EU Energy Policy, 1995-2010

EU energy policy aims to shift the developmental trajectory of this energy system. Ideally, a new trajectory would reduce emissions, provide greater security of supply, and be more supportive of the international competitiveness of EU firms. To accomplish this shift, the EU has since 1995 deployed an evolving and increasingly synthetic range of policy mechanisms to restructure gas and electricity markets, price greenhouse gas emissions, mandate the adoption of renewable energy, finance cross-border energy transmission infrastructure, and support R&D in new energy technologies.

The management of multiple energy-related externalities complicates the problem of policy formation. But it has also provided EU institutions, member states, and policymakers a means to build sustained policy coalitions through linkage of objectives in one domain to action in others. That linkage generates policy stability in two ways: first, the beneficiaries develop acute interests in ongoing progress that allow emissions reduction policies to move beyond mere cost minimization; and second, linkage provides for cross-subsidization of transition costs among political and economic actors both within the member states and between them. Indeed, whether intentional or not, the policy suite that has developed in Europe over the last decade shows all the signs of fulfilling these political economy functions.

The EU thus displays the kind of policy approach suggested as likely in chapter

3. As predicted there, the EU has not relied solely on emissions pricing to induce emissions reductions. Rather, they have combined an emissions pricing system with other instruments that more directly address other energy-related externalities, and seek to create and nurture interests supportive of systems transformation. In doing so, the EU policy suite has begun to lay the groundwork for an industrial policy targeting the long-term transformation of the energy system. As with earlier industrial and energy transformations, that policy seeks to reconcile the need for transformative change with the political conflict that change promotes. To do so, I argue that European policymakers have chosen policy that yokes support for long-term environmental goals to the realization of near-term material returns from pursuing those goals. As section 4.6 will argue, the distributional implications of European policy suggest they may succeed. But this success does not imply that the the EU approach provides a valid solution everywhere. Countries with very different energy systems may not find that issue linkage permits progress in the same fashion, or at all.

4.5.1 Energy market integration and reform, 1996-2010

The liberalization of the energy market began in 1996 as another step in the extension of the Common Market, in parallel with other EU attempts at services and goods market integration.[5] In its initial form, the European Commission justified the program on the basis of more competition in energy markets, lower prices for retail and industrial customers, and improved investment in energy infrastructure.(The European Commission, 2001)

By 2003, the Parliament and the Council had adopted the second gas and electricity directive to begin the process of integrating national markets via interconnection of

[5]This is true with one significant exception: unlike most goods industries, electricity does not permit integration via mutual recognition. Rather, integrated electricity markets require common standards for operation of the electrical grid. The ENTSO-E body has been tasked with this process, but the EU has relatively little experience in standards-based market integration.

national networks and reform of wholesale and retail markets for both electricity and gas. Those reforms were to include significant restructuring of domestic electricity companies. Most member states' markets were characterized by vertically-integrated firms that controlled the primary assets for electricity generation, transmission, distribution, and sale. In only three member states (Poland, the UK, and the Nordic countries) did the top 3 firms by turnover control less than 50% of the market.

In 2005, a year after the 2003 directives entered into effect, the Commission reported that progress on market integration had lagged behind directive goals. They noted that "the most persistent shortcoming is the lack of integration between national markets" owing to national barriers to entry and a lack of cross-border electricity and gas transmission capacity. Of particular concern was the lack of integration of southern European markets, as between France and Spain; the coupling of eastern and western European markets, as between Germany and Poland; and the persistence of the Baltic states as an energy island cut off from the rest of Europe. Energy markets thus remained "national in economic scope", and competition "[had] not yet developed to provide a fully effective constraining influence on the economic power of companies in each national market."(The European Commission, 2005a, 2)

The Directorate-General for Energy also criticized the reluctance of many member states to decouple ownership of electricity transmission and distribution from electricity generation or sale. They viewed the persistent vertical integration of the electricity markets as a hindrance to network neutrality and the entrance of new market participants and new energy technologies. With particular reference to renewable energy technologies (section 4.9), the technical annex to the report (The European Commission, 2005b) argues that both the introduction of low-emissions generation and the pursuit of energy efficiency gains require energy market liberalization. Put in energy systems terms, the ownership structure of electricity transmission in the Commission's view, hindered the restructuring of both energy generation and energy use.

Finally, this analysis also noted that insufficient liberalization of electricity markets had compounded perceived problems of the European emissions trading scheme, by preventing competition from helping to offset the higher energy prices caused by emissions pricing. Progress on energy market restructuring would, the Commission maintained, introduce competition that would help buffer the costs of emissions pricing for both citizens and industry.

These conclusions were supported by separate studies undertaken by the Directorate-General for Competition, under its Article 17 powers. In two reports, issued in 2006 and 2007, they found persistent high levels of market concentration in five of six major western European electricity markets; ongoing cross-border congestion; and evidence of discrimination by legacy energy utilities against new entrants.(Directorate General for Competition, 2006; London Economics, 2007)

Together, the Commission used these reports to frame the necessity of renewed action on market reform. The consequences of this framing are clear from the terms of the 2008 Third Climate and Energy Package.[6] It renewed the legal framework for energy market restructuring under the newly-signed Lisbon treaty, creating stronger mandates for implementing the earlier guidelines. It set new terms on access to cross-border electricity markets. It also institutionalized EU-level regulatory coordination in three new bodies:

1. The European Network of Transmission System Operators–Electricity (ENTSO-E), to manage regulatory coordination among national electricity grid operators

2. The European Network of Transmission System Operators–Gas (ENTSO-G) to manage regulatory coordination among national gas transmission system operators

[6]For text of the directives, see *Official Journal of the European Union* L211, volume 52, 14 August 2009, at `http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2009:211:SOM:EN:HTML`.

3. The Agency for Coordination of Electricity Regulation (ACER), to set and maintain regulatory standards at the EU level to ensure smooth grid and market inter-operation.

The ENTSO bodies were also tasked with contributing to planning for cross-border transmission infrastructure, with an emphasis on north-south and east-west bottlenecks and the Baltic energy island. Both the ENTSO and ACER bodies represent a first step towards the institutionalization of previously private- or para-public coordination between otherwise nationally-regulated and nationally-bound energy regulators.

To buttress this regulatory coordination, the EU has followed with support for coordinated approval for and investment in cross-border transmission infrastructure. The TEN-E network infrastructure development program provided a framework for identifying and funding cross-border energy transmission infrastructure in areas suffering from high congestion, or in areas of high renewable energy potential. These included offshore wind in the North Sea; and cross-border interconnections to the isolated energy "islands" of the Iberian peninsula, the Baltic states, Italy, and the former Warsaw countries (The European Commission, 2010c, section 4). [7]

4.5.2 The European Emissions Trading Scheme

In contrast to these market reforms, which continue a long pattern of European deepening, the Emissions Trading Scheme (ETS) was a direct response to environmental events. At the Kyoto talks in 1997, EU member states had committed to emissions reductions of 8% below the 1990 baseline by 2012. The EU believed that it could achieve these reductions more efficiently acting as a body, than if each member state

[7] See http://ec.europa.eu/energy/infrastructure/tent_e/coordinators_en.htm for specific detail on the major TEN-E projects. Last accessed 11 March 2013.

did so on their own. Since 70% of European Union trade takes place among the member states themselves, a pan-EU emissions regulation mechanism would minimize potential distortions to the Common Market that multiple state-level policy regimes could have introduced. It also had the potential to lower compliance costs, by allowing member states to invest in emissions reductions where the marginal cost of reduction was lowest. The Emissions Trading Scheme thus began largely as a carbon market, intended to price carbon and so incentivize emissions reduction via efficiency, investment, and innovation.

The use of market-based instruments for environmental regulation was unfamiliar and highly controversial. Europe had traditionally favored regulatory mandates, both out of distrust of market-based mechanisms and out of concern that markets would not provide for both equity and efficiency. In examining implementation options in the EU itself, the use of pricing rather than regulatory mandates only became the favored solution after a series of consultations through the first European Climate Change Programme in the period 2000-2001.[8] The outcome of those consultations unambiguously recommended the use of a market-based emissions control system, with emissions permit allocation derogated to individual member states.(Vis, 2001) But the report also saw emissions trading as one of a suite of policy tools, even if the particular contents of that suite were not foreseen at the time.[9]

These shortcomings in practice had originally motivated the Commission to favor an emissions tax over a cap-and-trade system. But the creation of a European-wide tax would have required either complex harmonization of emissions tax regimes across the member states, or the institution of a new EU-level financial instrument. Either would have set off an ongoing and likely unresolvable debate within the EU

[8]See `http://ec.europa.eu/clima/policies/eccp/first_en.htm` for further details and documentation.

[9]Interviews with European climate and energy policy officials in late 2010 confirmed the validity of these official reports and the evolution of concerns about the efficacy and distributional consequences of emissions trading.

over the fiscal powers of the Commission. Indeed, the Commission had worked for years, without making much headway, to convince the member states of the superiority of a taxation approach. MacKenzie (2007) suggests that the tax finally died in large part because the creation of that instrument would have counted as a financial matter under the terms of the Qualified Majority Voting rules, and thus required a nearly impossible unanimous vote of support. A cap-and-trade system, in contrast, could be justified as environmental policy and passed with qualified majority voting. Doing so also preserved the ability to cross-subsidize participants in the ETS while keeping the visibility of those payments low and depriving the Commission of substantial new financial resources.

After the initial, largely ineffective 2005-2007 "trial period", the ETS has operated as a system with freely allocated permits that could be banked between trading periods. This has meant that firms do not pay for the initial grant of rights to pollute, but can buy and sell permits on secondary markets. Those permits can be banked across periods, which helps to stabilize permit prices. The overall level of permits is set by the EU, on the basis of national Action Plans from the member states that specify where and how permits should be allocated to their domestic firms. In practice, as section 4.6.1 will show, free allocation functioned as a means of providing cross-payments to vulnerable or reluctant sectors and member states.

4.5.3 Renewable Energy Targets

Theoretically, the presence of the Emissions Trading Scheme should suffice to incentivize adoption of low- or zero-emissions energy sources. Nevertheless, from 2001 onward, the European Union pursued targets for renewable energy adoption as well. The Third Climate and Energy package, passed in 2008, made the initially indicative targets for 2020 and required states to outline their approach to meeting those targets in a series of national action plans. Like the ETS, the renewable energy mandates both support the decarbonization of the European energy system and provide for implicit redistribution of funds between member states. But while the ETS permit allocation process provided for west-to-east transfers, the structure of the renewable energy mandates will, as section 4.6.2 will show, benefit primarily the rich industrial economies of northwest Europe.

The first renewable energy directive (2001)

Renewable energy targets were first introduced as a policy instrument in September 2001 with the Directive on the Promotion of Energy from Renewable Sources.(European Union, 2001) The directive targeted a renewable energy share of EU electricity consumption by 2010, defined what counted as renewable energy for EU purposes, and presented indicative but nonbinding national targets for renewable energy generation. The directive's stated motivations for renewable energy adoption paired environmental goals with economic, security, and industrial policy outcomes:

> The promotion of electricity produced from renewable energy sources is a high Community priority ... for reasons of security and diversification of energy supply, of environmental protection and of social and economic cohesion... (European Union, 2001, 33)

The directive marked the culmination of an debate begun in the mid-1990s surrounding the uses of renewable energy and the mechanisms by which to promote renewable sources.(Jordan et al., 2011, 108) The Commission had viewed this debate with some concern. On the one hand, renewable energy promised to deliver energy security and improve economic competitiveness. On the other, the Commission remained concerned that a patchwork of national renewable energy support schemes would distort its attempts at integrating Europe's electricity markets.(The European

Commission, 1999) By 2001, the legality of a range of national support schemes had been settled by the European Court of Justice in *PreussenElektra v. Schleswag AG* (European Court of Justice, 2001). This decision confirmed that renewable energy support schemes were valid state subsidies and not illegal state aid, potentially providing member states with new means to justify industrial policy initiatives. Since then, member states have adopted a range of subsidy instruments for renewable electricity generation, including feed-in tariffs, portfolio standards, and secondary markets in "green certificates". Recognizing the growing diversity of support mechanisms and the impracticality of harmonization, the 2001 Directive permitted substantial flexibility in choice of policy instrument.

The question of the harmonization of support schemes has persisted. In developing the first renewable energy Directive, the Commission favored some form of tradeable certificates program that would allow member states to either build capacity domestically or buy it from other member states. In theory, such a program would have increased the efficiency of the renewable energy program by encouraging renewable generation in the most optimal locations, rather than carving up the market along national boundaries. But this program was opposed by the Parliament and the Council.

The second renewable energy directive (2008)

Unsurprisingly, given the absence of binding targets, none of the 2010 goals for renewable electricity generation were met. By 2010, the European Union generated only about 10% of its overall electricity consumption from renewable energy, though generation at the member state level varied from nearly zero to over 60% (for states like Austria with significant hydropower resources).

Despite these shortcomings, the Commission continue to articulate the goals of improved energy security and economic competitiveness, and lower greenhouse gas emissions. In light of the gap between achievements and goals, the Commission introduced a new proposal for binding renewable energy targets in its 2006 energy strategy white paper.(The European Commission, 2006a) Those targets eventually became the renewable energy pillar of the Third Climate and Energy Package. In addition to binding targets, reported in table 4.1, the Directive provided for the use of stabilization and solidarity funds to assist new member states in deploying renewable energy infrastructure, and provided benchmarks for what constituted renewable energy–notably for biomass used in either liquid fuel production or to fire thermal power plants.

The updated targets were set as a function of a member state's prior share of renewable energy, its renewable potential, and economic criteria referencing a state's ability to make investments.(The European Commission, 2008b, 7) To meet the targets, each member state was required to submit a renewable energy action plan detailing how they would meet their assigned targets. Beurskens and Hekkenber (2011) have formalized the projections made in each national action plan. Figure 4.11 presents their estimates for planned capacity expansions over the 2010-2020 time frame. In aggregate, the member states collectively plan to increase renewable energy use in their economies by over 6% per year. This implies, among other changes, the addition of 146,500 MW of wind capacity and 65,273 MW of solar photovoltaic capacity between 2010 and 2020–increases equivalent to 250% of 2010 capacity for solar and 173% of 2010 capacity for wind.

Notably, however, the 2008 directive did not resolve outstanding issues of harmonization in either the form or level of renewable policy support. Both the Commission's initial proposal (The European Commission, 2008b) and the final directive (European Union, 2009) included this option only in diluted form. Member states could negotiate "statistical transfers" of renewable energy production above and beyond their 2020 quotas, negotiate joint support schemes for renewable energy, or support joint projects to develop renewable energy resources. But no tradeable market in renewable electricity was provided for. The Parliamentary response to the initial Commission proposal (The European Parliament, 2008b) specifically cites member state flexibility and autonomy as the primary concern in maintaining the national structure of renewable energy goals in an increasingly unified European electricity market.

4.5.4 Origins, evolution, and policy coherence

Energy market reform, renewable energy adoption, and emissions trading thus clearly show significant inter-dependency in their goals, consequences, and costs. As the preceding sections have shown, however, they evolved from somewhat different motivations, both across issue areas and across countries. Internal market reforms started as a logical next step for completing the Common Market. Renewable energy mandates mixed industrial policy, energy security, and environmental goals. Emissions trading departed significantly from past European practice in environmental legislation, but only after Europe grappled with the incongruities of a continental energy market divided by national emissions schemes.

But while their origins were diverse, they have evolved to be deeply intertwined in their implications for and effects on the European energy system. That fact was recognized in the development and negotiation of the 2008 Climate and Energy package. The Commission, through a series of internal and third-party reports, consistently framed policy shortcomings as depriving the EU of the benefits of systems transformation. Insufficient market liberalization deprived the EU of the price and security benefits of an integrated European energy market. Insufficient adoption of renewable energy risked the EU's global lead in renewable energy technologies. The bureaucratic complexity of the ETS reduced its environmental impact and imposed extra costs on European firms.

Thus while the different threads of the EU's emissions and energy policy framework evolved separately, they have become more interwoven over time. They also represent clearly delineated choices about the means by which Europe pursues a low-emissions energy systems transformation. Perhaps most importantly, however, none are justified solely on the basis of environmental goals. Rather, each policy–even emissions trading–rests on a web of economic, environmental, and social justifications. Those justifications refer not just to the necessity of action, but to the benefits that action promises.

4.6 Winners, losers, and compensation in the EU policy suite

By 2008, then, the European Union had synthesized what had been separate initiatives on energy market reform, renewable energy adoption, and emissions control. The 2008 Climate and Energy package was negotiated as a single entity, building on the comprehensive proposal from the European Commission. That proposal, in turn, reflected a policy framework that had over time become more integrated, more stringent, and more enforceable. This pattern, moreover, had continued despite eastern enlargement of the EU.

This section outlines the four primary distributional implications of the EU's climate and energy policy regime. The emissions trading scheme functions as both an emissions cap and a compensation mechanism for three vulnerable groups: poorer east European member states, firms in tradeable sectors, and smaller and less-well-capitalized firms. In contrast, the renewable energy mandates create large new export markets for the relatively rich manufacturing economies of northwest Europe. Finally, energy market reform and integration benefits both systems stability in member states with significant renewable energy shares; and energy security in energy islands and states exposed to geopolitical energy supply instability.

This pattern of costs and benefits, summarized in table 4.2, provides crucial insight into the structure of EU policy choices. Functionally, the suite of policy instruments fulfill an array of technical, market, and regulatory tasks necessary to shift the EU energy system towards a low-emissions trajectory. Distributionally, the particular design of the instruments generates an array of benefits that accrue to member states differently based on the structure of their domestic energy systems. Together, these factors suggest that the EU's success at issue linkage derives from the way in which the structure of the European energy system permitted coupling of the functional requirements of systems transformation to the resolution of distributional conflict over the costs and benefits of energy systems transformation.

4.6.1 Compensation in the ETS: richer, larger, and protected to smaller, poorer, and exposed

Both the design of ETS permit allocation, and the outcomes of allocation, generated three empirical distributional patterns with political consequences. First, the ETS tended to over-allocate permits to the eastern European member states relative to the west. Second, it tended to over-allocate permits to smaller firms and emissions sources compared to large. Third, it over-allocated permits to exposed industrial sectors relative to non-traded sectors, particularly electricity generation. Because the over-allocated permits had cash value on secondary emissions markets, these patterns of over-allocation are equivalent to financial transfers. But those transfers were much more implicit than pure side-payments would have been, which played a critical role in a European Union that lacks real fiscal authority and in which explicit compensation had proven politically unpalatable.

ETS permit allocation for the 2005-2007 and 2008-2012 trading periods occurred as a two-stage process. The European Commission first allocated permits to individual countries on the basis of national estimates of future emissions submitted in National Action Plans. Member states then allocated permits to firms on the basis of the criteria laid out in their National Action Plans. The Commission exercised some veto power over the content of the national action plans, in line with its role in ensuring harmonization in the Common Market.[10] Aggregate permit allocation followed a historical-updating model, wherein permits were allocated based on prior emissions and expected future economic growth, with some correction factor to ensure declining emissions.

But within these aggregates, states had considerable discretion in the assignment of permits to firms. Moreover, nearly all permits–upwards of 90%–were freely granted rather than auctioned off. Permit allocation thus allowed for significant distributional discretion on the part of both the Commission (between states) and the member states themselves (between firms). Because the permits themselves had real value on secondary markets, they provided an implicit means of managing distributional conflict from emissions reduction. Over-allocation of permits to a country or sector can be treated as a net asset transfer from under-allocated sectors. Under-allocated sectors either had to either invest more in emissions abatement, or purchase permits on the secondary market. Excess permit allocation to the new member states may have represented up to €1 billion in implicit transfers as of 2007. In particular, figure 4.5 shows that the new member states received a net excess of permits in every sector throughout the first and second trading periods.

[10] In practice, the Commission used its veto power extensively. Sixteen of 25 National Action Plans for the 2008-2012 trading period were initially rejected by the Commission for a wide array of infractions. The Commission was particularly concerned that states would use permit allocation as a means of state aid to favored sectors, and policed this kind of distortion of the internal market very carefully. See EurActiv (2007)

Permit allocation also provided a means of compensation to vulnerable sectors in European economies. The first group were the so-called "carbon leakage" sectors, whose exposure to international competition meant that paying for emissions pricing risked their comparative advantage on global markets. The second group were the smaller firms and installations, who had relatively less access to the resources required to adopt low-emissions technologies or operating methods. For the "carbon leakage" sectors, particularly in western Europe, 4.5 shows that the ceramics, pulp and paper, iron and steel, and cement industries all received excess permits in all ETS trading years after 2005. In contrast, the electricity sector–which does not compete directly on global markets, even if electricity users do–began each trading year with a permit deficit. Likewise, figure 4.6 shows that smaller installations received relatively more permits than larger installations. In some cases the relative over-allocation exceeded actual emissions by a factor of 10: or 100:1. actual emissions.

It's important to point out that all these compensation patterns could have existed under an emissions tax as well. Instead of using permit allocation to compensate recalcitrant or exposed groups, tax revenues could have been recycled to the same effect. But that would have required the EU to either obtain the fiscal authority to engage in this kind of redistribution, or to police its member states to ensure that this occurred on a transparent basis that did not distort internal markets for goods or energy. It also would have made the patterns of compensation far more obvious. As the notion of "windfall profits" to specific sectors or firms from over-allocation proved politically controversial in its own right, explicit cash transfers would likely have proven unworkable. Consistent with Victor (2011) and Ellerman et al. (2010), the choice of a cap and trade system rather than a tax for emissions control fulfilled a particular political logic that tipped the scales between two otherwise theoretically equivalent climate change mitigation instruments.

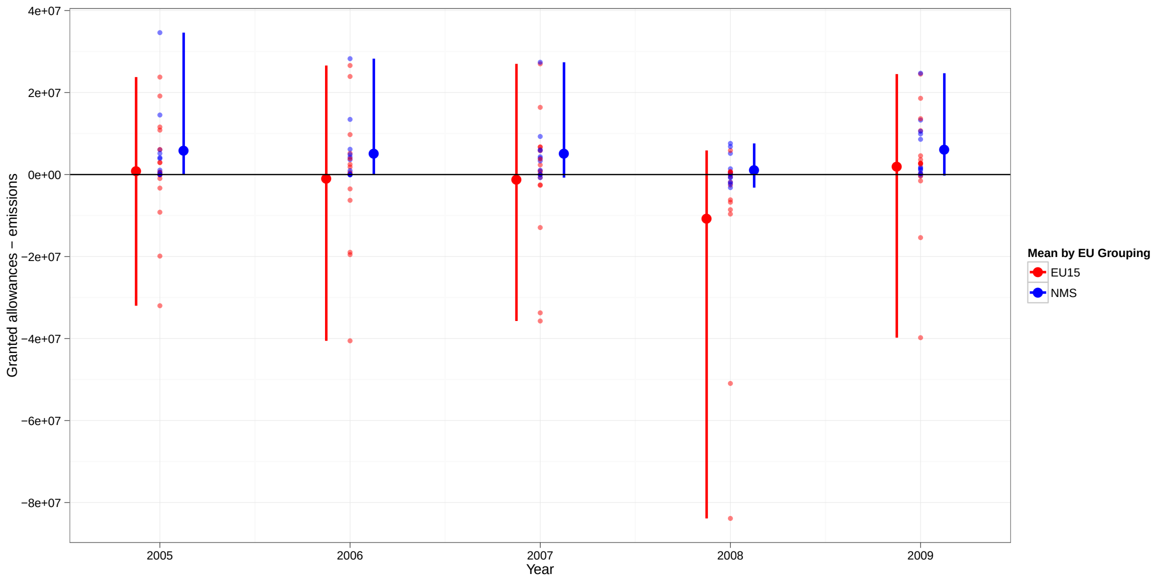


Figure 4.5: Net permit allocation and emissions under the EU ETS. All data from the EU Community Independent Transaction Log (CITL) for 2005-2009 verified emissions.

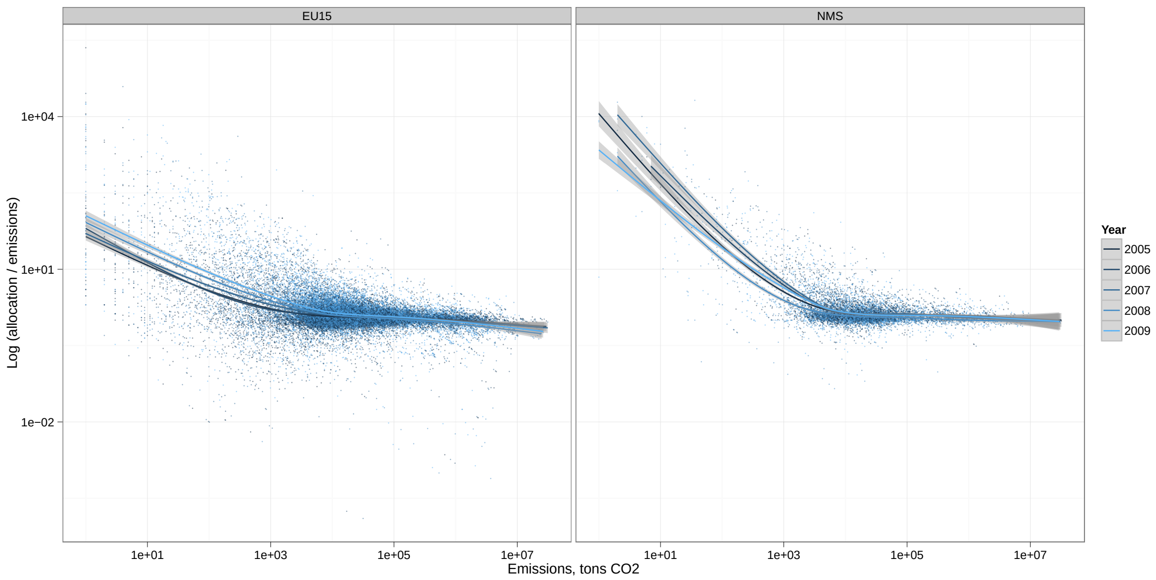


Figure 4.6: Ratio of ETS permit allocation to verified emissions by year and installation, compared with actual emissions at each installation. Each point represents a single emitting installation covered under the ETS. Lines are smoothed annual means via loess regression. All data from the EU Community Independent Transaction Log (CITL) for 2005-2009 verified emissions.

Caveats on over-allocation

These conclusions merit a few caveats. First, it remains very difficult to determine how much excess allocation was due to emissions abatement investments by the countries or firms in question, versus pure over-allocation. That is, firms may have had excess permits to sell because they found investments in energy efficiency or emissions reduction cheaper than the price of permits on the open market. This is particularly true for eastern European firms, whose comparatively less efficient capital stock may have resulted in very cheap emissions abatement opportunities relative to the sale value of the permit. Nevertheless, to the extent that the marginal cost of abatement was still less than the permit price, firms would have generated windfall profits from free permit allocation even if some of the permit revenue went to paying for abatement investments.

Second, there are plausible reasons for permit over-allocation to favor smaller firms. First, smaller installations may have less predictable emissions than very large installations like power plants. Second, it may be reasonable to expect that larger installations had already been optimized for efficiency to achieve operating cost improvements. If that were the case, then smaller firms may have had more leeway to find low-cost emissions reduction options, resulting in excess permits to sell on secondary markets. Nevertheless, it's also the case that very large firms probably have better access to resources to plan and finance efficiency investments than small firms do. Furthermore, and as figure 4.6 shows, many of the smaller installations received on the order of 10-100 times as many permits relative to their emissions, a level of over-allocation that would appear to tip the scales in favor of the subsidization argument.

These caveats aside, the design of the initial phases of ETS allocation provides substantial evidence that countries that faced either higher abatement costs, limited capacity to finance those costs, or loss of competitiveness from emissions pricing were implicitly subsidized through permit allocation. With approximately €30 billion in permits (2 billion or so metric tons at €15 / ton) distributed annually, the implicit amount of funds available for allocation is on par with the annual funding for the Common Agricultural Policy.(Zachmann, 2011) The ETS thus represents both a framework for emissions reduction, and a mechanism to effect transfers that buffer the costs of adjustment.

Implications of future changes to the ETS

The Third Climate and Energy Package, will alter some of these re-distributional patterns. Permit allocation to the member states will continue to occur on the basis of prior emissions. But permit allocation to firms will, after 2012, occur via auctioning rather than free allocation. This will reduce the value of permits to firms, since the permits will no long represent a net transfer of valuable cash assets.

However, two exceptions to the permit allocation process indicate ongoing distributional behavior inside the ETS. Together, these exceptions mean that only 40% of the total permit volume will be auctioned off at the start of Phase III of the Emissions Trading Scheme. First, the trade-exposed "carbon leakage" sectors, in which energy constitutes a substantial portion of the cost of finished products, continue to receive special treatment for allocation and subsidy in order to protect competitiveness. The Commission published the first list of sectors judged vulnerable to leakage in 2009; it covered most heavy manufacturing and energy-intensive sectors in the European economy. In practice, this means that 80% of the permits granted to manufacturing sectors will be freely allocated in 2013.[11]

Second, the new member states also receive some opt-out options for auctioning to their electricity sector. Those opt-outs expire after 2020. Of the ten new member

[11] See The European Commission (2010a) for the original announcement. Further updates are posted to http://ec.europa.eu/clima/policies/ets/cap/leakage/index_en.htm. Lasted referenced 27 February 2013.

states, all but Latvia and Malta requested derogations under the opt-out provision and will continue free allocation of permits to their electricity sectors. The wording of this section is an excellent demonstration of how the EU climate and energy policy suite allows for implicit rather than explicit compensation. The statute itself says nothing about the new member states in particular. But the specific wording of the section cites criteria on GDP, energy intensity, income, and other factors that implicitly mean that only the new member states will qualify.[12]

Thus the future ETS will have more muted distributional impacts than in the first two trading periods. Ellerman et al. (2010) suggest that the political controversy over "windfall profits" from free allocation, combined with firm dissatisfaction over the unpredictability of allocation levels, led to evolving preferences over time for auctioned rather than granted permits. But free allocation played a vital role in securing the participation of both trade-exposed sectors and the new member states of eastern Europe; and will continue to provide a means of side-payments for the foreseeable future.

4.6.2 Renewable energy targets and export expansion in the rich countries

Patterns of permit allocation provided the EU with a means of managing the costs of emissions reduction. In contrast, the Renewable Energy Directive provides implicit benefits to a set of rich countries whose domestic high-technology manufacturing sectors will supply the bulk of the technologies necessary to meet the 2020 target of a 20% renewable energy share in the electricity mix. Those countries and sectors, in turn, benefited not at all from permit over-allocation. Indeed, they usually operated

[12]In practice, it remains unclear how much latitude the Commission will give these states. Interviews with the Commission in early 2011 indicated that the Polish government had applied for and expected a much greater range of latitude in free allocation than the Commission was prepared to grant.

at a permit deficit and provided the demand (and thus cash) for excess permits from eastern Europe. Prevailing patterns of revealed comparative advantage in renewable energy technologies suggest that this pattern of redistribution will persist for the foreseeable future.

Using the wind industry as an example, we can estimate that the renewable energy mandate will generate as much as $48 billion in implicit benefits to these firms and countries by 2020. Assuming that the planned addition of 146,500 MW of installed wind capacity cited in section 4.5.3 is attained solely through the use of the newest generation of 3 MW wind turbines from leading firms Vestas or Siemens, that's equivalent to approximately 48,000 new turbines. Vestas estimates an installed cost per turbine of approximately $1.7 million, implying a total investment of $83 billion for the turbines alone. Perhaps 60% of that cost is captured by the manufacturing process alone, so that $48 billion of the $83 billion will go to procuring the turbines themselves. This is, of course, probably a conservative estimate: assumptions about future price reductions in wind turbine technology would reduce overall costs. But it provides a near-term estimate of the scale of investment required.

Who benefits from this investment depends on the sources for wind turbine procurement. The highly specific nature of wind turbine design, and the presence of significant learning-by-doing knowledge effects, has led to the dominance of the global wind industry by relatively few firms.[13] Within Europe, the advanced manufacturing economies dominate the market: Vestas in Denmark, Siemens in Germany, and Gamesa in Spain. Figure 4.7 shows that this has resulted in highly skewed patterns of comparative advantage in wind turbines within the EU member states.

[13] Heymann (1998) provides evidence that early Danish leadership over German and American firms in wind turbine design emerged from Denmark's strategy of repeat deployment rather than engineering optimization. Deployment provided information to firms and inventors that could not be replicated in the laboratory. As a result, Danish designs were more successful than their competitors until well into the 1990s, while efforts at very large turbine design in Germany and the United States failed.

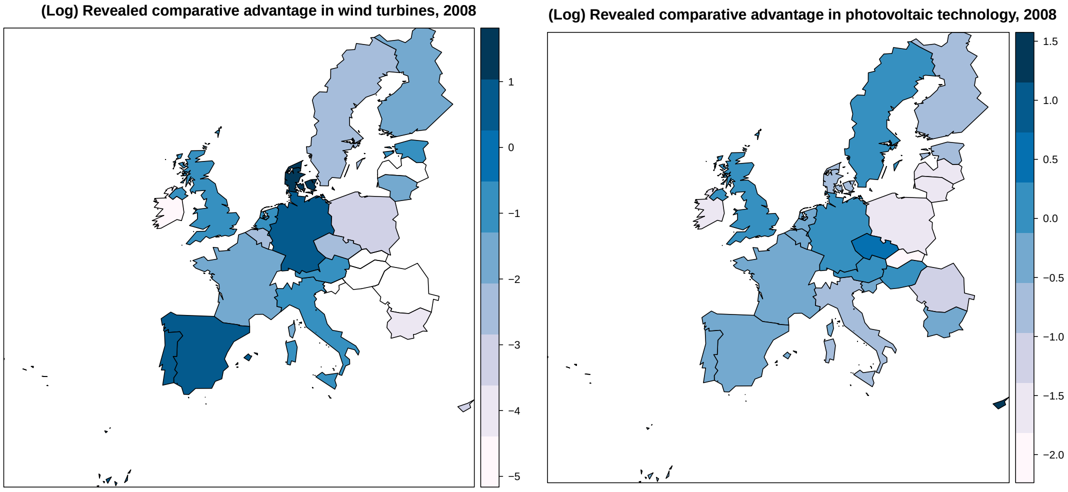


Figure 4.7: Revealed comparative advantage in wind turbine and solar photovoltaic cell exports within Europe. Calculated from the 6-digit UN COMTRADE export data for the period 2000-2010.

Addition of significant amounts of new wind capacity in the European Union will almost certainly result in expanded revenue streams for these firms and their supplier networks.[14] As such, the renewable energy mandates constitute a *de facto* market expansion for specific industries in specific member states.[15] As figure 4.10 shows, market expansion for wind electricity generation in particular has correlated with export growth for only two countries, Denmark and Germany. Moreover, figure 4.9(a) shows that this market growth is not reciprocal: Denmark and Germany have both maintained substantial positive trade balances in this sector since the mid-1990s.

Moreover, because of the structure of value-add in the wind sector in particular, the secondary effects of an expanded wind industry should be limited. Expanded

[14]This assumes a counter-factual world without binding targets in which those investments did not occur. The failure to achieve non-binding targets in the period 2001-2010 suggests that this is a reasonable assumption. The EU member states would, no doubt, have made some investments in renewable energy goods without the mandates. But the mandates increase the certainty and potentially the size of the investments and imply legally-guaranteed demand expansion in these sectors.

[15]Huberty and Zachmann (2011) provide evidence that renewable energy market expansion in home economies benefits or develops domestic renewable energy sectors only under limited circumstances, and does so preferentially based on pre-existing patterns of competitiveness in related markets.

production of wind turbines will, of course, generate expanded demand for inputs to wind turbine production. Many of these inputs–particularly for a small economy like Denmark–will come from other member states. But estimates of the value-added structure of a wind turbine place approximately 78% of the hardware cost in the generator and airfoil (Tegen et al., 2010).[16] Thus most of the value is tied up in the knowledge capital applied to turbine design and construction. This will limit the spillover from expanded domestic production.[17]

Solar photovoltaic electricity, the other major contributor to new renewable energy capacity in under the renewable energy targets, has a more broadly distributed pattern of comparative advantage and thus represents a less concentrated transfer. But as figure 4.10 shows, the countries that appear to benefit most from their neighbors' expanding demand for solar electricity are, with the exception of Hungary and the Czech Republic, all western European countries. Moreover, the international solar cell market has changed rapidly, and new entrants like China have rapidly acquired significant market share.(Woody, 2010) Because solar cells are more modular and more easily shipped than wind turbines, this will reduce the degree to which funds for solar energy market expansion stay within the EU. While this may not constitute intra-EU redistribution, neither does it suggest that expanding solar markets at home will lead to improved prospects for domestic solar electricity firms.

Thus the industrial benefits of the growth of renewable energy markets will likely be concentrated in the few countries that are today significant players in wind turbine manufacture. Those countries are themselves mostly highly advanced western

[16]This accounts for approximately 53% of the installed cost of a turbine. The tower accounts for an additional 25%, with the balance of the costs falling under engineering and construction finance. All calculations were based on a generic 2010 reference turbine.

[17]There is one caveat to this conclusion. The newest generation of very large offshore wind turbines cannot be shipped easily due to their size. On-site assembly is therefore required, usually in a port capable of moving the turbines directly to the point of installation. However, while this will capture more value-add for the installing country, it does not fully offset the fact that so much of the sale value is tied up in knowledge capital rather than labor or materials.

European member states. The renewable energy mandates thus have a significant distributional element to them, on the scale of billions of dollars annually, that runs in the reverse direction from the normal west-to-east pattern common to the EU's cohesion and structural adjustment funds and the ETS.

We may view this linkage process as a kind of technology fund theorized by Urpelainen (2012a). He proposes a fund in which developed countries subsidize low-emissions technology adoption by developing countries, as an implicit subsidy to their own domestic clean technology industries. Here, the subsidy of eastern Europe by western Europe combines implicit and explicit measures: explicit, via the solidarity funds; and implicit, via transfers through the ETS permit mechanisms as described in section 4.6.1.

4.6.3 Benefits from market integration and reform: systems security and stability

Finally, the move to integrate national energy markets generates several, highly diverse beneficiary pools. Those countries with high intermittent renewable energy shares–such as Denmark and Germany–are able to average their energy intermittency over a larger market, buffering their own market from energy shortages and selling into foreign markets at times of overproduction. This makes domestic energy systems transformation technically easier and financially less complicated to manage. The first steps in this direction were taken in late 2010, when the Nordic countries and the central-west European regional energy market entered into market-based price coupling, significantly reducing both cross-border price differentials and price volatility on the regional electricity markets.

In parallel, countries exposed to significant external energy supply instability benefit from increased integration with the European market. This last had been a signif-

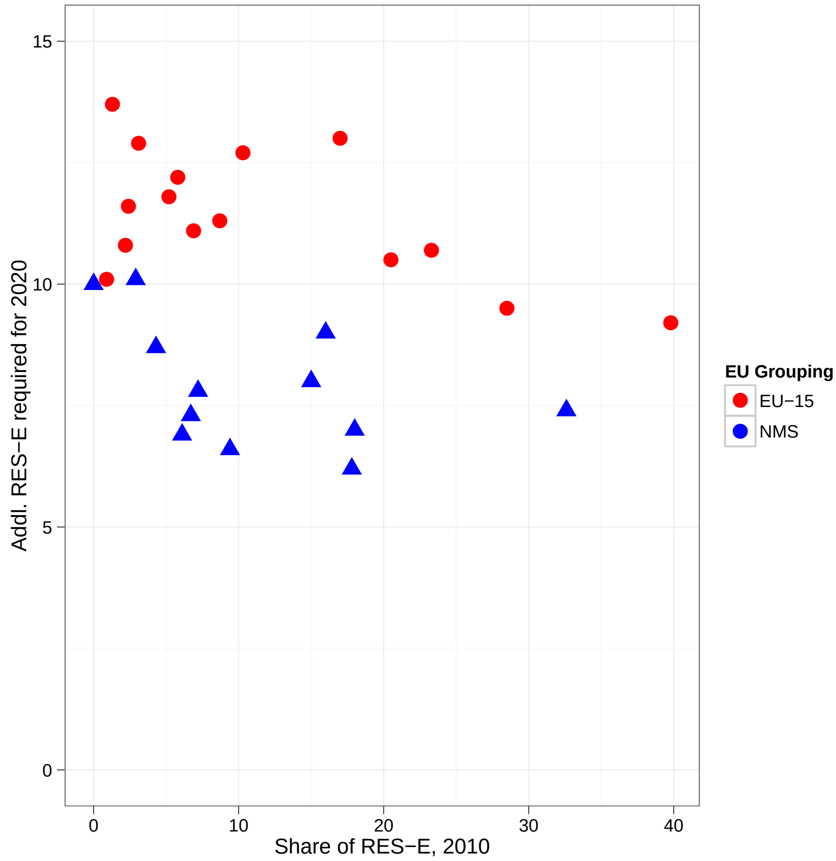
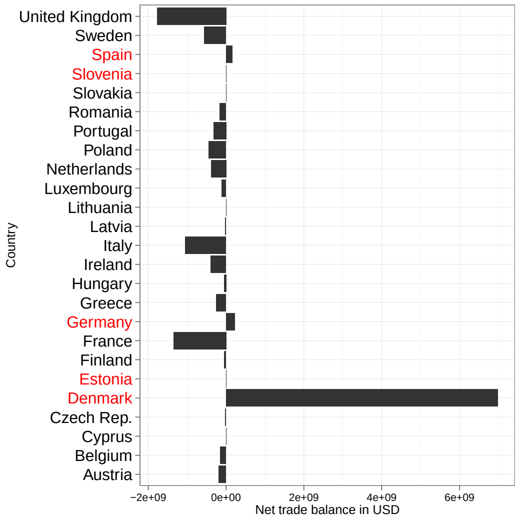
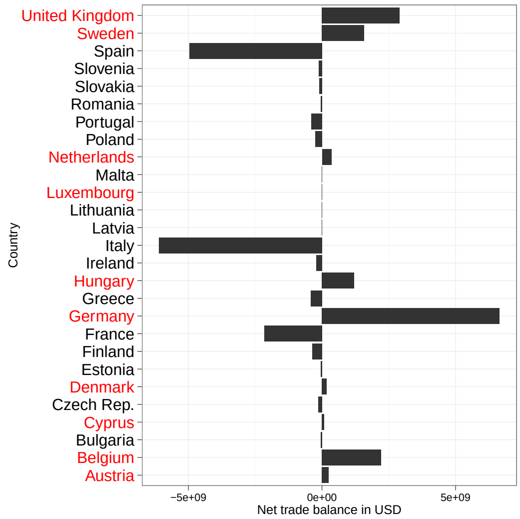


Figure 4.8: Clustering of EU 2020 RES-E targets by 2010 starting points. All numbers shown as the percentage of electricity generation derived from non-nuclear renewable sources. Data taken from Annex 1 of European Union (2009).

icant problem during the gas crises of 2000-2010, when western Europe often enjoyed gas surpluses while eastern Europe faced shortages. Then, the lack of sufficient cross-border energy market integration forestalled easy solutions and raised the costs of supply disruption considerably. The European TEN-T network integration programs specifically target those bottlenecks for resolution, even as they also facilitate the geographic averaging of renewable energy intermittency and smooth the integration of high levels of renewable energy into existing energy systems.

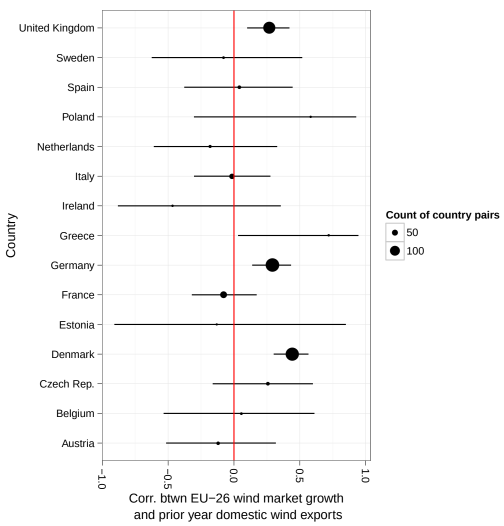


(a) Wind turbines

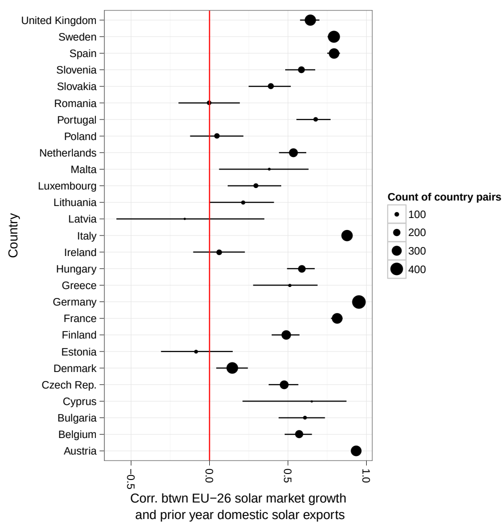


(b) Photovoltaics

Figure 4.9: Net trade balance in wind turbines and solar cells, 1996-2009. All data from the bilateral trade figures in the UN COMTRADE database.



(a) Wind turbines



(b) Photovoltaics

Figure 4.10: Correlation of prior-year home-country aggregate export growth with EU-26 market growth in renewable electricity generation. Market growth calculated as the year-over-year change in absolute amounts of renewable electricity from wind or solar. Exports calculated as total yearly exports by country for the prior year. Electricity data taken from the Energy Information Administration international accounts. Trade data taken from the UN COMTRADE database. All data from 1996-2009.

Member State	Share of energy from renewable sources in gross final consumption of energy, 2005	Target for share of energy from renewable sources in gross final consumption of energy, 2020
Belgium	2.2%	13%
Bulgaria	9.4%	16%
Czech Republic	6.1%	13%
Denmark	17.0%	30%
Germany	5.8%	18%
Estonia	18.0%	25%
Ireland	3.1%	16%
Greece	6.9%	18%
Spain	8.7%	20%
France	10.3%	23%
Italy	5.2%	17%
Cyprus	2.9%	13%
Latvia	32.6%	40%
Lithuania	15.0%	23%
Luxembourg	0.9%	11%
Hungary	4.3%	13%
Malta	0.0%	10%
Netherlands	2.4%	14%
Austria	23.3%	34%
Poland	7.2%	15%
Portugal	20.5%	31%
Romania	17.8%	24%
Slovenia	16.0%	25%
Slovak Republic	6.7%	14%
Finland	28.5%	38%
Sweden	39.8%	49%
United Kingdom	1.3%	15%

Table 4.1: EU 2020 RES-E targets, as reported in Annex 1 of European Union (2009).

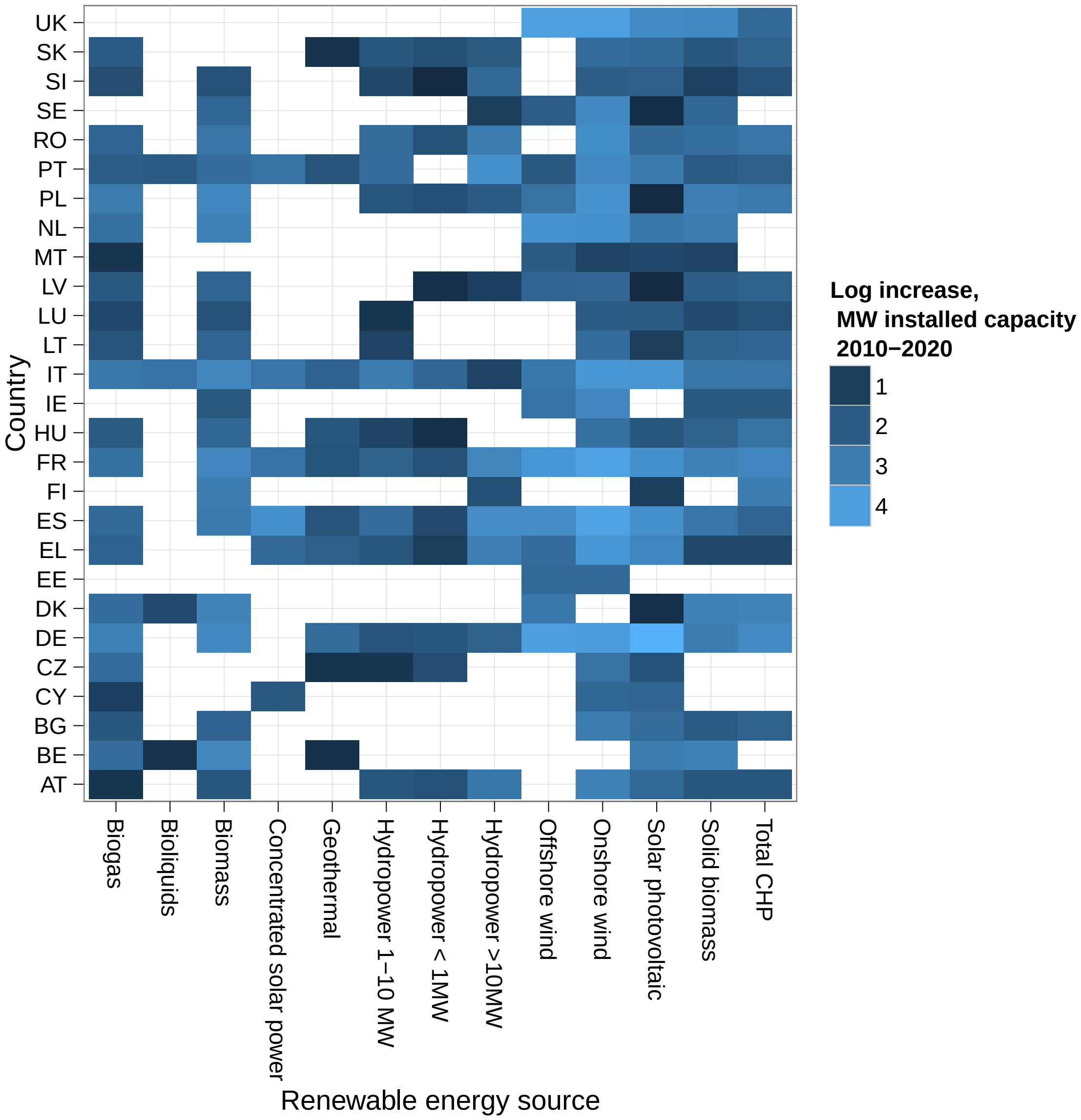


Figure 4.11: Patterns of planned renewable energy adoption in the EU member states, 2010-2020. Source: Beurskens and Hekkenber (2011).

4.7 Against multifaceted policy: emissions pricing and its discontents

This chapter has argued that the EU's success at unilateral climate change action in the face of powerful incentives to the contrary derives from a multi-instrument approach to low-emissions energy systems transformation. In this view, multiple instruments are required to effect the transformation of the assets, markets, and regulation that structure the production, distribution, and use of energy. In the case of the EU, the choice of instruments generated asymmetric patterns of near-term benefits from energy security, export competitiveness, and systems stability. The European Commission used those benefits to justify actions that climate change mitigation alone might not have. Those benefits underpinned the success of Europe's policy regime in the face of strong free-riding incentives, diverging energy interests among the member states, and the defection of its major trading partner from international emissions regulation.

Nevertheless, the European energy policy suite has encountered criticism, particularly from economists. They argue that the use of multiple instruments, especially technology-specific ones like renewable energy mandates, dilutes the economic efficiency that is the primary motivation for a pure emissions pricing system. As such, it raises the cost of systems transformation and risks generating inefficient or even dysfunctional outcomes for emissions reduction.

This section argues that such an interpretation ignores the importance of the distributional capacity of a multi-instrument approach to balance competing political interests and sustain policy momentum. What appears as rent-seeking distortion should instead be viewed, consistent with chapter 3 as a politically viable and sustainable approach to institutionalizing and improving emissions policy over time. Achieving this kind of outcome in the European Union was facilitated by the use of multiple instruments that addressed near-term challenges in energy security and economic competitiveness as well as long-term emissions reduction goals. An emissions price, deployed in isolation, could not have served these ends, and may have undermined the viability of the emissions regime over the long term.

4.7.1 Redundancy and inefficiency in the EU policy suite

Theoretically, most of the EU policy suite should be superfluous for the EU's climate policy goals. Economic analysis has consistently emphasized the sufficiency of a carbon price–whether through a carbon tax or a permit system–for incentivizing the necessary investments in renewable energy, energy efficiency, or research and development. Nordhaus (2010) has styled this "carbon price fundamentalism" and argues that this approach represents the best long-term strategy for climate change mitigation. In contrast, policies that promote renewables and push energy efficiency may constitute market-distorting industrial policy. For instance, it now appears that the renewable energy mandates will crowd out emissions reduction via energy efficiency investments, even though most cost estimates (such as Enkvist et al. (2007)) show that energy efficiency improvements are often much cheaper per unit emissions.

Most analysis has treated the EU's move to a redundant, multi-instrument climate and energy policy suite as a purely distortionary effect of rent-seeking by powerful industrial and member-state interests. Helm (2009), examining the 20/20/20 targets on emissions, renewable energy, and efficiency, asserts that "the probability that the correct answer. . . of what to do about climate change is even approximately [the 20/20/20 targets] is close to zero", believes that the targets were adopted solely for their signaling value, and concludes that the policies represent a "politically neat but economically inefficient set of targets." Victor (2011, 68-70) explains the EU choice of emissions trading for industrial emissions in terms of rent-seeking on the part of entrenched industrial interests, and the attractiveness of RES-E targets as a similar move on the part of renewable energy interests. Schmalensee and Stavins (2011) and Palmer and Burtraw (2005) argue that renewable energy mandates are a costlier way to achieve emissions reduction than an emissions price alone. These explanations (and critiques) of the EU energy policy suite point out, correctly, the pitfalls of the EU's approach and the potential for it to raise the overall cost of emissions reduction, and potentially increase the chance of outright policy failure.

This gap between theory and policy implementation is puzzling in light of the political economy of climate change action as outlined in chapter 3. Climate change poses fundamental policy problems because it imposes immediate, acute costs to achieve diffuse benefits far in the future. This structure of costs and benefits has led other major emitters–notably the United States in the developed world, and China and India in the developing–to resist or reject aggressive and coordinated climate action. In the case of the EU, they are powerful arguments for choosing the least-cost means of action. Indeed, interviews with the European Commission in late 2010 corroborated earlier evidence that the EU abandoned earlier ideas for a command-and-control approach to emissions regulation largely because of fears about cost. Despite those concerns, however, they have subsequently added to the carbon price framework a range of policies regarded as more costly, and less efficient, than a carbon price alone.

4.7.2 Complementarity, not redundancy: climate policy as energy policy

In the context of chapter 3, it's not clear that these critiques of the EU's policy suite are justified. As this chapter has argued, the EU's policy suite is attempting to satisfy three different policy goals: emissions, energy security, and economic competitiveness. In doing so, the structure of the EU's energy system has required and permitted the coupling of progress on emissions reduction to progress on other energy-related issues that deliver real, near-term benefits to economic actors. This has both an economic and a political logic. Economically, energy market integration and emissions reduction both required a range of major changes to the EU's energy infrastructure to integrate significant quantities of renewable energy in a stable energy system. Politically, both emissions reduction and energy systems transformation would impose distributional costs on a set of EU energy and emissions interests that had become more fragmented following on the 2004 and 2007 enlargements.

Section 4.6 argued that the policy suite evolved in the face of these issues in the direction of a synthesis that served both the logistical and infrastructure problem, and the distributional problems. It did so via linking long-term progress on emissions to near-term progress on security and economic competitiveness. The chosen policy instruments provided a range of distributional tools to policymakers that–while no doubt enabling rent-seeking–kept reluctant energy interests from becoming veto players, and built new advocates for policy stability.

In contrast, the narrow pursuit of emissions reduction, security, or competitiveness alone risked fracturing the coalition along these lines. Pursuing emissions reduction through a high emissions price would have two immediate effects: first, it would encourage the substitution of imported (Russian) gas for domestic coal in electricity generation, at an immediate 40% reduction in carbon per unit energy. Second, it would raise retail electricity prices substantially, and disproportionately in high-carbon-share economies. These developments threatened to create discord among member states concerned about energy security and industrial competitiveness, and among firms in more energy-intensive sectors.[18]

[18]For the ongoing geopolitical tensions within the EU over relations with Russia, see, for instance, Belkin (2008). Even with the new policy regime in place, Europe's member states continue to face difficulties coordinating external action.

Likewise, pursuit of energy security alone would lead to significantly greater use of domestic EU coal. This is particularly true of the new member states, who lack natural gas resources and lag behind in renewable energy technology.[19] Much of the remaining coal in eastern Europe, such as that around Silesia in Poland, is of the soft brown lignite variety (World Energy Council, 2010), which in addition to its carbon emissions carries a much higher share of other pollutants compared to hard coal. Its expanded use would alienate member states more committed to emissions and pollution reduction, and frustrate EU attempts to achieve its commitments under the Kyoto protocols.

In contrast, a renewables target alone would generate significant benefits for member states with strong wind and solar power industries. Those countries would stand to benefit from increased exports of capital goods, such as wind turbines and solar cells, to other member states lacking domestic production capacity.[20] But that would come at large costs to technology-importing countries, both in absolute terms and in the secondary effects on trade balances. It would also do little to solve the various market imperfections that prevent the adoption of net-positive-benefit energy efficiency measures, and would still require significant infrastructure and regulatory changes to achieve a stable, renewable-energy-dominated energy system.

Finally, each of these policy approaches would still have required a mechanism for EU energy market integration. As chapter 2 showed, the introduction of renewable energy generation resources poses stability problems that require significant down-

[19]See, for instance, the Polish response to the 2006 European Commission Green Paper on energy market reform. The Polish government emphasized the need for carbon capture and sequestration, and suggested that most of its domestic investment in more efficient energy technologies would go into more efficient coal energy plants and energy efficiency–not the elimination of coal from its energy supply.(The Government of the Republic of Poland, 2006). More recently, the Polish government has aggressively defended its continuing expansion of coal-fired power generation. See, for instance, Stonington (2012).

[20]This, of course, is limited to the case in which each member state had binding targets without tradeable certificates. In that case, member states could not satisfy their domestic targets through purchases of excess renewable energy production from abroad. As of 2011, the EU renewable energy goals permit only limited tradeability in renewable energy.

stream changes to energy distribution and demand. Making the investments required to maintain systems stability, however, would not have been in the interest of older, vertically-integrated state power monopolies. Their control of both production and transmission of electricity gave them large incentives to favor their own energy production assets in making new grid investments and allocating grid capacity. As a corollary, it also gave them few incentives to invest in new transmissions connections for renewable energy resources, or to harden the power grid to effectively manage intermittent generation. In this context, the breakup of the power monopolies and the creation of independent markets for production, transmission, distribution, and use was a critical step in pushing for the adoption of low-carbon energy sources.[21] But even absent a mandate for renewable energy adoption, improved energy security would also require cross-border grid integration, to solve the inadequacy and energy island problems identified in sections 4.4.2 and 4.4.2.

Thus each of these three policy issues–emissions, security, and competitiveness–carries with it unique interests, both for and against, that would pose problems for attempts to pursue them in isolation. Instead, the EU energy and climate policy suite has evolved to yoke progress along any one policy dimension to progress along the others. The mix of costs and benefits to any one interest group or member state varies by the policy instrument, implicitly underwriting a political strategy of issue linkage between both interest domains and member states, and cross-subsidizing policy compliance. Finally, the ability to pursue all of these policies was highly contingent on the market reforms that enabled their implementation, and provided the private

[21] The proper regulation of the network assets in network economies has received significant attention amidst both the rise of the Internet and the privatization of state-owned network industries like rail. Two examples provide some insight: Much of the success of the internet hinged on ensuring that neither the network operator, AT&T, or the IT standards setter, IBM, could use monopoly control of markets to dictate terms of entry. Antitrust regulation of both firms (and, later, Microsoft) provided openings for new competitors. In contrast, the privatization of the rail network in the United Kingdom generated insufficient incentives for the network owner, Railtrack, to maintain and improve the network infrastructure. Breakdowns, delays, and systems decline resulted, at great cost to the British state.

sector with incentives to pursue the investment necessary to achieve energy policy goals.

Political economy as a rebuttal to price fundamentalism

This analytic framework suggests that the arguments of the price fundamentalists miss the forest for the trees. As emissions policy alone, the ETS may be inefficient and cumbersome compared to a pure carbon price. As energy policy, the renewable energy mandates crowd out other, cheaper emissions-reducing fuels and efficiency investments. As market policy, energy market liberalization makes only partial sense in a world of massive, highly centralized fossil fuel generation plants.

But as table 4.2 shows, each of these policy instruments in fact serve multiple functional and distributional ends. Functionally, the support the integration of the European energy market, buffer renewable energy intermittency, reform monopolistic markets, support experimentation with and adoption of new energy technology at scale, and provide new forms of energy security. The benefits derived from these varied functions in turn provide the means of compensating rich and poor states alike, offsetting the costs of emissions reduction and generating near-term benefits that encourage policy stability and credibility.

Moreover, the varied policy targets–emissions, security, and competitiveness–provide greater flexibility to both EU and member state policymakers in justifying policy amidst a changing economic and political landscape. As the EU shifted from growth to recession in the 2008-2010 period, so too did the primary justification shift from climate change to job creation and firm competitiveness. The multiplicity of targets also allowed countries as diverse as Poland and Denmark to find accommodation inside the policy suite. Poland's response to the 2006 energy white paper (The Government of the Republic of Poland, 2006) emphasized security of supply and expanded use of domestic coal, and relegated the climate pillar of the policy proposal to third place. In contrast, Denmark emphasized renewable energy and reduced dependence on fossil fuels.(Danish Energy Authority, 2007, Appendix) Reconciling one set of interests to another required a means of both compensating Poland for participation and rewarding Denmark for taking on larger burdens. As this chapter has shown, the distributional patterns in the EU energy policy suite implicitly do both, by linking together emissions, security, and energy issue domains.

What we observe in the EU is, then, largely consistent with the predictions of the theory of political economy put forth in chapter 3. The EU has yoked progress on emissions to goals in energy security and industrial policy that promise short-term benefits. It has adopted policies to pursue those goals that both blunt the apparent cost of action and provide for implicit cross-subsidization of different policy domains. And, as policy has become institutionalized and stable, it has modified the policy regime–most notably with the turn to permit auctions after 2012–as policy actors have adapted to the emissions control framework and perceived as credible the mechanisms for cost management. The policy suite has thus permitted ongoing action on climate change, even as the original political climate has changed with EU enlargement, and the economic climate has changed from boom to bust.

In closing, critiques along the lines of those of Helm (2009) and Victor (2011) provide important insights into the actual and potential distortions of the EU's multifaceted policy suite. But it is equally important to realize that there is a logic to the policy suite that goes beyond mere rent-seeking on the part of industries and member states. Rather, the structure of the energy policy suite appears to address the suite of political economy problems created by a low-carbon energy systems transformation. Improving the policy suite to improve effectiveness and reduce costs cannot focus only on resolving the problems of economic distortion created by the current suite.

Rather, solutions must also identify how they would avoid exacerbating the political threats to policy continuity that the present system addresses. Finally, whatever the accuracy of the proposition that voters will probably need to pay more than they want for emissions reduction, haranguing them to do so (particularly amidst Europe's ongoing economic stagnation) appears unwise for both policy durability and electoral success.

4.8 Conclusions: managing functions and benefits in for low-emissions systems transformation in the EU

This chapter has argued that the Commission pursued an integrated climate and energy policy out of a specific conception of the emissions reduction problem. Sustainable support for climate policy had to rest on material returns from the pursuit of environmental ends. Structuring a low-emissions energy systems transformation to serve Europe's security and competitiveness needs offered a means to generate those material returns. The politics of issue linkage that emerged coupled tasks that served emissions reduction to actions that pursued long-term industrial change. That change benefited new firms in renewable energy and energy efficiency; generated gains from market integration; and tried to address Europe's burgeoning energy security problems.

The circumstantial evidence raises a number of political questions. First, this chapter has asserted that the pattern of benefits suggests a strategy of issue linkage among asymmetric, but overlapping, economic interests. That implies a world in which interests who many not agree on long-term environmental problems may nevertheless find common ground on the short-term consequences of climate action. Chapter 6 provides evidence of these interests. Using data from firm responses to regulatory comment periods, it shows that firms often share second-order interests even when their first-order interests differ. Thus, for instance, a wide array of firms support energy market integration and reform, even if they don't agree on the role that reform plays in encouraging the adoption of renewable energy. This pattern of interests, with specific reference to the Commission's proposed energy strategy for Europe, points to the possibility for issue linkage to resolve the otherwise difficult politics of emissions reduction.

Second, while the Commission's strategic objectives were clear, it is by no means the only policy actor in the EU institutions. Verifying that a coherent politics of issue linkage emerged from the Commission's objectives requires establishing whether and how the Commission's strategy survived the European legislative process. Chapter 5 shows that the Commission was quite successful in protecting its policy design in the European policy process. It also shows that the Parliament–historically a successful environmental advocate–was relegated to the policy periphery. Thus legislative history shows that the Commission's policy designs, as expressed in its 2006 energy strategy, carried the policy formation process. That history also informs against a competing hypothesis for Europe's climate policy leadership: the choice of policy instruments in many cases ran against the preferences of the European Parliament and its strong green parties, while the Parliament's attempts to enact those preferences in law were consistently rebuffed.

This evidence points to the intent, on the part of the European Commission, to craft a political strategy for emissions reduction rooted in the politics of energy systems transformation. In doing so, it has yoked support for emissions reductions to presumed benefits from energy security, employment, export-led growth, and market competition. The Commission here has clearly played the role of policy entrepreneur, in recognizing how disparate threads of Europe's energy policy might–or should–

serve a coherent whole. It's ability to do so, however, rests on the underlying structure of Europe's legacy energy system, and the costs and benefits that structure implies for the transformation itself.

This is not to say, of course, that the 2008 Climate and Energy package, and the present EU energy and climate policy suite, mark perfectly conceived instruments for the transformation of the EU energy system. As Jordan et al. (2011) have shown, the EU will continue to encounter significant questions of governance, cross-border harmonization, and policy feasibility. But emphasizing policy stabilization via issue linkage does not imply immobile policy. Rather, it suggests the institutionalization of a set of arrangements that may help stabilize the politics of policy implementation, and permit policy refinement over time.

Policy	Low carbon EST role	Other role	Political / distributional role	Primary beneficiaries
Market liberalization	• Promote new RES-E entrants • Reduce barriers to new technology	• Create market mechanisms for cross-border trading of capacity and security goods	• Increase price competition to offset ETS, RES-E costs	• New energy market entrants • Energy users
Infrastructure planning & investment	• Buffer renewable energy intermittency	• Connect energy "islands" to central EU energy markets	• Improve energy security • Reduce weight of national legacy utilities	• Energy islands • Surplus power producers • Large RES-E share countries
Emissions trading	• Financial incentives for emissions reduction		• Cross-national transfers via ETS permit allocation	• Eastern Europe • Small(er) firms
Renewable energy targets	• Bring new technology into the market • Provide learning-by-doing opportunities	• Provide non-fossil-fuel-based domestic energy resources	• Export revenues for leading RES-E sector firms • Improve energy security • Disguise emissions reduction cost	• Countries with comparative advantage in RES-E goods • Countries vulnerable to supply disruption
SET-Plan	• Invest in long-term low-emissions energy systems technologies	• Fund R&D for industrial competitiveness	• Promote comparative advantage for EU firms	• Countries and firms in the RES-E, energy efficiency, and energy services supply chains

Table 4.2: Distributional and functional contributions of major instruments in the EU policy suite.

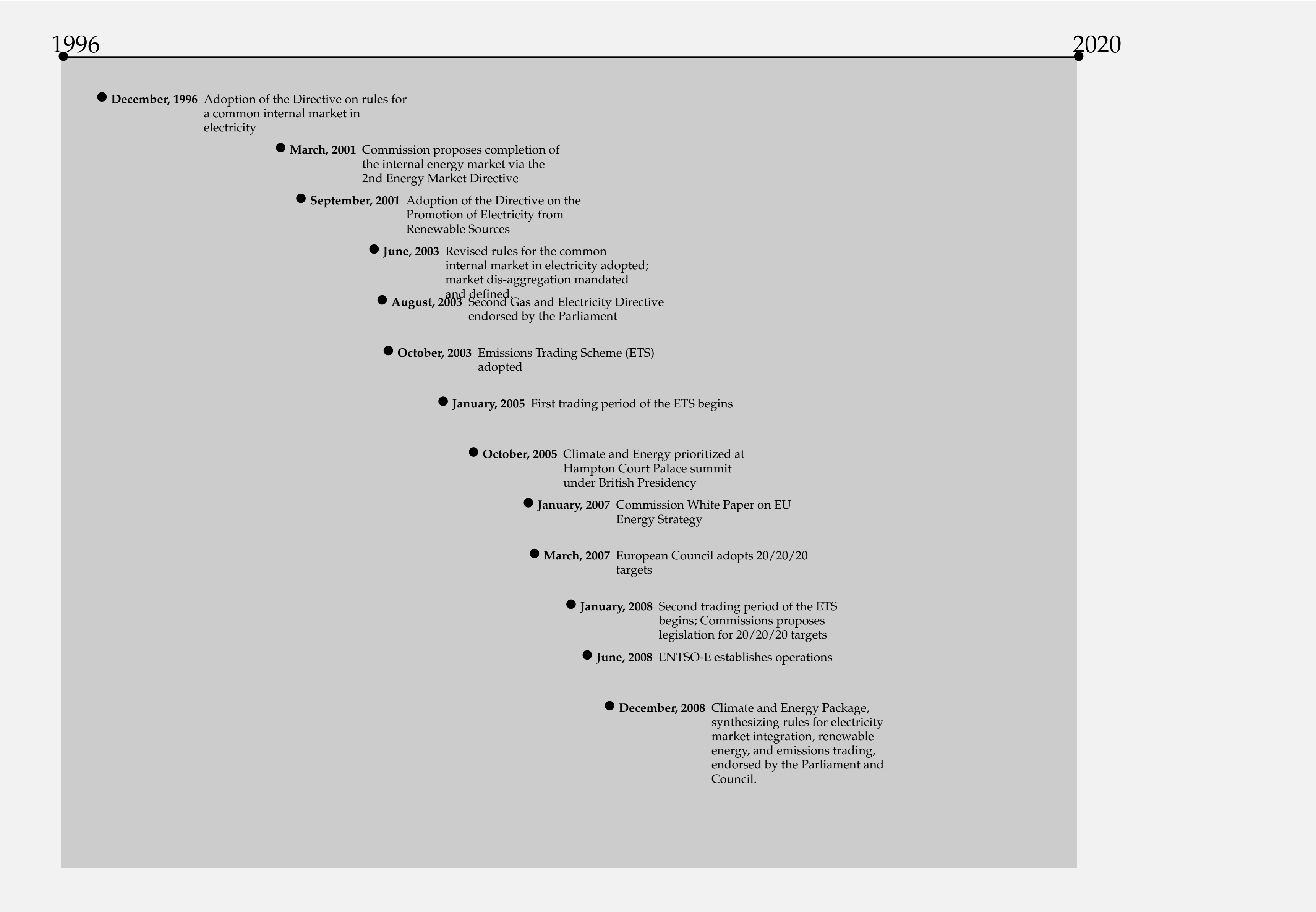


Figure 4.12: Timeline of EU Energy and Climate Policy

5 Design or politics? Legislating the Third Climate and Energy Package

5.1 Introduction

Chapters 1-4 argued that Europe's climate strategy should be understood as industrial rather than environmental policy. The history and configuration of Europe's climate policy suite points to a concerted attempt to use the industrial transformation of Europe's energy system to build political support for long-term emissions reduction. That support rests on material benefits derived from the set of technical, regulatory, and market changes required to take emissions out of Europe's energy supply. I argued that the European Commission pursued, over time, a policy strategy of configuring those changes to build supportive constituencies of economic, rather than environmental, interests. Crucially, while the ultimate goal might have been environmental, the Commission approached its task as a problem of industrial policy–of managing both the technical and political challenges of effecting a major sectoral transition in the European economy.

This argument departs from the emphasis on environmental interest groups common to more conventional explanations of climate policy outcomes. Those explanations credit strong environmental policy actors with overcoming the perceived tension between short-term economic gain and long-term environmental stability. As chapter 4 argued, however, that explanation appears very incomplete: it neither provides much explanation for the choice of policy instruments, nor does it explain how diffuse, non-material interest would sustain a complex economic policy in the face of acute opposition. Furthermore, an environmentally-focused explanation runs contrary to the preconditions that have permitted other complex economic reforms to overcome the resistance of well-organized and highly motivated incumbents.

This chapter provides evidence to support the claim that European climate policy choices relied far less on environmentally-motivated legislators than is commonly believed. Despite the European Parliament's reputation as an effective environmental advocate, the data presented here show that Parliament had relatively little influence over the central bargains struck in the 2008 reforms to the European climate and energy policy suite. Throughout the legislative process, the Parliament attempted to make policy more environmentally aggressive, less generous to legacy energy interests, less tolerant of member states' demands for regulatory flexibility, and less explicitly industrial. These attempts largely failed. Instead, in almost every major policy domain, the European Commission's preference for industrial policy prevailed.

The Commission's own statements in the course of the legislative process reinforce the claim that it pursued an integrated strategy for industrial change, rather than a narrowly focused environmental policy. In shepherding its policy agenda through the legislative process, the Commission repeatedly signaled its understanding of emissions reduction as a problem of systems transformation; and its policy prescription as a synthetic approach to technological, regulatory, and economic change. Together, these two developments point strongly towards the conclusion that European climate policy success has relied on a political strategy grounded in the material returns to industrial transformation. Conversely, it has avoided narrower, more environmentally-focused approaches that would have upset the delicate balance of interests at stake.

This evidence points strongly towards the thesis advanced in chapters 3-4: that policy success in the EU came as a result of a politics of issue linkage, wherein the means adopted to pursue a low-emissions energy system were tailored to serve the political task of building support for policy continuity. That support relied less on an affinity for environmental stewardship than it did on the material benefits created by the process of energy systems transformation itself. In doing so, however, that strategy relied on the opportunities and challenges present in Europe's legacy energy systems. That interaction between politics and systems, and the policy choices that flowed from it, suggests that national policy choices may prove successful climate policy strategies, while contributing relatively few lessons for countries with different economies and different energy legacies. The following chapter builds on this argument, demonstrating how these shared interests developed among disparate firms in the European economy.

5.2 The Parliament as an environmental actor

Chapter 4 argued that the policy choices made in the Third Climate and Energy Package (henceforth, the Package) shared both a political and a technical logic. Technically, they constituted a approach to a low-emissions energy systems transformation in Europe. However, European policymakers faced multiple potential pathways to that transformation. Hence technical demands therefore weren't enough to explain why European policymakers chose what instruments they did. Instead, I argued that these choices reflected a specific political logic that sought to yoke long-term action on emissions to short-term material gains for important industrial constituencies. By solving pre-existing problems in the European energy system–such as energy security or economic competitiveness in emerging industries–European policy could help secure industrial support for environmental actions that were otherwise politically unpalatable.

This argument locates the politics of European climate policy in the Commission itself, and in the Commission's attempt to craft a strategy that was both technically plausible and politically viable. But that leaves out the subsequent political process involved in actually passing legislation into law. This omission raises the question of whether this technocratic logic actually underpins European climate policy. Did the Commission's preferred policy design, expressed in its series of papers on European energy strategy, actually translate into law? Or are the distributional and technical outcomes discussed in chapter 4 the result of a more pedestrian process political bargaining, log-rolling, and rent-seeking among varied interests in the course of the legislative process?

This question is particularly important in the EU given the strong role traditionally played by the European Parliament in shaping environmental policy. Despite an array of institutional weaknesses, the Parliament has a strong reputation as an environmental policy advocate. Parliament has typically had a well-represented and organized environmental coalition, including the European Green Party Alliance and the center-left Progressive Alliance of Socialists and Democrats. Environmental policy also faces fewer restrictions on Parliamentary authority than the historically more significant domains of finance, tax, or trade policy. These factors contributed to the Parliament's relative success in both shaping European environmental policy outcomes and setting the European environmental policy agenda (Burns, 2005; Burns and Carter, 2010), though recent European expansion and constitutional reform may have muted this influence somewhat (Burns et al., 2012).

Hence the question of Parliamentary influence over European climate policy addresses two major elements of the argument introduced in chapters 1-4: first, did the technocratic logic of systems transformation truly shape European climate policy; and second, did environmental interests matter in passing and sustaining Europe's climate policy suite? The latter question is particularly salient given the European Green Party Alliance's very strong skepticism of the kind of technocratic solution proposed by the Commission. This is most obvious in the European Green Party Alliance's 2009 manifesto on green growth (European Greens Party, 2009; Schepelmann et al., 2009). There, the Greens display a policy stance skeptical of price-based means of environmental regulation, favorable towards command-and-control mechanisms for forcing environmental improvement, and less tolerant of accommodating the adjustment costs of legacy fossil fuel sectors. Yet the Commission's preferred policy design favored an emissions price, rejected top-down technological mandates, and provided numerous accommodations to legacy economic and energy interests.

Hence the pattern of influence on legislative outcomes reveals a great deal about the genesis of European climate and energy policy. A policy framework substantially shaped by the Parliament would point towards a politics that bore greater influence from raw politics and environmental interests. In contrast, a politics shaped largely by the Commission would point towards industrial policy, as reflected in chapter 6.

5.3 Moving policy forward: the uninformative vote

This background leads to an acute political question: does the record of policy formation reflect a specific intent to design and implement the policy suite at the heart of the Package? It's one thing for the Commission to introduce a synthetic package of reforms; but quite another for those reforms to survive the legislative process unscathed. Hence to what degree did the Parliament, given its environmental credentials, influence the ultimate legislative outcome? Did that outcome depend on the support and advocacy of environmental interests in the Parliament? Were those interests in favor of the policy strategy proposed by the Commission? Or did they attempt to restructure that strategy to better reflect their environmental policy priorities?

Traditional measures of Parliamentary interests, influence, and alignment offer little traction on these questions. Roll-call and plenary voting have been used successfully to identify broad patterns of European policy cleavage and political contestation (Hix et al., 2006). But in this specific case, voting is uninformative. Each of the major bills in the Third Climate and Energy Package passed by a minimum of 87% Yea votes.[1] Furthermore, those Parliamentarians who voted Nay fell largely into two specific groups: Euroskeptics opposed to EU policy in general; and those opposed to the entire policy package because (1) it was insufficiently ambitious and (2) it made use of the "fast track" negotiation procedures to, in the view of some MEPs, usurp Parliamentary authority. To the extent that these MEPs are accurately representing their positions, their disagreements with the bill had little to do with specific policy proposals, and much to do with larger issues at stake in European politics and the relationship between European institutions.

5.4 An alternative approach: tracking legislative influence through text

If votes provide little traction on how and where the Parliament and Commission disagreed, or what influence Parliament did or did not wield over policy choices, then we need to turn to the minutiae of the legislative process itself. Attributing the outcomes of the 2008 climate and energy policy reforms to the technocratic Commission versus the more political and environmental Parliament requires understanding *who* wrote *what* components of each *policy domain*; and where and how different legislative

[1]Votes were as follows: 2007 Internal Market Directive, 588 to 81 (87%); 2007 Renewable Energy Directive, 635 to 25, (96%); 2007 Emissions Trading Scheme reforms, 610 to 60 (91%).

actors *succeeded or failed* in authoring specific legislative language. Establishing this pattern of legislative behavior can provides insight into whether and how the Parliament wanted to, and succeeded at, changing the Commission's policy proposals.

Measuring these processes poses some difficulty. Documentation of the legislative process itself is readily available–in the form of individual bills, committee reports, and legislative proposals. But the European Parliament publishes no standardized concordance that links each element of a final piece of legislation to its origin in these sources. Hence determining who–the Commission the Parliament, or the Council–wrote any given piece of legislative language normally requires very labor-intensive efforts to trace each legislative component back to its origins.

I propose a different approach to this tracing that promises both more efficiency and a the potential to generate new insights into legislative processes. Section 5.8 provides a technical overview of this approach, which Huberty and Sanders (2012) deals with in complete detail. Here, I provide an overview of the methodological approach and its innovations before presenting results in section 5.5. To foreshadow those results, I show that the Parliament attempted, but consistently failed, to push a more environmentally-focused agenda for the the Package. This was consistent with the preferences of the European Greens in particular, who were at the time developing proposals for policy less tolerant of legacy energy interests, more favorable towards alternative energy, more aggressive in its approach to regulatory reform, and more stringent in the requirements placed on member states.(Schepelmann et al., 2009). Hence Parliamentary preferences were, on balance, not necessarily aligned with the Commission's choices focus on using industrial policy to promote issue linkage. By implication, the focus on green parties and environmental interests as agents of European climate policy success must contend with their relative failure to influence policy in this case, and the departure of European policy from some of the Greens' stated policy agenda.

5.4.1 Methodological overview

Quantifying legislative influence requires identifying which legislative actor wrote each section of a final piece of legislation. This measurements point directly to the question of whether and where the European Parliament attempted to modify the Commission's technocratic policy design, and where and how they succeeded in doing so. Earlier studies have traced these patterns of legislative influence through careful hand-matching of legislative precursors, for whom the authors are known, to the final bill, where authors are anonymous. However, this process is laborious, hard to scale, and difficult to replicate.

Treating this problem as analogous to *plagiarism* opens up ways to improve on this process. The authorship of each legislative proposal–the original legislative drafts and amendments–is clear. A final bill is nothing more than a collection of these sources. By implication, final legislation is, effectively, a compilation of direct quotations, without attribution, of some earlier piece of legislative language. Tracing legislative history and influence is therefore a matter of uncovering the pattern of plagiarism that resulted in a final bill.

This insight permits the use of well-understood tools from computational plagiarism detection and document retrieval to aid the construction of a legislative history. Using these tools to help recover the authorship of each component of a final bill permits more regularized, repeatable, and efficient summary of *who* authored *which sections* of a piece of legislation. For contested areas of legislation, this measure points to who ultimately succeeded in inserting their preferred policy language into the statute.

Completing this analysis requires identifying not just which actors wrote what components of a final bill, but also how those components grouped into common policy areas. Doing so permits a detailed consideration of which actors exercised influence over what policy domains, and at what point in the legislative process. For this purpose, the methods here employ computational topic modeling to discover the policy domains from the text of the legislative corpus itself. To do so, I employ Latent Dirichlet Allocation and similar models (Blei et al., 2003) to recover the policy structure of legislation from the legislative text. Assigning each section of a bill both an author, from the plagiarism analysis, and a policy domain, enables the quantification of *which* policy actor influenced *what* policy domains, and to what degree. Figure 5.7 provides a schematic explanation of how data flows through both the topic models and plagiarism tools to identify legislative influence by authorship and policy domain.

5.5 Reforming the ETS: legislative outcomes and Parliamentary influence

This methodological approach permits a straightforward analysis of which legislative actors affected which policy domains, and to what degree, in each of the three major bills in the 2008 European Union climate and energy legislation. Together with the Commission's own statements in the legislative record, the results strongly suggest that the Commission intended the package to be treated as an integrated whole, and for the core policy instruments to function as complementary to one another. The Commission subsequently protected both the package integration and policy complementarity successfully. Parliament did exercise some influence over the final legislative outcomes, but was most successful in policy domains ancillary to the core configuration of policy instruments and goals. Qualitative evidence from the legislative record corroborates this quantitative evidence. These results suggest that the distributional consequences of the Package documented in chapter 4 were clearly understood by the major legislative actors, and represent an attempt to use the instruments of climate policy to generate political support grounded in the material benefits generated by the policy regime.

5.5.1 The 2008 ETS Reforms: strengthening industry protections and expanding scope

The 2008 ETS reforms constituted a package of amendments to the original 2003 Emissions Trading Scheme legislation. These amendments addressed six broad substantive areas of the ETS framework:

1. Updates to sectoral emissions accounting rules, including the expansion of covered sectors to include aviation and broader exceptions for carbon leakage. Aviation was later covered in complete detail under Directive 2008/1010/EC.

2. A move to the use of auctioned rather than freely allocated emissions permits, to reduce the perceived windfall profits resulting from free allocation.

3. Exceptions to auctioning for trade-exposed sectors, as an implicit subsidy for sectors prone to so-called "carbon leakage"

4. Changes to the administrative functioning of the emissions markets

5. More elaborate rules governing emissions accounting for biomass fuels and carbon sequestration projects

6. More elaborate rules governing emissions accounting for electricity production that included co-generation technologies[2]

[2]Co-generation refers to a class of electricity generation plants that generate both steam heat and electricity. By combining both functions, these plants are usually significantly more efficient–up 100% more–than other forms of thermal generation.

7. New rules requiring the use of some revenues from emissions permit auctioning to fund research and development in low-emissions technologies

Figure 5.2 summarizes the authorship of the final ETS reform bill by legislative actor and policy domain. Table 5.1 provides an alternative view of the data presented in that figure. Both views make clear that the Commission retained primary influence over most of the policy domains in the final bill. Parliament proposed amendments to nearly every substantive policy domain, as figure 5.1 makes clear, most of that language went unadopted. Instead, the Parliament exercised primary influence over only a few policy domains, including:

- Domain 1, on installation-level emissions equivalency
- Domain 6
- Domain 16, on the treatment of combined heat and power facilities under the ETS
- Domain 23, on the allocation of revenues from ETS permit auctioning
- Domain 28, on procedural auditing

Further context puts this influence in greater relief. In particular, the Parliament's success at allocating some emissions auctioning revenues to fund renewable energy and energy efficiency technology is attenuated by two realities. First, the bill contains no requirement that those revenues go above and beyond existing commitments; and hence these revenues will likely substitute for, rather than complement, states' existing investment. Second, those revenues will be late in coming in any case, since mandatory auctioning does not go into effect until 2027.

The final ETS bill reflected, instead, a negotiated compromise between the Parliament and Council that followed on Parliament's First Reading. The major points of compromise included:

1. A delayed transition to 100% auctioning, ending in 2027 rather than 2020 as preferred by the Commission and Parliament
2. An escape clause permitting free allocation of permits through 2020 if no international climate change agreement was reached
3. Mandatory allocation of 50% of permit auction revenues for investment in research, development, and deployment of low-emissions technologies; or in carbon sequestration alternatives like reforestation

The outcomes in these domains represent mutual compromises between the Parliament and Council. They especially reflect national concerns that changes to the ETS–in particular the use of permit auctioning in place of free permit allocation–would erode the competitiveness of domestic economies if implemented too quickly, or if adopted without regard for the success or failure of the 2009 COP-15 climate negotiations.

Separately the Parliament did succeed at introducing new language intended to protect consumers from disproportionate price increases resulting from changes in the scope and process of permit allocation. It also introduced conditionality language to the ETS that would strengthen European emissions targets if a binding international agreement on emissions reduction were reached. However, the subsequent failure at both the Copenhagen and Durbin COP conferences to arrive at such a deal has rendered this success largely moot.

None of these changes altered the fundamental goals expressed by the Commission in its green paper. The move to auctioned permits, the expansion of the scope of the ETS, the use of auction funds to support research and development, and other features of the original legislative proposals remained in the final directive; and their provisions could be adopted by some member states even if others elected to avail themselves of extended implementation periods. Finally, while the Parliament had published amendments in its First Reading Report aimed at extending the ETS reforms to accomplish other ends–notably the promotion of renewable energy–those amendments were rejected in the final compromise with the Council. That compromise, moreover, was endorsed by the Commission with reference to its broader legislative goals. In its response to the text of the compromise position, the Commission (The European Commission, 2008a) specifically noted that the amendments contained therein are "acceptable to the Commission in the context of an overall agreement on the climate and energy package."

The 2008 reform of the Emissions Trading Scheme thus preserved its role as both a weak price instrument for emissions control, and a mechanism of fiscal transfer among the member states. Over the long term, the shift from free allocation of permits to auctioning, and the tightening of the permit volume, should reduce some of the rent seeking that took place prior to 2008. But the carve-outs for eastern Europe, energy-intensive industries, and other important economic constituents points to the ongoing role played by the ETS in buffering the distributive consequences of Europe's move to low-emissions energy. The rejection of Parliamentary attempts to make the ETS a stronger environmental instrument point to the limits of emissions pricing as a politically-sustainable environmental policy instrument. Instead, the Commission looked elsewhere for instruments to improve energy efficiency, reform energy markets, and foster the adoption of renewable energy.

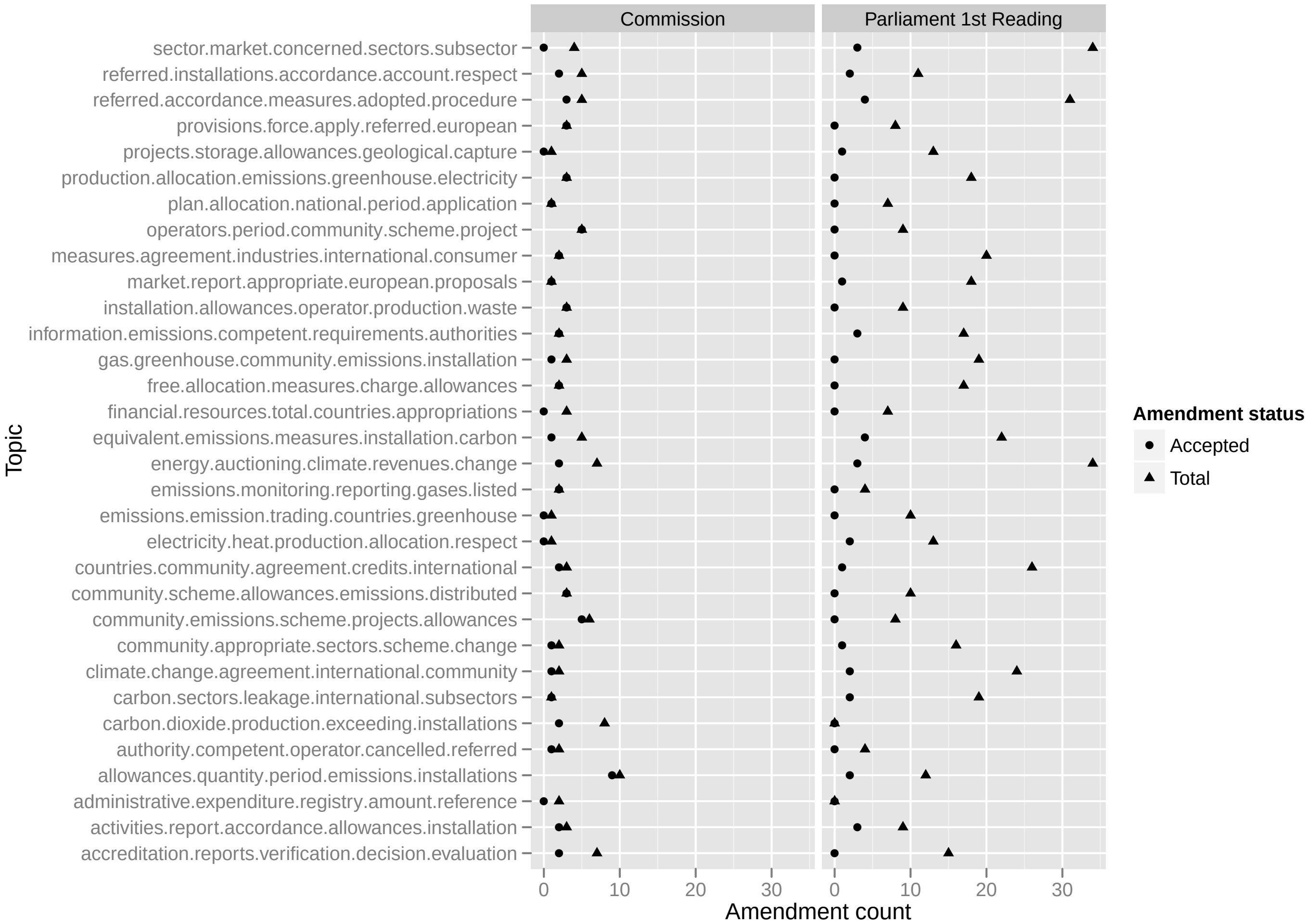


Figure 5.1: Record of proposed and accepted amendments from the Commission and Parliament during the legislative process for Emissions Trading reforms in the Third Climate and Energy Package. Counts refer to bill sections, nominally paragraphs, rather than complete amendments. Topics derived from Latent Dirichlet Allocation as applied to the entire set of potential and actual bill sections.

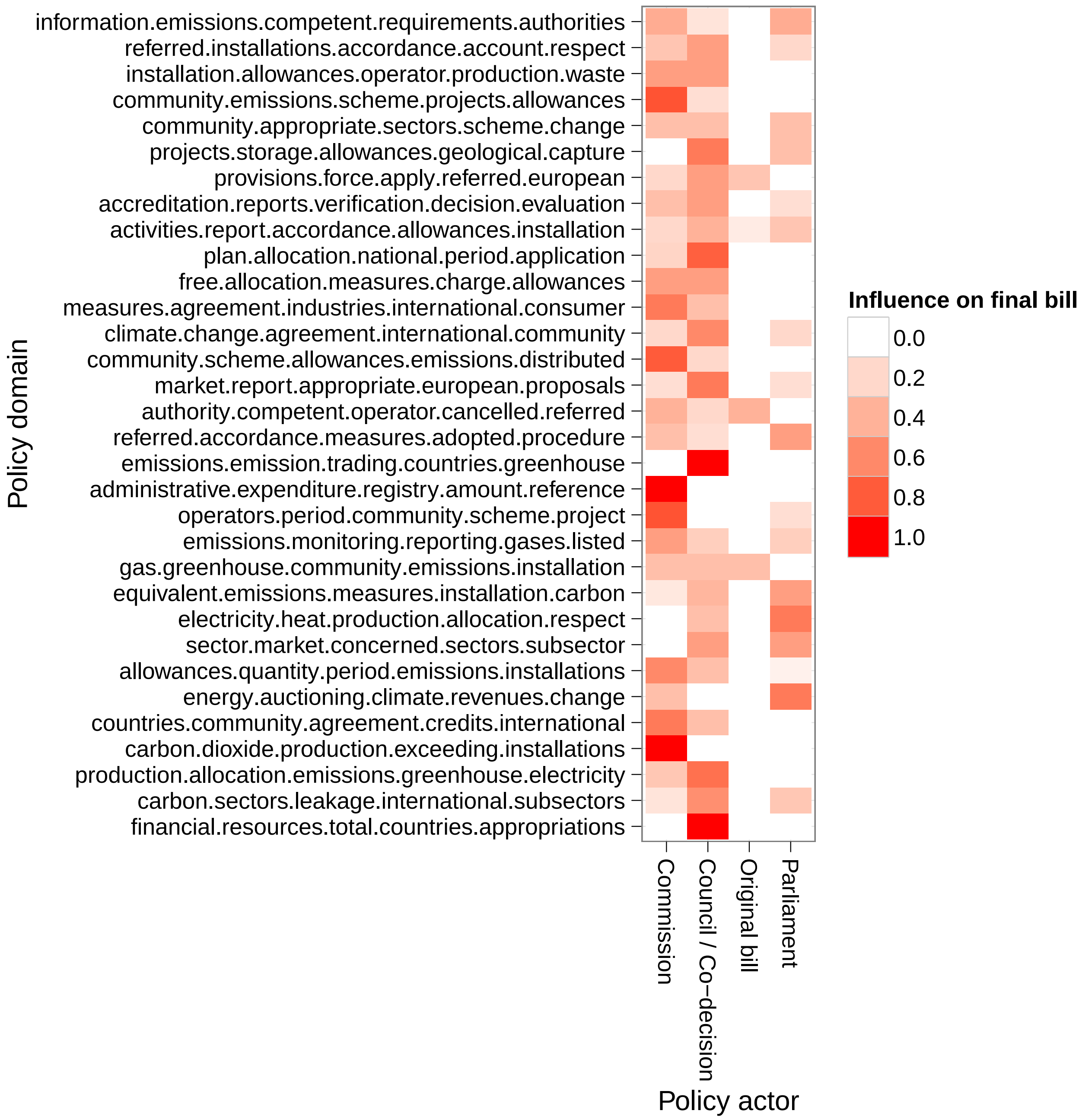


Figure 5.2: Contributions to the 2008 Emissions Trading Scheme directive by legislative actor. Contributions attributed to the "Final" outcome reflect additions to the approved legislation not attributable to identified legislative actors. These reflect in particular compromises undertaken at the behest of the Council. Topics derived from Latent Dirichlet Allocation as applied to the entire set of potential and actual bill sections. See figure 5.7 for a schematic explanation of how these data are generated.

Table 5.1: Origin of content in 2008 Emissions Trading System Directive by legislative actor. Shaded rows indicate policy domains where the Parliament accounted for the plurality of content in the final bill.

Topic Words	Topic	Commission	Final	Original	Parliament 1st Reading
equivalent.emissions.measures.installation.carbon	1	0.12	0.38	0.00	0.50
referred.installations.accordance.account.respect	2	0.30	0.50	0.00	0.20
community.scheme.allowances.emissions.distributed	3	0.80	0.20	0.00	0.00
authority.competent.operator.cancelled.referred	4	0.40	0.20	0.40	0.00
community.emissions.scheme.projects.allowances	5	0.83	0.17	0.00	0.00
sector.market.concerned.sectors.subsector	6	0.00	0.50	0.00	0.50
plan.allocation.national.period.application	7	0.22	0.78	0.00	0.00
provisions.force.apply.referred.european	8	0.20	0.50	0.30	0.00
financial.resources.total.countries.appropriations	9	0.00	1.00	0.00	0.00
administrative.expenditure.registry.amount.reference	10	1.00	0.00	0.00	0.00
countries.community.agreement.credits.international	11	0.67	0.33	0.00	0.00
emissions.monitoring.reporting.gases.listed	12	0.50	0.25	0.00	0.25
activities.report.accordance.allowances.installation	13	0.20	0.40	0.10	0.30
measures.agreement.industries.international.consumer	14	0.67	0.33	0.00	0.00
carbon.sectors.leakage.international.subsectors	15	0.14	0.57	0.00	0.29
electricity.heat.production.allocation.respect	16	0.00	0.33	0.00	0.67
operators.period.community.scheme.project	17	0.83	0.00	0.00	0.17
emissions.emission.trading.countries.greenhouse	18	0.00	1.00	0.00	0.00
market.report.appropriate.european.proposals	19	0.17	0.67	0.00	0.17
allowances.quantity.period.emissions.installations	20	0.60	0.33	0.00	0.07
climate.change.agreement.international.community	21	0.20	0.60	0.00	0.20
carbon.dioxide.production.exceeding.installations	22	1.00	0.00	0.00	0.00
energy.auctioning.climate.revenues.change	23	0.33	0.00	0.00	0.67
community.appropriate.sectors.scheme.change	24	0.33	0.33	0.00	0.33
gas.greenhouse.community.emissions.installation	25	0.33	0.33	0.33	0.00
production.allocation.emissions.greenhouse.electricity	26	0.29	0.71	0.00	0.00
free.allocation.measures.charge.allowances	27	0.50	0.50	0.00	0.00
referred.accordance.measures.adopted.procedure	28	0.33	0.17	0.00	0.50
information.emissions.competent.requirements.authorities	29	0.43	0.14	0.00	0.43
projects.storage.allowances.geological.capture	30	0.00	0.67	0.00	0.33
installation.allowances.operator.production.waste	31	0.50	0.50	0.00	0.00
accreditation.reports.verification.decision.evaluation	32	0.33	0.50	0.00	0.17

5.5.2 The 2008 internal market package

While the ETS reforms dealt most explicitly with the environmental goals of the Package, the Internal Market Directive updated European regulation of electricity and gas markets and incentives for energy market liberalization and integration. These updates were intended to address ongoing problems of monopoly power and market rigidity identified in an earlier series of Commission reports (The European Commission, 2005a,b). Compared to the Second Internal Market Directive, passed in 2003, the resulting Third Internal Market Directive updated eight broad policy domains:

1. More explicit requirements on the unbundling of ownership and control in firms operating vertically-integrated generation, transmission, and distribution systems

2. Expanded protections for consumers and new market entrants, including specific requirements for contract dispute resolution

3. Rules governing the supervisory board and administrative structures of transmission and distribution systems operators

4. Rules governing public service obligations for system operators

5. Rules for cross-border cooperation and regional energy systems integration

6. Rules governing capacity management and third-party generator access in transmission and distribution grids

7. Rules for regulatory oversight of systems operators by the Commission, the newly-created ENTSO-E[3] European grid regulatory body, and national-level regulators

[3]European Network of Transmission System Operators-Electricity

8. Rules governing system operator responsibilities and rights with respect to power system management and access restrictions

Within these changes, Parliament contested two outcomes in particular. First, the Commission draft permitted member states flexibility in choosing how to unbundle their vertically-integrated national energy utilities. Under the Commission's language, unbundling could occur formally, by breaking up and selling off such firms' generation, transmission, and distribution assets; or administratively, by separating a firm's assets and management structures under an umbrella holding company. In doing so, the Commission permitted firms and member states substantial flexibility to determine how best to police the market power of legacy public utility monopolies.

The Parliament preferred a more aggressive solution to policing monopoly power, fearing that the Commission's approach was too weak to achieve Europe's environmental goals. By granting discretion to incumbents with strong incentives to favor their own (fully-depreciated) fossil fuel power sources, Parliament thought the Commission proposal risked slowing the expansion of low-emissions energy. Consequently, the Parliament introduced a series of amendments attempting to force physical breakup of legacy energy utilities. In its First Reading Report, these amendments were justified as a cleaner solution that required less regulatory oversight; and as a means of promoting new entrants into moribund national energy markets.

Both the Commission and the Council rejected this attempt. Instead, the final directive emphasized regulatory responsibility and oversight of the maangement of integrated companies, rather than the formal separation of ownership and control. The data in table 5.2 makes this clear. The eventual resolution over the responsibilities of boards of directors (domain 34) and management (domain 23) in integrated companies, and the role of compliance officers in policing internal violations of legal unbundling rules (domain 26) were written largely by the European Council. In the Council, France in particular sought to minimize disruption to its national energy utility, Electricitè de France–which, as it repeatedly argued, already generated most of its electricity from emissions-free nuclear power. Germany also resisted the breakup mandates, reflecting the desires of its large regional energy utilities and their large industrial customers. The preference for a cleaner environmental solution lost out to the demands of market incumbents.

Parliament also attempted to introduce language in its First Reading Report requiring priority connection of renewable energy sources to the power grid, except in cases where this would endanger systems stability. As with its unbundling amendments, this would have made the Package more supportive of renewable energy in general, and would have limited the ability of incumbent system operators to use their market power to slow the transition to a low-emissions energy system. The Commission was once again opposed to the Parliament's proposals. However, in doing so they signaled their understanding of the policy problem as one of synthetic policy change within a package of reforms. In testimony before the Parliament, Energy Commissioner Andre Piebalgs indicated that the Commission supported the objective, but preferred that it be dealt with in the renewable energy legislation directly.(The European Parliament, 2008a)

The Parliament did succeed in shaping policy elsewhere, particularly in policy domains not directly related to either the structure of energy markets or the promotion of alternative energy. As figure 5.4 and table 5.2 shows, Parliament shaped much of the content of policy for dispute resolution (domain 7), consumer protection (domain 17), regulatory compliance (domain 26) and network investment planning (domain 35). Those areas stand out from the suite of amendments introduced by the Parliament to alter nearly every other facet of the Commission's original legislative proposal, as shown in figure 5.1.

Thus the Commission wrote, and retained influence over, the central reform of Europe's internal energy market regulation: opening access to the power grid, expanding cross-border integration of European energy markets, and focusing investment on relieving energy security bottlenecks.[4] The Parliament's most significant contributions came in not in these core areas, but instead in areas of consumer protection and grid investment. Finally, in several instances, the Parliament and the Commission remained aligned on broader goals, even if the Commission opposed specific amendments on the grounds that they belonged elsewhere in the integrated climate and energy package.

[4]The Commission did not, however, secure guaranteed funding for infrastructure investments. Energy Commissioner Öttinger would later return to the Parliament with a proposal for €1 trillion of investment over the 2010-2020 period.(The European Commission, 2010c) However, that proposal came amidst increasing chaos in European financial and monetary markets and was not prioritized by the Member States at that time.

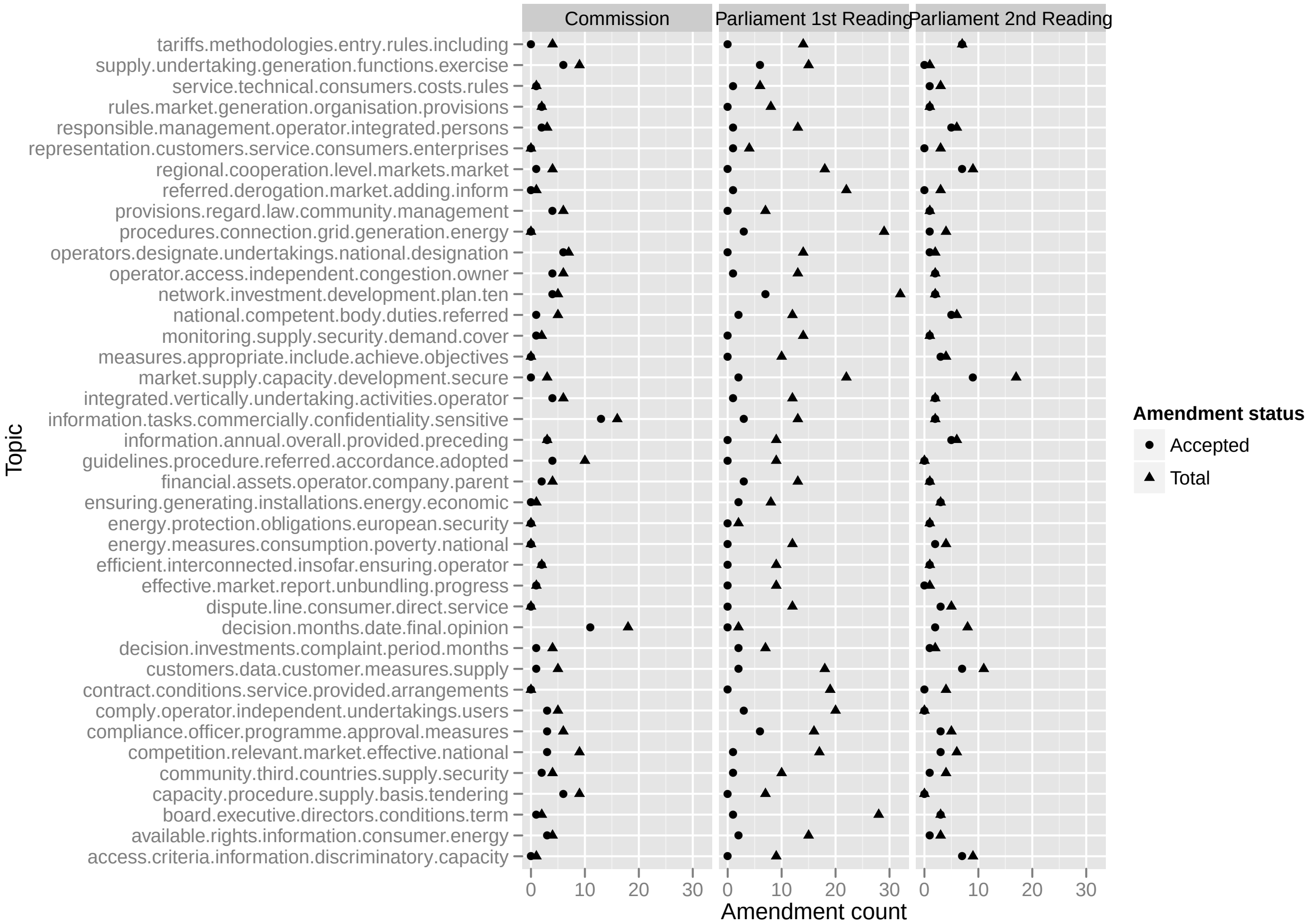


Figure 5.3: Record of proposed and accepted amendments from the Commission and Parliament during the legislative process for Internal Electricity Market reforms in the Third Climate and Energy Package. Counts refer to bill sections, nominally paragraphs, rather than complete amendments.

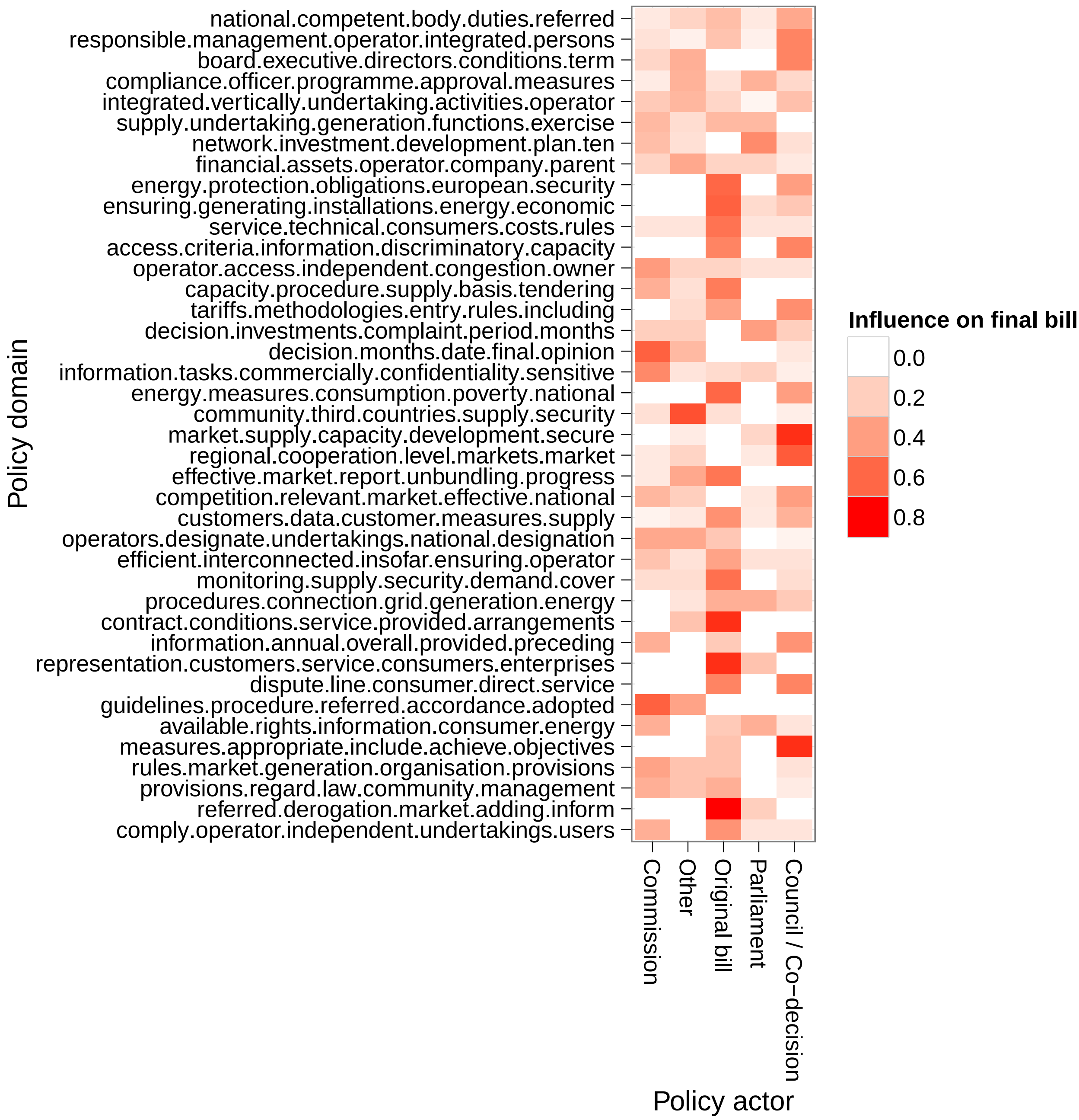


Figure 5.4: Contributions to the 2008 Internal Electricity Market Directive by legislative actor. Contributions attributed to the "Final" outcome reflect additions to the approved legislation not attributable to identified legislative actors. These reflect in particular compromises undertaken at the behest of the Council. See figure 5.7 for a schematic explanation of how these data are generated.

Table 5.2: Origin of content in 2008 Internal Market Directive by legislative actor. Shaded rows indicate policy domains where the Parliament accounted for the plurality of content in the final bill.

Topic Words	Topic	Commission	Final	Original	Parliament 1st Reading	Parliament 2nd Reading
information.annual.overall.provided.preceding	1	0.33	0.00	0.22	0.00	0.44
decision.investments.complaint.period.months	2	0.20	0.20	0.00	0.40	0.20
tariffs.methodologies.entry.rules.including	3	0.00	0.15	0.38	0.00	0.46
ensuring.generating.installations.energy.economic	4	0.00	0.00	0.62	0.15	0.23
comply.operator.independent.undertakings.users	5	0.33	0.00	0.44	0.11	0.11
operator.access.independent.congestion.owner	6	0.41	0.18	0.18	0.12	0.12
dispute.line.consuamer.direct.service	7	0.00	0.00	0.50	0.00	0.50
effective.market.report.unbundling.progress	8	0.09	0.36	0.55	0.00	0.00
guidelines.procedure.referred.accordance.adopted	9	0.62	0.38	0.00	0.00	0.00
access.criteria.information.discriminatory.capacity	10	0.00	0.00	0.50	0.00	0.50
rules.market.generation.organisation.provisions	11	0.38	0.25	0.25	0.00	0.12
information.tasks.commercially.confidentiality.sensitive	12	0.48	0.11	0.15	0.19	0.07
customers.data.customer.measures.supply	13	0.05	0.09	0.45	0.09	0.32
provisions.regard.law.community.management	14	0.33	0.25	0.33	0.00	0.08
contract.conditions.service.provided.arrangements	15	0.00	0.25	0.75	0.00	0.00
efficient.interconnected.insofar.ensuring.operator	16	0.25	0.12	0.38	0.12	0.12
available.rights.information.consumer.energy	17	0.33	0.00	0.22	0.33	0.11
regional.cooperation.level.markets.market	18	0.09	0.18	0.00	0.09	0.64
capacity.procedure.supply.basis.tendering	19	0.33	0.13	0.53	0.00	0.00
supply.undertaking.generation.functions.exercise	20	0.29	0.14	0.29	0.29	0.00
community.third.countries.supply.security	21	0.13	0.67	0.13	0.00	0.07
competition.relevant.market.effective.national	22	0.30	0.20	0.00	0.10	0.40
responsible.management.operator.integrated.persons	23	0.12	0.06	0.25	0.06	0.50
representation.customers.service.consumers.enterprises	24	0.00	0.00	0.75	0.25	0.00
measures.appropriate.include.achieve.objectives	25	0.00	0.00	0.25	0.00	0.75
compliance.officer.programme.approval.measures	26	0.08	0.32	0.12	0.32	0.16
energy.measures.consumption.poverty.national	27	0.00	0.00	0.60	0.00	0.40
financial.assets.operator.company.parent	28	0.18	0.36	0.18	0.18	0.09
market.supply.capacity.development.secure	29	0.00	0.08	0.00	0.17	0.75
referred.derogation.market.adding.inform	30	0.00	0.00	0.80	0.20	0.00
national.competent.body.duties.referred	31	0.09	0.18	0.27	0.09	0.36
integrated.vertically.undertaking.activities.operator	32	0.22	0.30	0.17	0.04	0.26
decision.months.date.final.opinion	33	0.62	0.29	0.00	0.00	0.10
board.executive.directors.conditions.term	34	0.17	0.33	0.00	0.00	0.50
network.investment.development.plan.ten	35	0.27	0.13	0.00	0.47	0.13
operators.designate.undertakings.national.designation	36	0.36	0.36	0.23	0.00	0.05
energy.protection.obligations.european.security	37	0.00	0.00	0.60	0.00	0.40
monitoring.supply.security.demand.cover	38	0.14	0.14	0.57	0.00	0.14
procedures.connection.grid.generation.energy	39	0.00	0.11	0.33	0.33	0.22
service.technical.consumers.costs.rules	40	0.11	0.11	0.56	0.11	0.11

5.5.3 The 2008 renewable energy mandates

Finally, the 2008 renewable energy reforms sought to resolve two specific problems created by the prior renewable energy directive, passed in 2001: the lack of binding targets for adoption, and the weak criteria for what counted as renewable energy. To do so, the new directive mandated legally binding commitments to specific levels of renewable energy adoption, backed by detailed national action plans specifying how each member state would meet its obligations. Alongside these mandates, the reforms strengthened the criteria for what counted as renewable energies, paying particular attention to the sustainability of biofuels and biofuel feedstocks. In pursuing these changes, the Commission was quite clear that it had multiple goals in mind. The 2007 Renewable Energy Roadmap (The European Commission, 2006b), which formed an input to the eventual legislative proposal, articulated a specific vision of renewable energy promotion as a program of both environmental and economic improvement:

> In the complex picture of energy policy, the renewable energy sector is the one energy sector which stands out in terms of ability to reduce greenhouse gas emissions and pollution, exploit local and decentralized energy sources, and stimulate world-class high-tech industries.

These three policy goals–emissions reduction, energy security, and competitiveness–remain largely untouched as the Commission's policy proposals progressed through the subsequent legislative process.

Compared with the other two bills considered in this chapter, Parliament exercised a particularly large degree of influence over the content of the renewable energy directive. As figure 5.5, shows, Parliament proposed amendments in nearly every policy domain covered in the final bill. The final bill subsequently adopted many of them, in the form of a compromise text negotiated by the Parliament and Council on the basis of the Parliament's First Reading Report. As figure 5.6 and table 5.3 show, Parliament had substantial influence over biofuel sustainability criteria, the requirements surrounding national renewable energy targets (though not the targets themselves), grid access for renewable electricity, the impact of European renewable energy demand on third countries, and the use of renewable energy in transport.

Despite this success, however, many of these represented second-best outcomes for the Parliament. The First Reading Report clearly shows that the Parliament had desired different outcomes in many respects. In particular, it had hoped to cap the use of biofuels out of concern for their environmental damage; it wanted to grant the Commission stronger regulatory oversight of national renewable energy action plans; and it sought greater European-level authority over regulation of and investment in renewable energy access to the electrical grid. The Parliamentary rapporteur, Claude Turmes of the Green Party in Luxembourg, expressed some regret that these positions–and in particular the biofuels limits–did not make it into the final legislation (EurActiv, 2008).

5.6 The 3rd Climate and Energy Package and European legislative politics

This analysis of the legislative process surrounding the 3rd Climate and Energy Package suggests specific intent by the Commission to craft an integrated approach to energy systems transformation. At various points in the legislative process, the Commission clearly expressed a view of its policy reforms as an integrated and complementary approach to restructuring Europe's energy system and dealing with climate change. For renewable energy policy in particular, the Commission made explicit the link between investing in emissions reduction and improvements to energy security,

Table 5.3: Origin of content in 2008 Renewable Energy Directive by legislative actor. Shaded rows indicate policy domains where the Parliament accounted for the plurality of content in the final bill.

Topic Words	Topic	Commission	Final	Original	Parliament 1st reading
electricity.produced.production.excess.cogeneration	1	0.33	0.67	0.00	0.00
heat.energy.consumption.pumps.purposes	2	0.57	0.00	0.00	0.43
national.renewable.energy.action.measures	3	0.18	0.27	0.00	0.55
solar.installation.training.systems.pipe	4	0.83	0.17	0.00	0.00
targets.joint.interim.mandatory.national	5	0.00	1.00	0.00	0.00
energy.renewable.heating.cooling.sources	6	0.36	0.24	0.00	0.40
system.transmission.electricity.operators.distribution	7	0.33	0.11	0.22	0.33
bioliquids.biofuels.purposes.account.referred	8	0.55	0.18	0.00	0.27
costs.producers.grid.discriminatory.objective	9	0.33	0.33	0.00	0.33
reports.analyse.purpose.local.resources	10	0.50	0.50	0.00	0.00
renewable.energy.infrastructure.development.sources	11	0.00	0.25	0.00	0.75
food.generation.biofuels.target.security	12	0.00	1.00	0.00	0.00
energy.renewable.sources.promotion.framework	13	0.14	0.00	0.00	0.86
carbon.land.emissions.stock.unit	14	0.33	0.44	0.00	0.22
effects.production.energy.regional.community	15	0.20	0.60	0.00	0.20
compliance.national.amount.measuring.requirements	16	0.12	0.33	0.00	0.54
support.schemes.scheme.national.energy	17	0.33	0.50	0.00	0.17
solar.certification.schemes.installers.criteria	18	0.25	0.50	0.00	0.25
including.process.content.residues.calculation	19	1.00	0.00	0.00	0.00
agricultural.production.list.raw.emissions	20	0.50	0.00	0.00	0.50
emissions.transport.fuel.distribution.processing	21	0.25	0.50	0.00	0.25
production.transport.environmental.imports.benefits	22	0.17	0.83	0.00	0.00
biomass.energy.fuels.transport.biofuels	23	0.64	0.00	0.00	0.36
gas.greenhouse.emission.fuel.saving	24	0.83	0.08	0.00	0.08
training.provider.practical.including.programme	25	0.83	0.00	0.00	0.17
values.default.land.raw.cultivation	26	0.46	0.23	0.00	0.31
purposes.international.schemes.standards.production	27	0.33	0.33	0.00	0.33
energy.share.renewable.sources.consumption	28	0.38	0.25	0.00	0.38
systems.energy.equipment.promote.technical	29	1.00	0.00	0.00	0.00
energy.renewable.transport.community.development	30	0.00	0.50	0.00	0.50
buildings.energy.heating.cooling.minimum	31	0.67	0.00	0.00	0.33
countries.third.country.convention.concerning	32	0.20	0.40	0.00	0.40
indicative.trajectory.transfer.system.measures	33	0.50	0.00	0.00	0.50
origin.guarantees.transfer.competent.accounting	34	0.40	0.60	0.00	0.00
regulatory.adopted.essential.procedure.referred	35	0.18	0.36	0.00	0.45
oil.ethanol.gas.wood.vegetable	36	1.00	0.00	0.00	0.00
energy.renewable.sources.produced.guarantee	37	0.45	0.36	0.00	0.18
land.significant.forest.human.natural	38	0.00	0.25	0.00	0.75
report.referred.european.national.proposals	39	0.18	0.71	0.00	0.12
biofuels.effect.provided.bioliquids.criteria	40	0.75	0.25	0.00	0.00
local.planning.regional.suppliers.consumers	41	0.25	0.12	0.00	0.62
table.filled.stroked.operational.installation	42	0.25	0.42	0.08	0.25
notification.period.letter.months.accordance	43	0.00	0.36	0.00	0.64
information.economic.require.referred.operators	44	0.33	0.67	0.00	0.00
sustainability.verification.methods.criteria.consignments	45	0.50	0.33	0.00	0.17
produced.plants.generated.biomass.electricity	46	0.50	0.25	0.25	0.00
procedures.administrative.authorisation.energy.renewable	47	0.27	0.09	0.09	0.55

economic growth, technological innovation, and other near-term benefits.

Where Parliament attempted to alter that package to make European policy more environmentally aggressive, less tolerant of legacy energy interests, or more narrowly focused on climate change mitigation, it largely failed. Instead, apart from the sovereignty concerns of the European Council, the Commission's policy proposals–and their industrial policy essence–largely came through unscathed.

This legislative record is particularly striking given the Parliament's reputation as a strong and often quite effective advocate for environmental issues. Parliament's influence on many areas of policy–notably finance and taxation–had historically been highly constrained by both institutional rules and member state prerogatives. But on environmental issues, the Parliament had attained a reputation among observers as an effective policy actor (Tsebelis, 1999; Burns, 2005). The co-decision procedure afforded the Parliament greater influence over environmental policy, which it exercised to influence both individual pieces of legislation and longer-term European policy objectives.[5] In practice, Parliament used its authority, sometimes in collusion with the Commission, to push European policy on automobile emissions, chemical regulation, international leadership, and other environmental issues.

A series of recent studies (Burns and Carter, 2010; Burns et al., 2012) have argued that that Parliament's environmental credentials may have weakened over time. Evidence from the 6th European Parliament (2004-2009) points to a Parliament that submits fewer environmentally-ambitious amendments, and sees fewer of those amendments adopted in final legislation. Possible explanations for this decline include a less pliable European Council; more aggressive industrial lobbying of the Parliament; an increased Parliamentary workload, leading to a reduced appetite for legislative con-

[5] Co-decision, which made the Parliament an institutional equal with the Council in its ability to amend and veto legislation, was introduced in the 1992 Maastricht Treaty. But the legislative domains governed under co-decision remained narrowly constrained. The Treaty of Amsterdam, which went into effect in 1999, expanded co-decision to cover nearly all policy domains.

flicts with the Commission and Council; the enlargement of Europe to include less environmentally-friendly central and eastern European states; and the declining influence of the center-left Party of European Socialists, who had supported environmental issues more aggressively than their center-right counterparts the European People's Party.

While the evidence presented for the Third Climate and Energy package is broadly consistent with declining "green" ambitions in the Parliament, it also points to a more nuanced view of Parliament's power to pass environmentally-ambitious amendments. As we have seen, the Parliament did propose, in many cases, more aggressive legislative language on core climate and energy policy issues. In amendments proposed at the First Reading stage, Parliament sought more stringent requirements for renewable energy adoption, less flexibility for energy market reforms, greater funds allocation to clean technology research and development, and stricter regulation of biofuels and the effect of biofuels on food security.

The evidence presented here shows that those amendments were most successful where they focused on environmental and consumer protection issues with limited impact on the broader evolution of Europe's energy system. Thus Parliament succeeded at securing better consumer protection in liberalized energy markets, stricter definitions for sustainable biofuels, and the diversion of emissions permit auction revenues to clean technology research and development.

But Parliament was less successful when its amendments touched more explicitly on economic and industrial policy problems. Capping the use of biofuels had to give way to regulating their impact. Mandating the formal breakup of national energy monopolies gave way to a less aggressive compromise that permitted weaker administrative solutions to policing monopoly power. Mandated grid access for renewable energy gave way to a requirement that countries publish clear and impartial rules for all energy providers. In each case, reforms of economic and industrial policy that would make it more environmentally aggressive ran into serious opposition from the Council or the Commission.

Thus even though the Third Climate and Energy package constituted environmental policy broadly conceived, its content varied widely. Parliament's effectiveness as an environmental advocate varied with it. These results suggest an another possible explanation for the perceived decline in Parliament's environmental influence. Climate and energy policy presents one instance wherein broadening ambitions for environmental policy bleed over into more traditional economic and industrial policy concerns. Where policy touches most directly on those concerns, Parliament appears to have less latitude to push environmentally-ambitious legislative language. But where policy remains narrowly focused on environmental issues, Parliament appears to have retained its influence as an environmental advocate. In short, we may be witnessing not a decline in Parliamentary environmental ambition, but instead the collision of that ambition with the mixing of environmental and economic policy. Parliament's environmental influence has waned where that mixing is most pronounced, but persisted otherwise.

5.7 Conclusions: Systems transformation, legislative politics, and the 3rd climate and energy package

This chapter has made three overarching arguments. First, building on the preceding chapters, it argued that the structure of the Third Climate and Energy package constituted a coherent attempt to craft a technical and political strategy for a low-emissions energy systems transformation. Second, it argued that the legislative record provides strong evidence of that intent, and in particular the Commission's success at preventing the Parliament from altering the core priorities of the package as a whole. Finally, it argued that these results pointed to a more nuanced view of the European Parliament's evolving role in environmental legislation: that the Parliament retains influence on more narrowly environmental questions, but has performed less well where broad legislative packages confront more explicitly economic or industrial policy questions.

These arguments align with the central propositions of chapters 3 and 4. The Commission's statements in its 2007 green paper on energy strategy (The European Commission, 2007) reflect a view that effective climate change mitigation will require the broader transformation of Europe's energy systems. That goal poses both a technical and a political problem: how to satisfy, or at least mollify, the multitude of competing industrial interests that would win or lose from a large-scale systems transformation, while accomplishing the tasks required for transformation itself. As chapter 6 showed, the structure of European industrial interests suggested an out. Linking long-term progress on emissions to tasks that would deliver near-term returns to energy security, industrial competitiveness, or economic efficiency opened up the possibility for broader coalition-building, even among interests otherwise opposed on long-term climate strategy.

The Third Climate and Energy Package put that view into practice in a multi-instrument policy framework. As the Commission stated explicitly throughout the legislative process, that framework intended for policy instruments to serve multiple ends: emissions reduction, innovation, and competitiveness for renewable energy; improved market efficiency and reduced barriers for new entrants via electricity market liberalization; emissions control and protection of exposed heavy industry via the Emissions Trading Scheme. Furthermore, while the package was submitted as a series of legislative proposals, the Commission stated repeatedly that the bills were intended to operate together; and fought attempts to re-purpose one bill in service of goals handled by policy proposals contained in another.

Finally, these outcomes suggest the utility of combining qualitative analysis of the legislative record with novel computational approaches to understanding legislative history. The tools presented here offer analysts the chance to make sense of large volumes of legislative data, and to build new analyses on this data using tools from computational text analysis. In this case, these tools suggested a more nuanced characterization of Parliament's changing influence on environmental policy outcomes in the European Union. They also point to the need for greater attention to the diversity of policy domains contained under a single legislative umbrella. These results suggest the potential gains available from applying these and similar tools to larger corpora of European legislation.

This chapter leaves open, however, the question of how the Commission managed to craft its policy choices in the first place. The Commission's success at linking environmental outcomes to industrial policy depends, as chapters 3-4 argued, on the qualities of Europe's legacy energy systems. It also assumes that the European economic actors operating within that system held interests amenable to the linkage of environmental goals to economic outcomes. The next chapter turns to this intersection of structure and interests, showing that the Commission could and did capitalize on the opportunities Europe's legacy energy system created for yoking support for environmental outcomes to the realization of industrial benefits from systems transformation.

5.8 Appendix: data and methodological approach

This appendix provides a more formal overview of the methods used to generate the results discussed in section 5.5. For a complete discussion of the methods themselves, see Huberty and Sanders (2012). For code implementing the workflow discussed below, see https://github.com/markhuberty/leghist.

5.8.1 The need for methodological innovation in legislative analysis

As section 5.4 elaborated, establishing the fine-grained influence of legislative actors on legislative outcomes is often confounded by the lack of a careful concordance between legislative proposals and legislative outcomes. Instead, amendments are voted on and incorporated into the legislation without citation. Absent this detail, building a detailed legislative history requires carefully tracing legislative content and comparing it to the record of proposed legislative language.

This form of manual tracing of legislative history is laborious, prone to error, and difficult to scale. Tsebelis et al. (2001), for instance, code more than 5000 amendments by hand to identify how the procedural setting of European legislation affects Parliamentary influence. The effort exerted here was impressive. Their coding scheme identified both the success of the amendment (whether it was adopted or not) and the degree of incorporation (on a scale from "modified" to "adopted verbatim"). But 5000 amendments ultimately only cover 231 bills over a 10-year period, for a Parliament that considered 108 regulations, decisions, or directives in 2011 alone.[6] Scaling manual methods to match the increased Parliamentary activity that has followed on the Treaties of Amsterdam, Nice, and Lisbon thus poses challenges.

Computer-assisted textual analysis offers one potential solution. The central task of establishing a detailed legislative history–matching final legislation to its origins in the legislative record, and the actors who wrote it–can be treated as a problem of document retrieval: given a corpus of texts, identify definite or likely duplicates or overlaps within that corpus (Elmagarmid et al., 2007). Applications include email and

[6] Data taken from the published statistics of the European Parliament, at http://eur-lex.europa.eu/en/statistics/index.htm.

email attachment de-duplication for efficient storage. In this case, we face a specific version of this problem, akin to plagiarism detection: given a document, identify exact or partial duplicates of each section of that document given a corpus of possible sources. Here the document is the final bill, and the sources are comprised of the original bills, amendments, and other potential sources in the legislative process.

At present, however, no automated methods for studying legislative history are known to exist. Some projects, such as the ManyBills project at IBM or the LobbyPlag project on Europe's General Data Protection Regulation, have applied computer-assisted tools to summarize legislation and improve access for non-specialists.[7] But these do not attempt to identify the origin or author of the components of finalized legislation. They also focus on specific bills, rather than on general solutions that might be applied to an entire legislative corpus.

To fill this gap, I propose computer-assisted, semi-automated methods for the analysis of legislative history. The methods proposed here assist analysts in an array of tasks, including:

1. Identifying the origin of each section of a bill from set of potential amendments and proposed legislation
2. Modeling the policy topics raised by the bills and amendments
3. Tabulating the rates of acceptance or rejection for content proposed by each legislative actor
4. Identifying the emergence of new policy domains within a bill during the legislative process
5. Identifying portions of the final bill with no clear origin, suggestive of the influence of negotiated outcomes or the influence of legislative actors with limited

[7]On ManyBills, see http://manybills.researchlabs.ibm.com/. For LobbyPlag and its ParlTrack companion, see http://lobbyplag.eu/#/compare/overview.

disclosure requirements

Formally, we may consider a piece of legislation as a document D composed of I sections d_i. The legislative process begins with an initial bill D_1, and concludes with a successful bill D_2. During the legislative process, J amendments $a_j \in A_J$ are proposed by some set of legislative actors L, of which $A_K, 0 \leq K \leq J$ are adopted. For $D_1, D_2,$ and A_J, we assume that the sections $d_{1,i}, d_{2,i}$, and a_j are all at the same level of dis-aggregation. The analysis presented in this chapter assumes sections are equivalent to paragraphs, consistent with the structure of proposed amendments in the European Parliament. But the tools themselves are agnostic to the level of dis-aggregation.

We consider three possible legislative processes, in increasing order of complexity. For the simple case, the final bill is a verbatim combination of the proposed bill and the proposed amendments. Every section of the final bill D_2 was originally either a section of D_1 or an amendment. We can represent that process as a mapping function $f(\cdot)$, such that $D_2 = f(D_1, A_J)$. The challenge is to identify the sections of the original bill and the amendments that comprise the final bill.

To find the origin of each section of the final bill, we can thus define a similarity measure S to permit comparison between the final bill and its potential origins. For simplicity, we assume that $S \in [0, 1]$. For each final section $d_{2,i}$ we construct a similarity vector s_i between all possible matches in D_1, A_J. The best match is thus $d \in arg \max_{s_i} S(D_1, A_J)$. Under the assumption that S is well-ordered, we can use nearest-neighbor matching, since for each $d_{2,i}$ there is one and only one best match. Here, similarity is defined as the cosine similarity between between the term-frequency vector of the final bill section and the term-frequency matrix of all candidate matches.[8]

[8]Cosine similarity implicitly measures the cosine of the angle between two vectors in an N-dimensional space. Formally, for two term-frequency vectors A and B, the cosine similarity $S =$

Adding complexity, we note that amendments may be modified between their drafting and final inclusion in a bill. This could occur for at least two reasons. First, the specific format could change: amendments proposed as one paragraph may be split into two, or vice-versa. Second, formal language, such as dates or cross-references, may change to reflect more current information.

We anticipate the first aspect of this complexity–splitting or combining–through nearest-neighbor matching with replacement. A continuous similarity measure S ensures that we do not require perfect matches, only the best match out of a set. By allowing each amendment to match to multiple sections in the final bill, we handle cases where amendments were split up (and thus the first half of an amendment matches one section, while the second half matches a different section). The second aspect of this complexity–subtle changes to formal legislative language–is implicitly handled by choosing a similarity measure S that permits fuzzy rather than exact matching.

We face a third complication: many legislative processes allow amendments through channels that are not formally documented. Plenary amendments in the European Parliament are made via floor proposal but not released as formally documented Parliamentary reports. Likewise, the European co-decision process sometimes involves negotiated texts representing a compromise between the Parliament and the European Council. The history of text drawn up during negotiation has no public record and thus no entry in the set of potential source documents. In this case, some sections of the final bill may have no good match in either the initial bill or the documented amendments.[9] The reconciliation process in the United States Congress poses similar

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$\frac{\sum_i A_i \cdot B_i}{\sqrt{\sum_i A_i^2} \times \sqrt{\sum B_i^2}}$.

[9]Note that these processes do produce output, often in the form of a comprehensive final bill or amendment package voted on as a unit. But this record does not document who is responsible for what. Nor is the document useful in the matching process as described: including it in the corpus of potential matches would merely generate a synthetic bill that was largely composed of the comprehensive bill.

challenges for identification.

Given that the nearest-neighbor matching process defined above will return some match even if no actual match exists, handling this third complication requires a filter for identifying and rejecting "poor" matches. We implement this process with a filter on the similarity measure itself: for matches whose similarity measure s is below a user-supplied threshold T, we reject the match and instead match the section to itself. This "false" match can aid the identification of elements in a bill that came out of negotiated processes that have no formal amendment record.

Setting the threshold poses the precision/recall trade-off (Buckland and Gey, 1994). A low threshold level will match 100% of the actual matches (high recall), while returning many false positives (low precision). A high threshold level will do the reverse. We treat this trade-off as a supervised learning problem in which the optimal T is derived from a set of user-coded data. We hand match a random subset of each final bill to its potential sources. Based on that hand coding, the proper threshold value can be chosen to maximize the accuracy of the matching algorithm. Empirical tests with actual EU legislation show that this process yields precision and recall rates above 80% across multiple bills.

The output of the matching process permits a wide range of analyses. In particular, we wish to identify not just aggregate influence by policy actor, but influence by policy actor and policy domain. Doing so requires first identifying those policy areas. Semantic topic modeling (Blei et al., 2003) provides one avenue for unsupervised labeling of the topic domains, using the language present in each bill section. To do so, a Latent Dirichlet Allocation topic model is fit to the entire collection of candidate and final bill sections.[10] That model assigns each bill section to a single

[10]Formally, we fit an LDA model to a collection of "documents" constituting 90% of the bill sections and choose the optimum topic count to maximize the log likelihood of the model in a held-out 10%. A final LDA model was then fit to the entire set of bill sections using the optimum topic count. Bill sections were first cleaned to remove punctuation, normal English stopwords, and common domain-specific stopwords such as Parliament, Council, energy, article and paragraph. All topic modeling was

topic, or policy domain, from the language it contains. Given that topic, the final status of each bill section (adopted or rejected) and the author of each section, we can now attribute to each legislative actor their activity in and influence over each policy domain discussed in the legislative process.

done using the `topicmodels` package for R (Grün and Hornik, 2011).

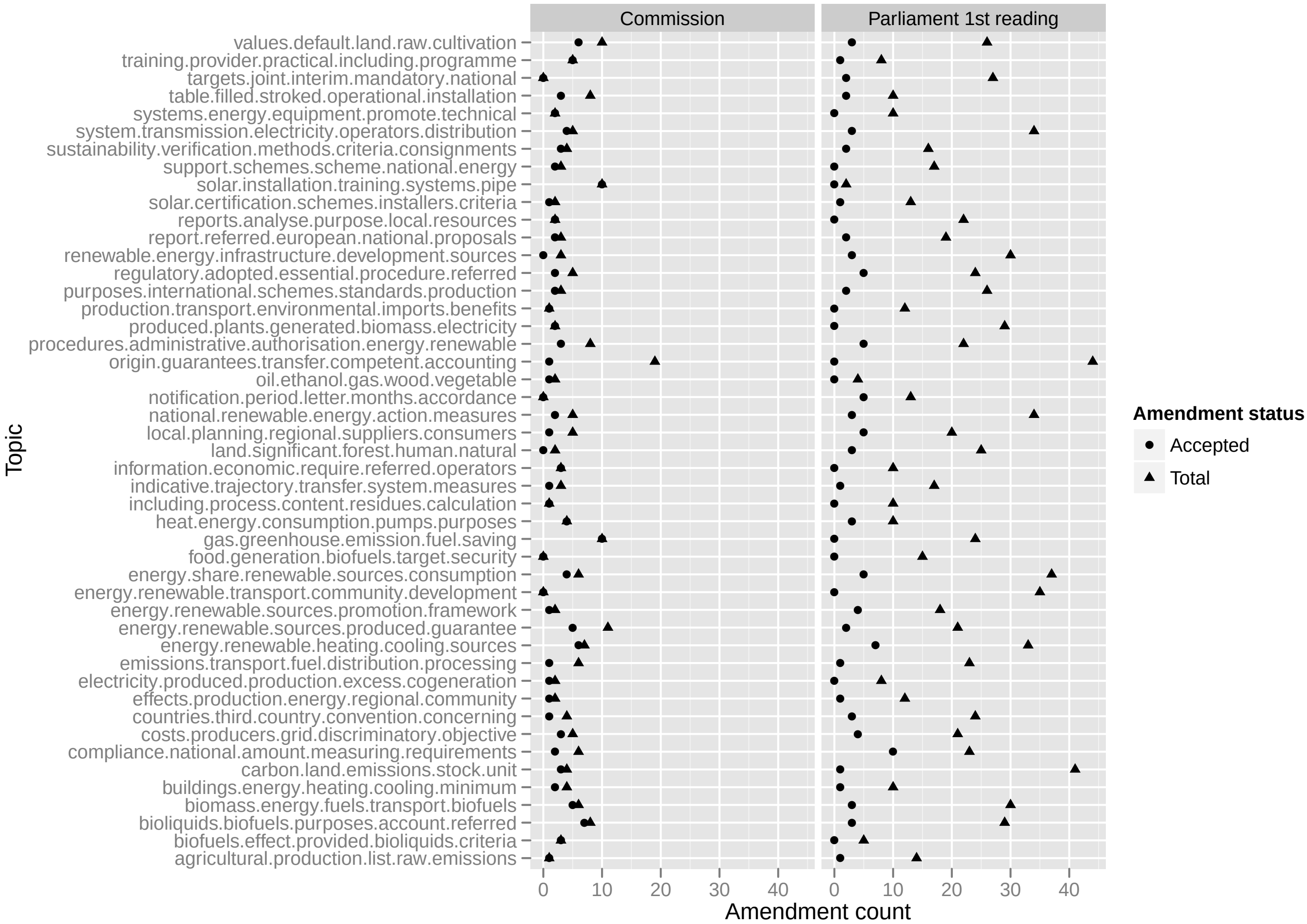


Figure 5.5: Record of proposed and accepted amendments from the Commission and Parliament during the legislative process for Renewable Energy Mandate reforms in the Third Climate and Energy Package. Counts refer to bill sections, nominally paragraphs, rather than complete amendments.

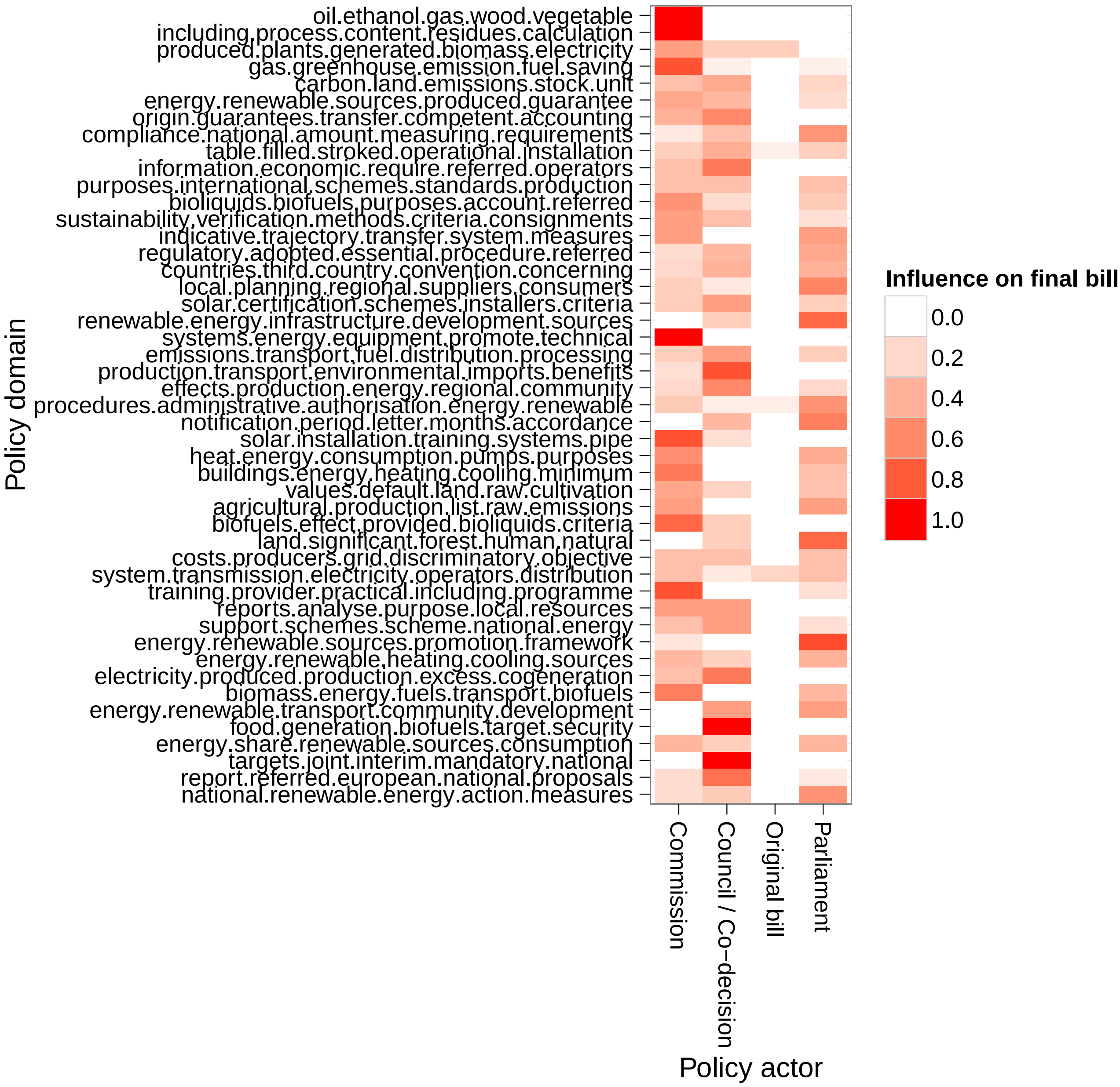


Figure 5.6: Contributions to the 2008 Renewable Energy Directive by legislative actor. Contributions attributed to the “Final” outcome reflect additions to the approved legislation not attributable to identified legislative actors. These reflect in particular compromises undertaken at the behest of the Council. See figure 5.7 for a schematic explanation of how these data are generated.

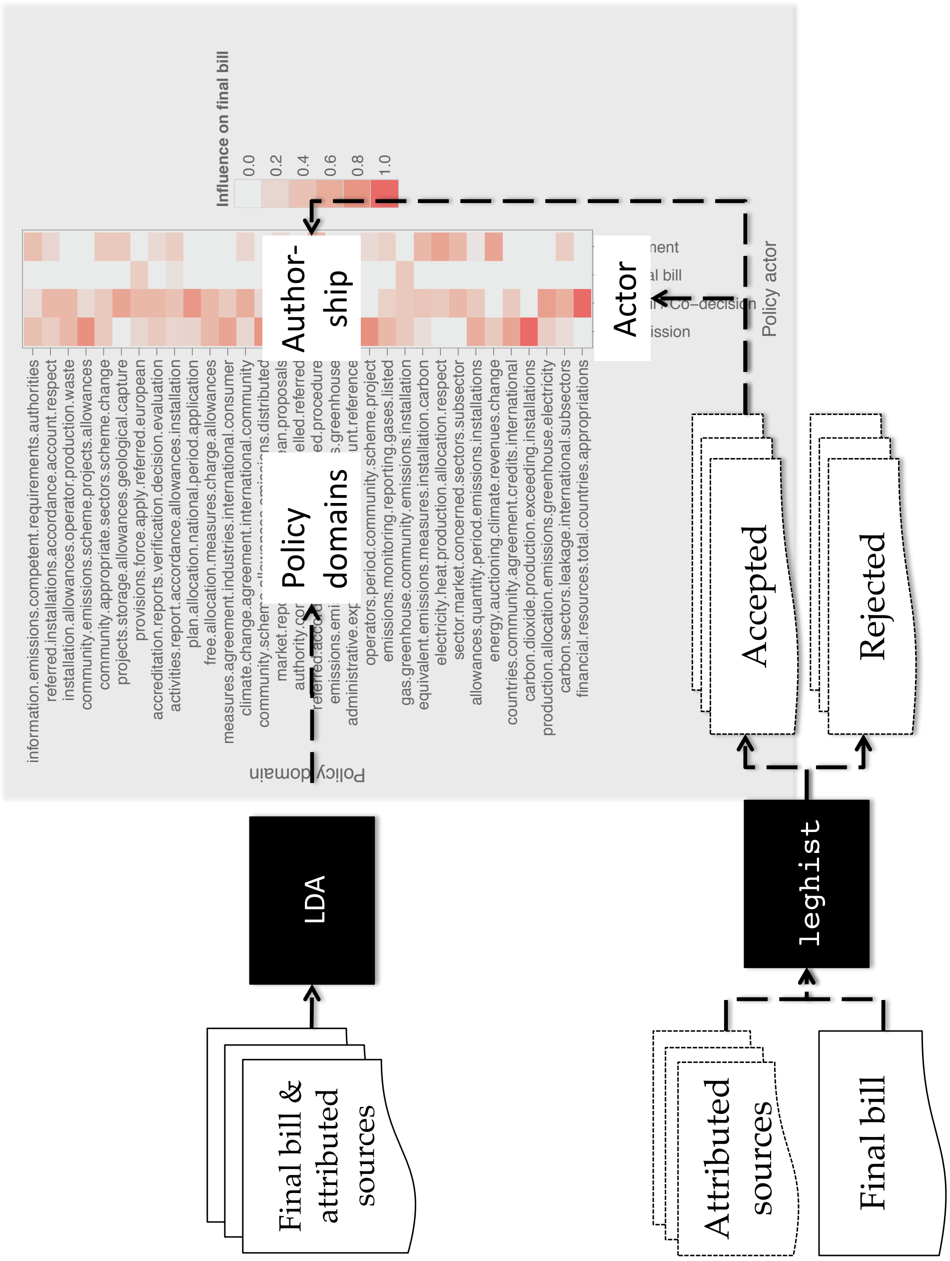


Figure 5.7: Flow of data through the `leghist` modeling process.

6 Economic actors and interests in European climate and energy policy

6.1 Introduction

Climate policy, like other environmental problems, may conflict with demands for unbridled economic growth or development. Given this tension, successful environmental policy has often required non-economic interests and interest groups to provide the political impetus to overcome opposition of private industry. Chapters 1-4 argued, however, that applying this framework to climate policy leads to a very incomplete picture of climate politics. The degree of change required for serious emissions reduction promises to generate economic winners as well as losers; and to open up opportunities to address existing shortcomings in legacy energy systems. These real economic benefits, I argued, point to an opportunity to ground support for emissions reduction in the material returns to energy systems transformation. Doing so, however, may require policies inconsistent with the more narrowly environmental preferences of environmental interest groups or parties.

Chapter 5 subsequently showed that, for the European Union, industrial policy won out over environmental politics in the construction and reform of EU climate and energy policy. Despite the European Parliament's reputation as an effective environmental advocate, it largely failed in its attempts to restructure European climate policy on more narrow environmental grounds. Instead, the European Commission proved quite successful at pushing its synthetic policy strategy through as a package of reforms. That package, as chapter 4 discussed in detail, contained a complex and multifaceted policy suite. That suite targeted the broad technical, regulatory, and market reforms necessary to take emissions out of Europe's energy system. But it did so in ways explicitly focused on a range of economic benefits: improved economic competitiveness, export-led growth, energy security, and market efficiency.

These empirical findings support the claim that European climate policy success rests on a political strategy of issue linkage. By tying progress on environmental goals to the realization of near-term material gains, the Commission has, I have argued, sought to ground support for climate policy in economic rather than environmental motivations. Europe has succeeded not because of its concern for environmental stewardship–though such concern certainly shapes the political background–but because it could make policy choices that served environmental goals through remunerative economic means.

This result leaves open the question of why Europe, and specifically the European Commission, could craft this particular bargain. Were, in fact, European economic interests amenable to the bargain implicit in the Commission's policy proposal? Did those interests reflect the particular legacy conditions of Europe's energy system, as chapter 2 suggested they would? Did interest in the economic opportunities from energy systems transformation transcend political tensions over emissions reduction itself?

Answering these question cuts to the heart of how economic interests perceive European climate policy. Chapter 3 suggested that the Commission's strategy of issue linkage would work only if the underlying structure of the energy system provided opportunities to generate salient material benefits from the process of systems transformation. Those benefits could come from new opportunities for export competitiveness, solutions to energy security problems, or improvements to energy cost and availability. Building a strategy on those opportunities, however, required that (1) they existed consequence of the legacy energy system; (2) that firms and other economic actors understood them as salient opportunities; and (3) that those opportunities allied interests who might otherwise have fought over climate policy narrowly construed. In other words, firms had to see their interests as a function not only of the marginal effects of climate policy on their narrow corner of the energy system; but also of the broad consequences of transforming how the economy produced, distributed, and used energy.

This chapter demonstrates that firm interests vis a vis European climate policy exhibit all these qualities. Drawing firms' own words in response to European policy proposals, I show that firms' expressed interests go beyond firms' narrow positions in the economy. Instead, firm interests clearly reflect the ability of the energy system to propagate the consequences of change throughout the economy, and in so doing to tie together otherwise disparate interests. Consequently, even where firms or sectors may not agree on climate policy itself, they often share interests in the consequences of actions taken to serve climate policy goals.

However, I caution that this phenomenon is highly contingent. Europe's economic interests exist in the context of both the structure of its economy and the nature of its legacy systems. The interaction between these institutions generated the context in which firms understood their policy interests. Given a different combination of background conditions, the conjunction of economic means and environmental ends may have failed as a political strategy. The United States, as I argue at the end of this chapter, points to just such a failure.

6.2 The prerequisites of issue linkage

Chapter 3 proposed issue linkage as an alternative explanation for how states have managed to overcome the formidable political barriers to climate change mitigation. Taking emissions out of the energy system requires an array of complementary and parallel changes in how an economy produces, distributes, and uses energy. Those changes encompass the technical, economic, and regulatory actions to incorporate renewable energy, improve energy efficiency, and retire fossil fuel infrastructure without impeding the function of the economy a whole. The technical superiority of fossil fuels, the cost of renewable alternatives, the behavioral and structural rigidity of energy consumption, and the political power of the fossil fuel industry and its users all make building concentrated political support for these actions difficult.

These costs have led both activists and analysts to look elsewhere for the political support for climate policy. Both groups have in many cases concluded that successful climate policy must rely on a base of support grounded in non-material interests–and in particular concern for environmental stewardship. Hence the focus of study has often settled on the behavior of environmental interest groups, environmentally-aligned political parties, and similar phenomena, often in opposition to industry assumed (in some cases correctly) to be implacable in its opposition.

Chapter 3 argued that this view of climate politics was incomplete. Without discounting the potential cost of climate change mitigation, focusing solely on that cost ignores the potential economic opportunities created by a low-emissions energy systems transformation. Those opportunities come from the benefits realized, or the problems solved, through the technical, regulatory, and market changes required to take emissions out of modern energy supplies. Doing so will require firms and workers bringing new technologies, services, and skills to market; and will potentially improve efficiency and reduce exposure to volatile and expensive international energy sources. The catalog of potential material benefits thus includes export-led growth, technological innovation, high-skilled employment, improved energy security, improved infrastructure stability, and reduced energy costs. The scope of each of these potential benefits will depend on historically contingent national choices about how to structure legacy energy systems, and how those systems are integrated in the broader economy.

These potential benefits open up the opportunity for building policy coalitions on material, rather than non-material, interests. Material interests with an acute stake in the particulars of climate policy promise, as shown by an array of political science research (Patashnik, 2003, 2008; Jacobs, 2008), a better foundation for policy continuity than the diffuse non-material aspirations of environmental interests. Realizing these benefits, however, will likely lead policymakers in the direction of a multifaceted, complex, and superficially redundant policy suite. That suite will eschew narrow appeals to economic efficiency, like those that underpin the logic of emissions pricing, in favor of industrial policy that targets specific problems in the context of the broad goal of shifting the trajectory of a national energy system towards a low-emissions pathway.

The logic of issue linkage points to four prerequisites for making effective use industrial policy to pursue and stabilize long-term environmental policy:

1. The domestic energy system must contain either economic opportunities or existing inefficiencies, solutions to which generate material returns to industrial actors

2. Those opportunities and benefits should generate specific returns to specific parties

3. The actors themselves must perceive these opportunities or improvements as benefits

4. The coalitions interested in these benefits should span the political cleavages generated by climate change mitigation itself.

In other words, issue linkage may work if economic actors who disagree on climate change mitigation nevertheless find common interests in the opportunities created by, or the inefficiencies addressed by, specific tasks undertaken to reduce greenhouse gas emissions. That dynamic changes climate change mitigation from a zero-sum fight over environmental versus economic policy priorities, to a positive-sum regime capable of sustaining consensus over time.

6.3 Measuring issue linkage in European climate policy

Chapter 4 argued that European climate policy has come to embody a technical strategy aimed at energy systems transformation, and a political strategy that uses systems transformation to underpin a politics of issue linkage. Technically, the EU targets very narrowly the replacement of European energy sources, the reconfiguration of energy transmission infrastructure, and the improvement and restructuring of energy demand. In doing so, its policies focus not only on the physical configuration of the system, but on the markets and regulatory structures in which that physical infrastructure is embedded. Hence the EU not only has renewable energy mandates, energy efficiency standards, and coordinated grid planning; but also a broad program for energy market reform, regulatory coordination, cross-border market integration, and technological research and development.

As chapter 4 showed, the European Commission has been quite explicit about its evolving understanding of the link between emissions, security, and growth. In both its 2006 and 2010 energy policy strategies, the Commission explicitly tied progress on emissions to the realization of benefits from export-led growth and energy security.

Its reports on progress in European energy market integration, issued in 2005-2006, articulate the failure of policy progress as a failure to realize available benefits from market integration and reform. Its discussion of renewable energy deployment cites European competitiveness in emerging markets for high-tech green capital goods, alongside climate change, as a motivating factor. Furthermore, as chapter 5 showed, the Commission introduced policy along all these dimensions as an integrated package of policy reforms; and pushed the Parliament to pass them as a policy unit rather than isolated attempts at regulatory, environmental, or industrial policy.

But while this history points to a *technocratic* conception of climate change mitigation as a problem of systems transformation, it still leaves the political question unanswered: why could the European Commission use this technocratic solution to structure a durable *political* bargain? Do firms actually share interests in common, despite disagreement over long-term environmental goals? Does that commonality of interest correspond to the Commission's choice of policy instruments? How broadly does overlap, if any, extend? Does that overlap reflect sensible intuitions about the structure of Europe's energy system, its attendant problems, and the potential opportunities that systems transformation might create?

This chapter presents a straightforward answer to these questions: major economic interests in the European Union identified benefits as well as costs in the tasks required for a low-emissions systems transformation; they voiced support for those benefits; and the coalitions in favor of benefits transcended political fault lines drawn along disagreements over environmental policy itself. Hence the Commission could succeed because firms and other economic actors perceived opportunity in systems transformation. Commission policy sought to highlight those opportunities, and hide or otherwise mute costs. That strategy facilitated policy coalitions among interests otherwise at odds on long-term climate policy. Industrial policy, understood as managing both the technical and political challenges of industrial change, carried the particulars of climate policy. Environmental politics were, instead, a background condition.

6.3.1 Measuring the structure of European climate interests

Demonstrating that European firms both perceived these benefits and expressed interest in them across sectoral boundaries requires an approach to measuring the perceived interests of firms across the entire economy. That approach must reflect the implication of an energy systems view of climate policy: that the energy system creates shared fortunes for firms both within and outside the energy sector itself. In doing so, it must provide a means of answering four questions:

1. What interests do firms have in specific policy proposals?
2. How do those interests compare to other firms in the same sector?
3. How do those interests compare to firms in other sectors?
4. Do shared interests among firms in different sectors span political disagreements over emissions reduction?

Issue linkage presumes that the firms may share interests in common with other sectors to the same, or perhaps greater, degree as they do with their own sector. This is because the energy system itself transmits the effects of transformation throughout the system itself. For instance, renewable energy firms and steelmakers may disagree on emissions reduction itself. But the changes to the power grid necessary to incorporate low-emissions energy may aid both–the one with adding every-larger volumes of renewable energy to the system, the other by reducing the incidence of blackouts or systems instability borne of an aging power grid.

Answering these questions requires a means of measuring the interests firms express, and then evaluating how those interests overlap with other firms and sectors. This section discusses that measurement process in brief. Section 6.7 presents the formal statistical description of these measurements, and discusses potential issues stemming from, and means of compensating for, respondents' strategic behavior and selection bias.

Firm interests and public consultation

Firms have a variety of opportunities to express their interests in policy. Most, however, are opaque to scholars. Most forms of lobbying, particularly in the European Union, are somewhat opaque. Furthermore, for active policy areas like emissions policy, firms are often unwilling to disclose their interests. For systemic interests, it may also be the case that only a very few elite actors have a comprehensive view of the balance of firm interests in a complex process like energy systems transformation. Hence studying these interests requires an opportunity to observe firms' interests in the context of complex policy, rather than from the isolated perspective of one or a few individuals.

Public consultation provides a unique opportunity to both observe firm interests across a wide swath of the economy, and to measure the similarity of those interests both within and between sectoral boundaries. The European Commission regularly solicits input from firms, citizens, and interests organizations. For energy in particular, these solicitations usually prompt responses to specific policy proposals which ultimately become draft legislation. Consultations usually receive responses from hundreds of firms and other interest groups, spanning a diversity of economic sectors. They are also often very comprehensive, taking thousands of words to articulate both which parts of the proposal most interest firms, and what specifically they may wish to see happen in those areas.

For the 2008 energy policy reforms, public consultation provides a unique opportunity to understand firms' interests in specific European legislation. The 2006 Green Paper on European Energy Strategy was the immediate predecessor to the legislative proposals that made up the Third Climate and Energy package. Hence the public consultation on that Strategy reflects firms' expressed interests on major European legislation, at the time that legislation was being drafted. It thus offers a particularly relevant opportunity to study comprehensive firm interests in specific European climate and energy policy proposals.

Sector	Count
Elec. Gen	20
Eng. / General	3
Eng. / Fossil	9
Natl. Gas	6
Gen. business	14
Mfg.	9
NGO	1
Eng. / Nuclear	2
Regulators	3
Eng. / Renew.	7
Eng. Transmiss.	6

Table 6.1: Breakdown of 2006 Energy Green Paper public comment respondents by subsector.

Measuring firm interests in public consultation

To reiterate: linkage politics rely on significant overlap among firm interests, in areas that deliver real and material benefits to economic actors. That overlap may occur even if it *doesn't* extend to agreement on longer-term environmental or climate goals. But that disagreement between, say, steelmakers and wind turbine manufacturers over emissions reduction, need not prevent agreement on the mutual advantages of

Sector	Count
Construction	9
Elec. Gen.	22
Eng. / Efficiency	2
Eng. / Fossil	15
Eng. / General	13
Eng. / Nuclear	4
Eng. / Renew.	23
Eng. / Transmiss.	5
Gen. business	19
Mfg.	8
Natl. Gas	12
NGO	33
Regulators	1
Research	7
Transport	3

Table 6.2: Breakdown of 2010 Energy Strategy White Paper public comment respondents by subsector.

strengthening the power grid and reforming power markets.

Measuring the degree and kind of overlap between firm interests requires that we identify and measure four separate phenomena:

1. What policy domains are at stake in a policy proposal?
2. Which of those domains matter to any given firm?
3. How do one firm's interests intersect with another's?
4. How do one sector's interests intersect with another's?

We exploit public consultation–the process of soliciting public feedback on specific policy proposals–to quantify and measure each of these phenomena. In doing so, we exploit the fact that public consultation processes are *framing* processes: the Commission frames the policy discussion with their strategy and firms and interest groups respond largely within the framework set up by the Commission. Conceptually, this means that public consultation allows the identification of both (1) which policy domains are under consideration and (2) which of those policy domains firms express interests in.

We take two complementary approaches to measuring these quantities. Quantitatively, we exploit the direct analogy between framing and a class of statistical text models known as *topic models*. The particulars are fully discussed in section 6.7. In brief, topic models assume that all documents contain a latent structure, defined by the topics they cover. Those topics, in turn, are characterized by the likelihood that we find specific terms in one topic versus another. Hence terms like “football”, “baseball”, and “game” might be far more likely to occur in a document discussing “sports”, while “iraq”, “war”, and “un” might be more likely to occur in a document discussing “foreign policy”. Documents are assumed to contain a *mixture* of topics. For example, Blei et al. (2003), in the canonical paper introducing topic models, model the entire corpus of articles from the journal *Science*. Any one of these articles might discuss, for instance, both *biology* (`cell`, `gene`, `mutation`) and *medicine* (`disease`, `treatment`, `mortality`). Topic models provide a means of modeling both the topics and the occurrence of topics simultaneously.

With this background, we can draw a direct analogy between topic models and public consultation. In public consultation, the Commission introduces a policy document with specific policy domains, each of which is characterized by a specific vocabulary. Hence *emissions control* might use terms like `carbon`, `price`, and `permit`, while *renewable energy* favors terms like `technology`, `research`, and `renewable`. When firms respond, they choose among those policy domains, and likely use the Commission’s own policy language to frame their responses. Figure 6.1 provides a schematic overview of the framing and response process, and the role of topic modeling in measuring firm interests in light of that process.

Topic modeling thus provides the means to quantify answers the questions above. Using the Commission's own policy documents, topic models can assist in discovering policy domains from the patterns of language itself. Using a model built from that language, we can then locate each respondent's interests in that set of policy domains based on the language in their response. This modeling process thus locates a diverse set of firms in a common policy space, and in doing permits straightforward measurement of the commonality of firm interests.

Complementing this quantitative approach, section 6.4.2 examines in detail a representative subset of firm responses. Close reading of the stated interests of a range of firms points to the same result as obtained by computational modeling: that European economic actors hold interests in climate and energy policy that go beyond their narrow place in the energy system; that those interests often overlap; and that the pattern of overlap transcends, in many cases, political cleavages over the narrow environmental problem of climate change itself.

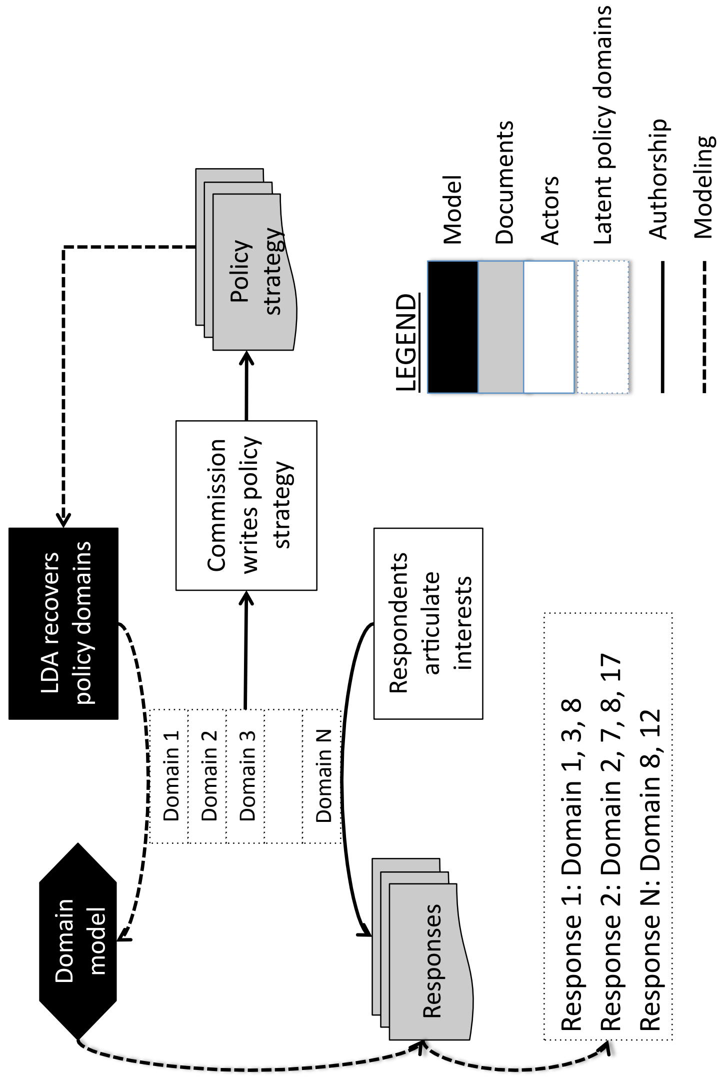


Figure 6.1: Overview of the process of modeling respondent interests in consultation processes. The Commission draws on a set of policy domains to craft a policy strategy. Respondents voice interests in one or more of those policy domains when writing their responses. Topic modeling can recover those policy domains, treated as a latent set of topics, from the Commission document. Using that model, we can infer the interests of each respondent from the language used in their responses.

6.4 Results: firm interests reinforce issue linkage on climate policy

6.4.1 What the models say

Anticipating reform: interests in the 2006 Green Paper

The 2006 European Green Paper on energy strategy provides a unique opportunity to directly tie interests to legislation. The Green Paper articulated the European Commission's proposed strategy for reforming the European climate and energy policy strategy. Its policy proposals for energy market reform and integration, emissions trading, energy efficiency, and renewable energy promotion tie directly to subsequent legislative proposals in each of those policy domains.

Figure 6.2 represents each of those policy domains using the terminology from the Commission document itself. The policy domains themselves comport well with a close reading of the energy strategy green paper. We highlight several for illustration purposes:

- Technological research and development (topic 2)
- Fuel choices and alternatives (topic 5)
- Emissions and technological innovation (topic 9)
- Market reform and competition (topic 16)
- Infrastructure development (topic 17)
- Nuclear policy (topic 20)
- Gas supply and supply insecurity (topic 19)

- Network infrastructure development (topic 24)

As the close reading of responses in section 6.4.2 showed, respondents framed their responses in terms of these policy domains. We can thus use the model of policy language to locate firms' interests, and study the commonality of interests among firms and sectors. Here, we use the Jaccard index to quantify interest overlap between any two firms. Take, for example, a firm that expresses interests in topics 1, 2, and 6; and another, expressing interests in 6, 23, and 14. The Jaccard index is simply the ratio of interests held in common (1) to the total interests identified in both firms (5). Restated, the Jaccard index tells us how many interests firms hold in common compared to the total set of interests they express. Moving from pairs of firms to pairs of sectors, we can summarize how similar two sectors' interests are as the average and the variance of the similarities between their firms.

Figure 6.3 illustrates the resulting overlap among firms in different sectors of the European economy. We can take three major conclusions away from these results:

1. Sectors with fixed, non-transferable assets have very concentrated interests. These sectors include energy transmission, fossil fuel firms, and natural gas generation and transmission.

2. Outside these sectors, we observe significant overlap among sectors not often thought to share interests in common. For instance, fossil fuel and renewable energy firms express interests in common to the same degree as do fossil fuel firms and natural gas firms

3. Overlap among interests across the energy system is actually common–firms don't have narrow, sector-specific interests or highly concentrated interests.

As a robustness check, we can employ a different measure of similarity among firms' expressed interests. The Jaccard index treats interests as discrete–a firm that spends 75% of its response talking about renewable energy, and 25% talking about grid investment, is assumed to have the same interests as a firm that spends 25% of its time discussing renewables and 75% discussing the grid. Obviously this throws away a lot of information about the structure of firm preferences. Alternatively, similarity could use a measure called the multidimensional simplex, described fully in section 6.7, that preserves that information. Figure 6.4 shows that this very different measure of similarity produces substantively similar results. Once again, firms in sectors with very specific, fixed, non-transferable assets like the power grid tend to be very similar. But outside these sectors, similarity across sectors is both common and comparable to similarity within sectors. Furthermore, that similarity spans political cleavages on long-term environmental policy itself, up to and including firms in otherwise opposed sectors like fossil fuels and renewable energy.

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5
action	technolog	object	technolog	renew
term	market	overal	countri	coal
effici	develop	level	effici	fuel
exampl	renew	secur	relat	technolog
integr	bring	develop	fossil	econom

Topic 6	Topic 7	Topic 8	Topic 9	Topic 10
competit	renew	market	technolog	competit
market	sourc	measur	target	communiti
secur	effect	intern	provid	level
gas	framework	ensur	emiss	nation
compani	plan	electr	scheme	consid

Topic 11	Topic 12	Topic 13	Topic 14	Topic 15
market	develop	import	standard	gas
creat	countri	demand	mean	communiti
secur	agreement	depend	effici	oil
neighbour	promot	global	minimum	pipelin
gas	transit	oil	perform	suppli

Topic 16	Topic 17	Topic 18	Topic 19	Topic 20
competit	infrastructur	technolog	gas	nuclear
secur	develop	research	stock	climat
industri	secur	time	suppli	ensur
suppli	particular	level	disrupt	contribut
sustain	partnership	capac	oil	world

Topic 21	Topic 22	Topic 23	Topic 24
effici	extern	gas	network
public	suppli	countri	regul
action	communiti	consum	grid
concret	common	global	oper
level	level	dialogu	develop

Figure 6.2: This figure illustrates policy domains in the 2006 European Energy Strategy Green Paper. Each policy domain is showcased by the terms identified by a topic model as most indicative of the domain itself.

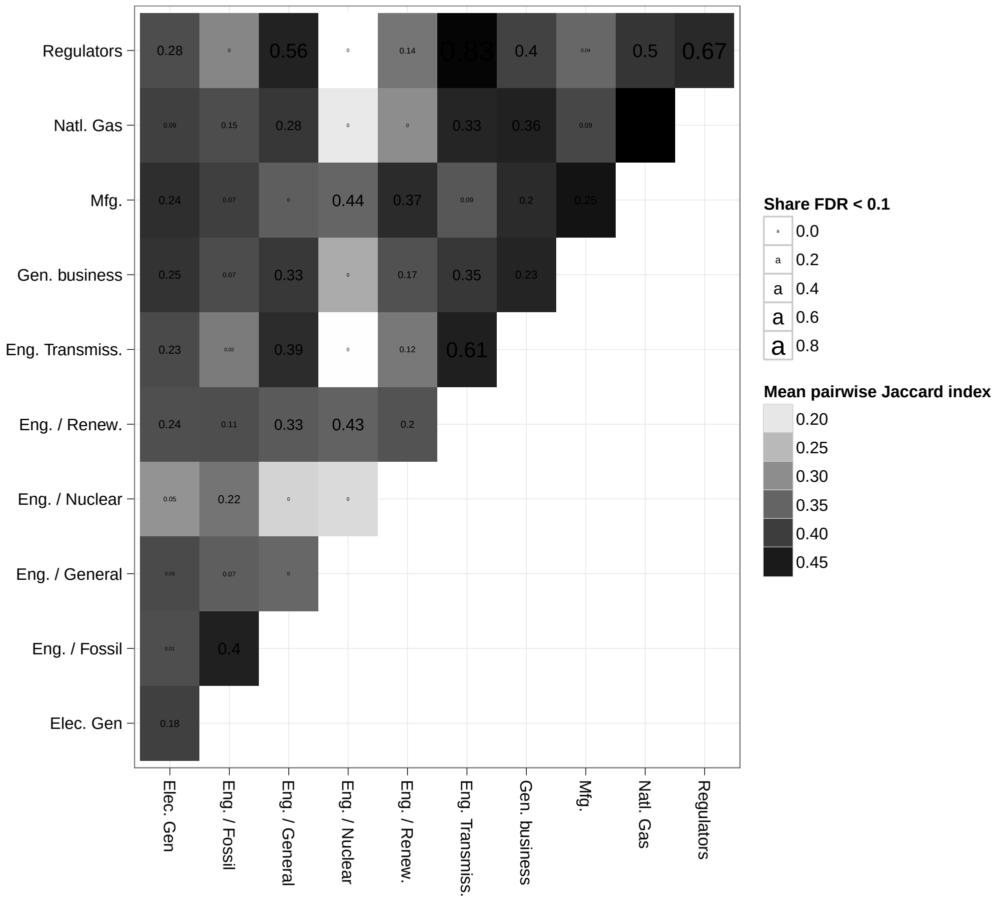


Figure 6.3: Pairwise sectoral interest similarity for the 2006 Energy Strategy green paper. Similarity is computed from the firm-level interests as expressed in responses to public comment. Interests are defined as topics that constitute greater than 5% of a respondent's topic posterior topic mixture. Pairwise respondent similarities are computed as the Jaccard index. Sector similarities are computed as the mean pairwise Jaccard index values for pairs of firms from different sectors. Cell shading indicates sector-wise similarity. Cell statistics illustrate how novel overlap is, represented as the share of all comparisons with Benjamini-Hochberg false discovery rates FDR of 0.1 or lower (Benjamini and Hochberg, 1995). See section 6.7.3 for formal definitions

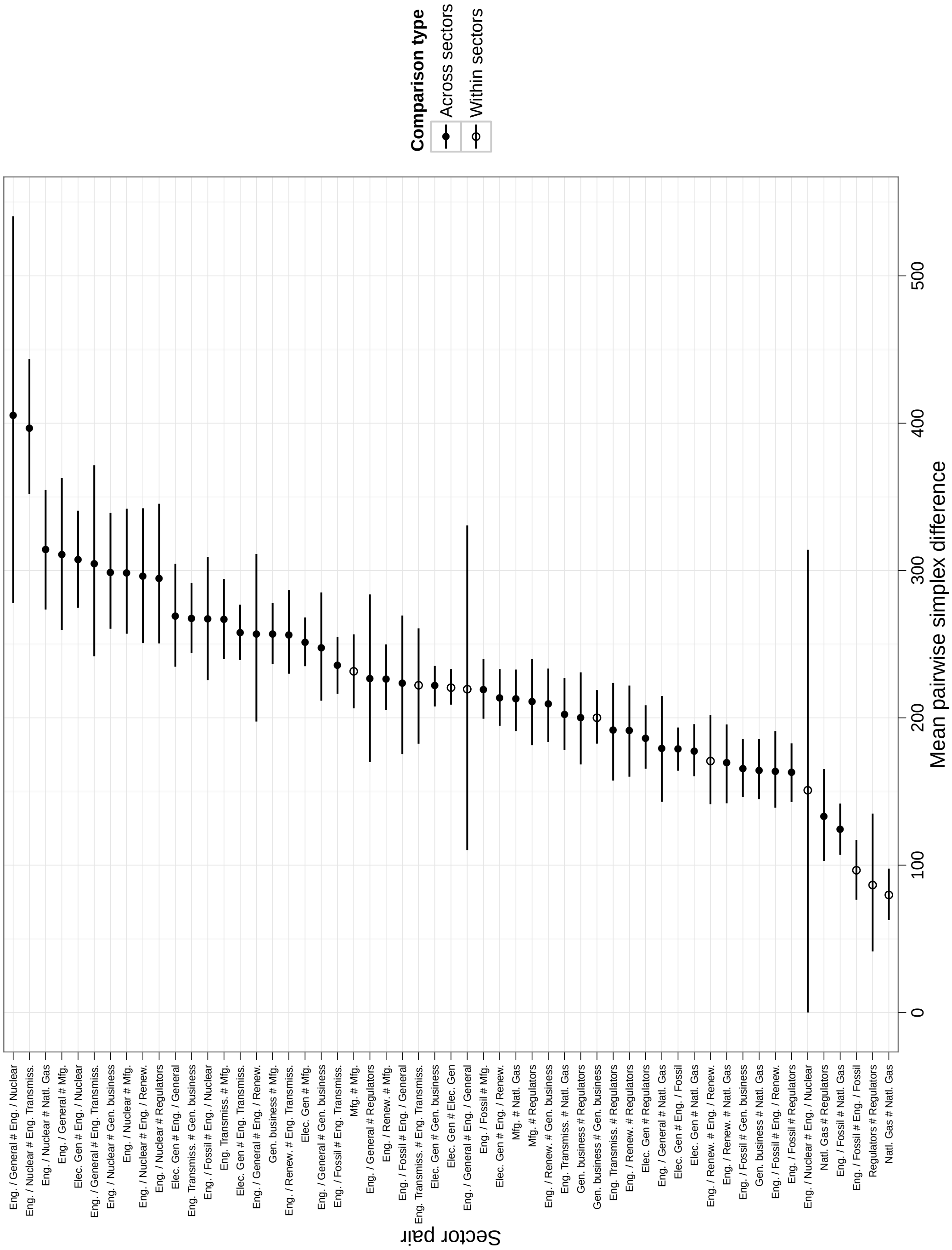


Figure 6.4: Similarity of interests in the 2006 Energy Strategy green paper, as measured on the multidimensional simplex. The constitutes an alternative measure of sectoral similarity, using the continuous simplex distance as adopted by Grimmer (2010).

After reform: interests in the 2010 White Paper

These results suggest that the structure of European energy interests prior to the 2008 policy reforms was amenable to a strategy of issue linkage. This raises the question, however, of whether these patterns of economic interests were ephemeral. Much changed in the European economy after 2006. Most notably, the 2008-2009 financial crisis inaugurated a period of prolonged fiscal retrenchment and economic stagnation and recession. Such conditions are often fatal to enthusiasms for climate policy because of its attendant costs.

A second public consultation provides a useful opportunity to check whether this commonality of interests survived these changes. As the European Commission looked towards European energy policy after 2020, it again introduced a broad policy strategy designed to update European policy frameworks for renewable energy, emissions regulation, and energy market reform. Once again, as table 6.2 shows, hundreds of firms across many sectors returned input. Hence 2010 provides a chance to check whether, as the European Commission looked towards European energy strategy in 2020, its linkage strategy had brought firms along with it or had been left behind by economic troubles.

Figure 6.5 illustrates the policy domains covered by the Commission's revised energy strategy. Highlighting a subset of those domains, we once again see that they touch on durable themes in European energy policy:

- Nuclear energy policy and strategy (topic 3)
- Market competition (topic 4)
- External security (topic 7)
- Energy efficiency (topic 12)

- Renewable energy strategy (topic 13)
- Smart grids, metering, and storage (topic 15)

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5
market	secur	nuclear	competit	intern
invest	term	safeti	market	market
capac	afford	intern	ensur	countri
price	challeng	secur	industri	technolog
competit	cost	legal	action	border
Topic 6	**Topic 7**	**Topic 8**	**Topic 9**	**Topic 10**
market	extern	infrastructur	consum	technolog
competit	secur	entso	effort	market
consum	develop	market	sustain	develop
nation	infrastructur	intern	market	level
choic	effect	includ	citizen	prioriti
Topic 11	**Topic 12**	**Topic 13**	**Topic 14**	**Topic 15**
countri	effici	renew	effici	smart
develop	public	strategi	industri	electr
common	build	chang	consum	storag
goal	transport	challeng	current	grid
access	sector	competit	fund	innov
Topic 16	**Topic 17**	**Topic 18**	**Topic 19**	**Topic 20**
renew	effici	access	countri	term
support	object	procedur	agreement	set
framework	action	project	treati	plan
scheme	nation	public	intern	programm
commerci	develop	fund	market	research
Topic 21	**Topic 22**			
market	gas			
suppli	suppli			
intern	oil			
consum	invest			
competit	import			

Figure 6.5: This figure illustrates policy domains in the 2010 European Energy Strategy White Paper. Each policy domain is showcased by the terms identified by a topic model as most indicative of the domain itself.

Topic modeling again permits the identification of respondents' interests among these policy domains. Using the Jaccard metric, figure 6.6 points to conclusions similar to those drawn from the 2006 policy cycle. Robustness checks, again using the simplex measure of interest similarity, confirm these impressions, as shown in figure 6.7. In particular:

1. Sectors with non-transferable, fixed assets tend to have highly concentrated interests

2. Other sectors show a remarkable degree of commonality of interest

3. That commonality spans political cleavages on climate policy itself, including the renewable/fossil fuel debate

Finally, 2010 included responses from the construction and transportation sectors, neither of which were well-represented in the 2006 policy cycle. Two interesting features come out. First, the energy efficiency and construction sectors share a significant share of interests in common. This is sensible given the important role of buildings and building energy consumption in advancing energy efficiency, and the need to accelerate the retrofitting and replacement of building stock to reduce the energy and emissions footprint of the built environment. Second, the common interests of the transportation sector with both electricity generation and transmission infrastructure point to the critical role played by an expanded and reinforced power grid in accommodating alternative-fueled, and in particular electric, vehicles.

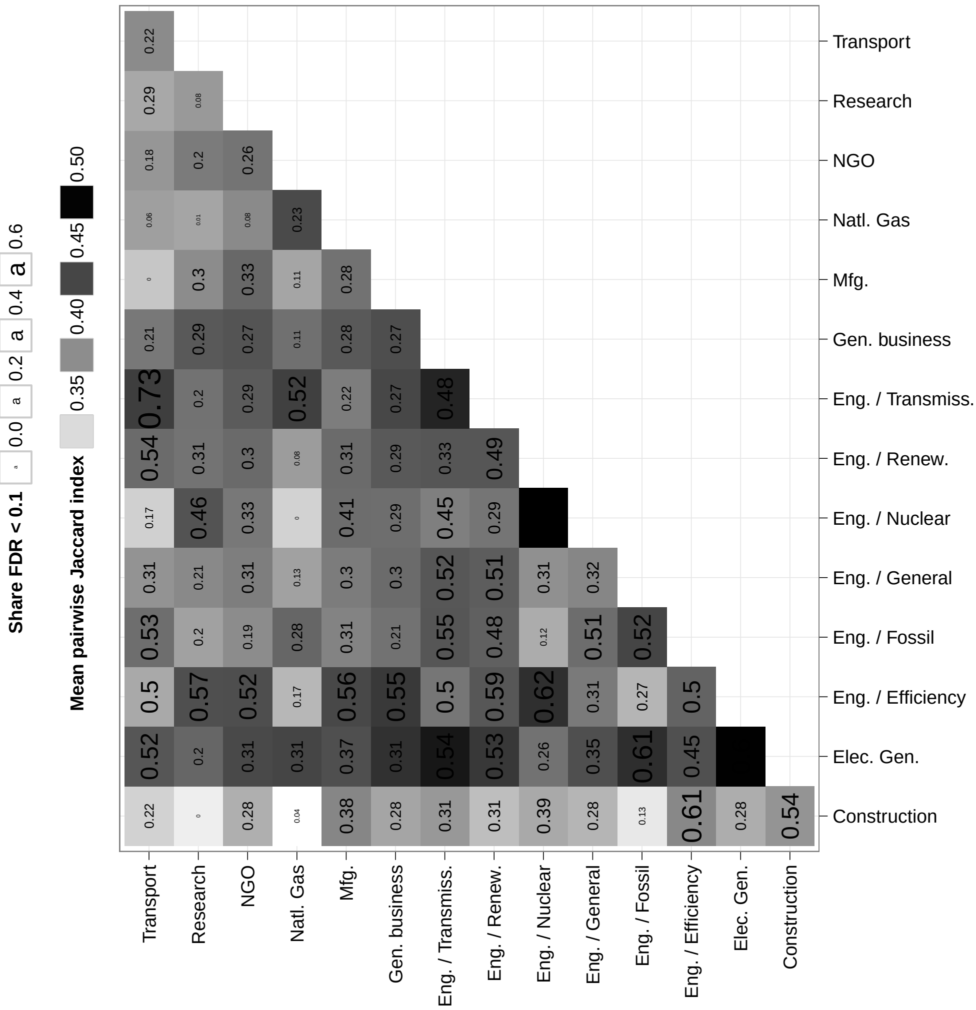


Figure 6.6: Pairwise sectoral interest similarity for the 2010 Energy Strategy white paper. Similarity is computed from the firm-level interests as expressed in responses to public comment. Interests are defined as topics that constitute greater than 5% of a respondent's topic posterior topic mixture. Pairwise respondent similarities are computed as the Jaccard index. Sector similarities are computed as the mean the pairwise Jaccard index values for pairs of firms from different sectors. Cell statistics illustrate how novel overlap is, represented as the share of all comparisons with Benjamini-Hochberg false discovery rates (FDR) of 0.1 or lower (Benjamini and Hochberg, 1995). See section 6.7.3 for formal definitions.

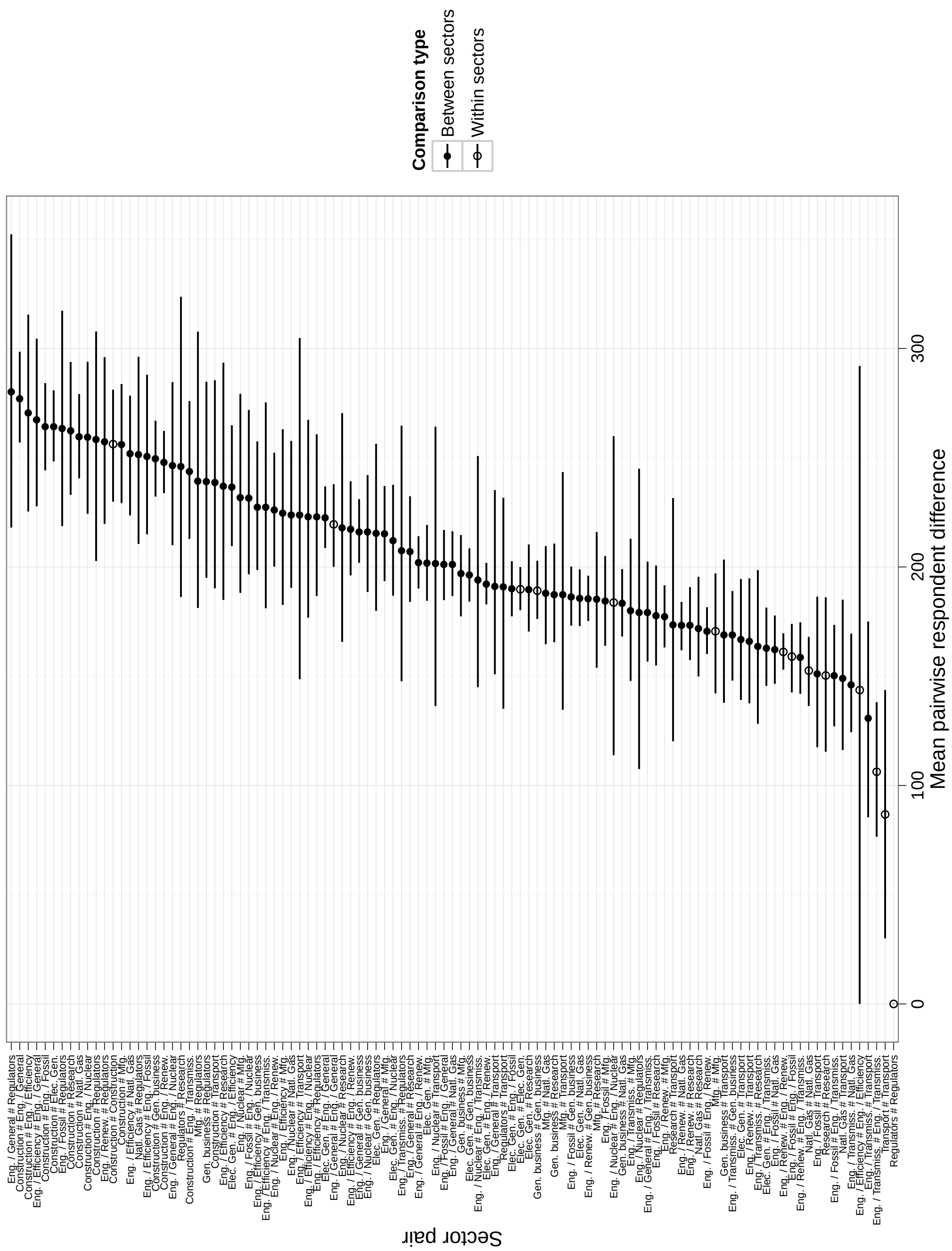


Figure 6.7: Similarity of interests in the 2010 Energy Strategy white paper, as measured on the multidimensional simplex. The constitutes an alternative measure of sectoral similarity, using the continuous simplex distance as adopted by Grimmer (2010).

Linkage over time: the convergence of firm interests, 2006-2010

Finally, we can use the measures of similarity between sectors to study how the opportunity for linkage–due to the structure of interest group overlap–changes over time. Figure 6.8 plots the similarity of two sectors in 2006, compared with their similarity in 2010. We see that sectors that exhibited significant commonality of interest in 2006 continued to do so in 2010. For other sectors, however, we observe *convergence* in interest commonality. In other words, sectors on balance appear to have developed more similar interests, increasing the opportunity for issue linkage over time.

Why this occurred remains unclear. Two potential explanations stem from the interaction of climate politics and economic developments in the EU after 2008. First, as Zysman and Huberty (2013) propose, firms may undergo a cycle of "green spirals" in which policy change leads them to alter internal business models such that their interests now reflect demands for policy continuity. In this process, firms who may not have understood their interests in 2006 as broadly set in the energy system writ large may, by 2010, have come to do so.

Alternatively, the convergence in firm interests may reflect a more explicit strategy by the Commission to articulate the economic benefits of systems transformation. That shift would reflect the imperative for economic growth in Europe after the 2008-2009 financial crisis and ensuing economic stagnation.

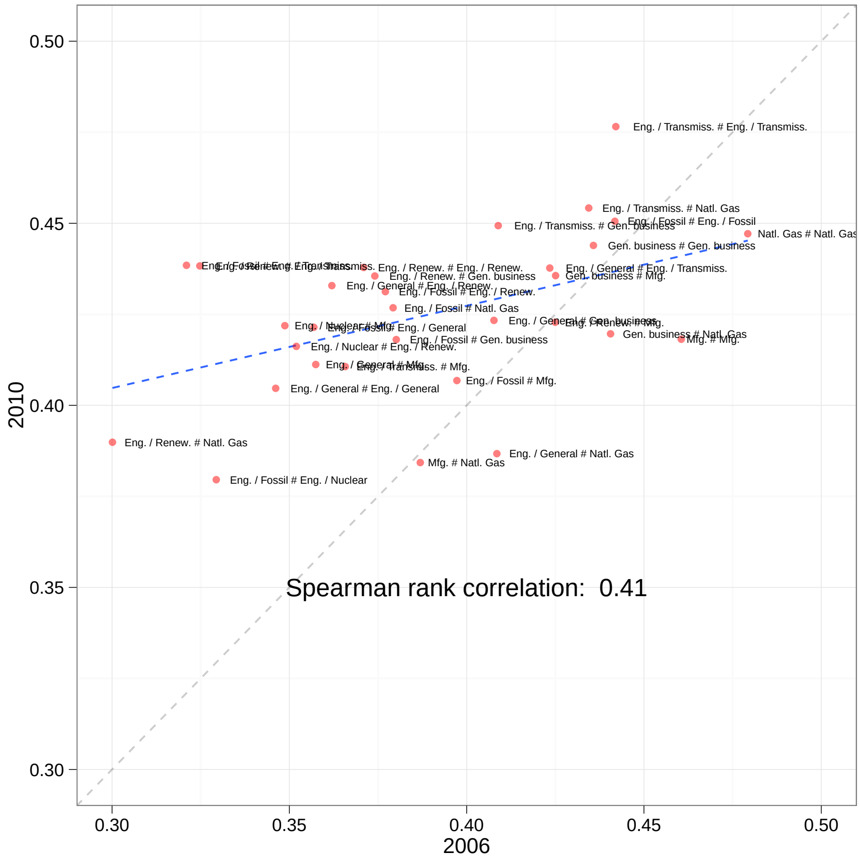


Figure 6.8: This figure shows how stable interest group similarity is over time. It correlates the similarity of expressed interests between sectors in 2006, with those in 2010. It illustrates that sectors with significant overlap in 2006 remained largely unchanged in 2010. Sectors with lower levels of overlap in 2006 had converged in their expressed interests by 2010.

6.4.2 What the text says

These quantitative results strongly reinforce the primary arguments made here:

- That European economic interests vis a vis EU energy strategy were complex and nuanced
- That this complexity showed significant commonality of interest among firms who might otherwise disagree on long-term environmental policy
- And that therefore the Commission could structure policy to reinforce areas of

common interest and mute areas of conflict, to build political support for broad climate and energy policy reforms

However, as Grimmer and Stewart (2013) and others have pointed out, automated text analysis does not alleviate the need for confirmation of the conclusions via close reading of a sample of the underlying texts. Hence we now turn to firm responses in detail for each comment period analyzed above. Close study of these responses demonstrates the potential for asymmetric but overlapping interests among different firms in different sectors, and suggests how the structure of the energy system itself influences firms' expressed interests in policy domains outside those that most immediately affect them.

The responses selected below are intended to be indicative of the positions of the major sectors involved in European climate and energy policy formation. Checking these responses against those from other major firms in the same sector showed that the expressed interests were by and large consistent. In specific instances–as with the 2006 responses from Eurometaux, the American Chamber of Commerce, and the Alliance for Energy-Intensive Industry–the use of common source material meant there was nearly perfect correspondence.

The 2006 Energy Strategy Green Paper

We begin with the energy firm **E.ON**. **E.ON** is one of the major energy and power generators in Germany, supplying over one trillion kilowatt-hours of electricity to European customers in 2011. It also runs electricity distribution networks, sells and distributes natural gas, and acts as a trader and middleman on European energy exchanges.

This business profile was particularly exposed to the Third Climate and Energy package. In particular, the package (1) pushed for the unbundling of firms with vertically integrated operations like E.ON's electricity generation-distribution-retail operation; (2) encouraged cross-national coordination of grid regulation and investment; and (3) sought binding targets in renewable energy adoption that would impact the operations of large generators.

E.ON's response reflects these concerns. It advocates first and foremost attention to reformed markets for electricity, in which it remains highly competitive. But it pushes against recommendations that vertically-integrated firms be forced to break apart their companies to achieve in pursuit of market reform. Rather, it suggests that legal separation among assets held under common ownership can achieve the same ends. Legal separation was a weaker option than full breakup, insofar as it kept generation, transmission, and distribution assets under common ownership even as it attempted to keep separate the management of day-to-day operations. This position was later ratified in EU legislation at the insistence of the Council of Ministers, in spite of attempts by the Parliament to require member states to break up and sell off vertically-integrated domestic energy firms.

Second, E.ON suggests that very aggressive renewable energy support schemes run contrary to the goal of market competition. But it acknowledges that rapid expansion of European renewable energy use will require subsidies, and encourages the Commission to seek harmonization of renewable energy support schemes so that "investments [are] made in wind power and photovoltaic where the wind blows and the sun shines, not where subsidies are the highest". At the time (2006), Germany had the most generous solar energy subsidy regime in Europe. This had led to an explosion in solar energy deployments, many of which were probably inefficient due to Germany's northern European weather. Hence harmonization of support schemes and mechanisms for cross-border credits for renewable energy adoption would likely have reduced E.ON's exposure to renewable energy mandates. However, this proposal was only partially implemented in the 2008 Renewable Energy Directive, which permits countries to traffic in certificates for renewable energy generation under limited circumstances, but does not impose harmonized rules for renewable energy subsidies across the EU.

Third, E.ON is broadly supportive of European efforts to push research, development, and deployment of energy efficiency and renewable energy technologies. It endorses the Green Paper's proposal (later passed into law) for a strategic energy technology plan. But it advocates that this push include (unsurprisingly for a firm with significant fossil fuel assets) attention to technologies like carbon capture and sequestration (CCS). Successful CCS technologies would enable natural gas and coal-fired power plants to operate without emissions, permitting their survival alongside naturally zero- or low-emissions renewable and alternative energy sources.

E.ON's positions were indicative of the priorities estimated by the quantitative models: primarily interested in liberalized and competitive markets and energy security; encouraging of renewable energy subsidies with some regulatory reform; and committed to technological research and development with the proviso that it support a wide portfolio of energy technologies.

Cogen-Europe, in contrast, represents the joint interests of co-generation operators across the member states. Co-generation refers to highly efficient technologies for simultaneously generating electricity and steam heat. By using heat left over from the electricity generation process for industrial and building heat needs, co-generation can contribute to radical increases in energy efficiency. It has been used to great effect in many European member states; Denmark, for instance, is roughly twice as efficient as the United States in using heat from coal-fired power plants, due to its widespread use of co-generation in its district heating systems. Co-generation is also fuel-neutral, and in many installations has been optimized to use waste products with very-low-emissions life cycles.[1]

Cogen-Europe presents a case for market reforms in service of both emissions reduction and energy security. It argues for "solidarity between Member States" through implementing common energy market regulations that prevent "Member States' predilection for favouring national players." These changes will benefit highly efficient solutions like co-generation, they claim, by inhibiting the abuse of oligopoly control over energy markets by large players. This position–common among other renewable energy firms–overlaps in part with E.ON's preference for liberalized and competitive markets. But it is clearly at odds with E.ON's preference for national and regional discretion on standardized grid codes and regulation. Only part of Cogen-Europe's preference here was implemented: network operators were required to produce transparent rules for grid access under the 2008 Energy Market directive, but the specifics of those rules were left open and coordination among them was left to the uncertain powers of the newly-created ENTSOE-E (European Network of Transmission System Operators-Electricity).

Like E.ON, Cogen-Europe strongly supports a joint European effort in research, development, and deployment of energy technology. While it says little about carbon sequestration, it does favor other adaptations of fossil fuels for use in co-generation, including coal gasification.

In contrast, to E.ON, however, Cogen-Europe is heavily in favor of explicit requirements for renewable energy adoption. In particular, it proposes that any new thermal (that is, fossil fuel) generation capacity be co-sited with existing heat demand. This implicitly means decentralized generation of electricity, with the use of leftover heat to supply residential, commercial, and industrial heat demand. This is significant

[1]For instance, organic residues from forests, sawmills, or farms would typically rot or otherwise decompose, releasing greenhouse gasses in the process. Burning those residues in co-generation plants displaces the additional emissions that would have occurred if fossil fuels had been used instead. These residues' contribution to the carbon cycle further reduces the marginal emissions footprint of co-generation. See, for instance, Perry et al. (2008).

departure from what large generators like E.ON would prefer. While the Third Climate and Energy package was broadly supportive of co-generation and introduced specific rules regarding the training, certification, and permitting of co-generation installations, it did not go so far as to impose this requirement.

Finally, **Eurometaux** represents the European metallurgical industry, a very energy-intensive sector facing intense competition from overseas competition in global commodities markets. In its comments on the Green Paper, it emphasized its support for an integrated European energy policy but focused specifically on functioning and competitive energy markets with stable long-term prices for industrial users. These comments were echoed by other representatives of energy-intensive sectors, including the European Aluminum Association and the Energy Intensive Industries alliance, who used language that in many cases was identical to that used by Eurometaux. This use of common lobbying language suggests a very high degree of sectoral coordination.

For energy markets, Eurometaux notes that the deregulation of the industrial market has gone ahead without parallel deregulation of residential markets. With residential prices remaining highly regulated, Eurometaux argues that any price pressures–notably from the cost of the Emissions Trading System–appear disproportionately in the energy costs for industrial users. These concerns, shared by other energy-intensive industries, were later reflected in the explicit allocation of Emissions Trading Scheme revenues for support of "carbon leakage" sectors that risked losing competitiveness due to energy and emissions price increases.

Concerns over price also led Eurometaux to agree with Cogen-Europe that full ownership unbundling of large producers like E.ON would facilitate greater market competition and greater price stability. It also argues for increased activity by the Directorate-General for Competition in policing oligopoly abuse of market power in energy markets. Both activities, it suggests, will be facilitated by new investment in cross-border inter-connectors (which, as chapter 2 noted, can also serve the problem of renewable electricity load balancing).

This confluence of interests on market regulation doesn't extend, however, to renewable energy. Given its price concerns, Eurometaux favors conventional power sources and a transition to a low-emissions energy base dominated by nuclear and hydroelectric generation. In contrast to Cogen-Europe and other renewable energy firms, Eurometaux opposes renewable energy subsidies except when the subsidy cost is competitive with other emissions reduction alternatives. In other cases, it argues that the cost of these subsidies to major energy consumers exacerbates an already uncompetitive energy cost structure.

This constellation of firms across different sectors–integrated generation and distribution, renewable energy, and energy-intensive manufacturing–suggests a complex interplay among the interests exposed by the European Union's pursuit of energy policy reform. Sector-specific interests are clear: in favor of lower prices and price stability for heavy manufacturing, market competition and innovation for large generators, and intensive support for new entrants in renewable energy sectors. But while these interests are well-defined, they do not preclude areas of agreement. End-users and new generation entrants alike favor greater regulation of suppliers' market power; both legacy and new entrant generators support a coordinated approach to research, development, and deployment of new energy technologies; and greater market integration via investment in cross-border inter-connectors is viewed as favorable by all.

Furthermore, the ultimate legislative outcomes, discussed further in chapter 5, tend to reinforce areas of mutual agreement, and adopt less radical solutions in areas where the sectors disagree sharply. Renewable energy policy, for instance, introduced strategic coordination of renewable energy research and development, and provided one (though perhaps not the optimal) means of harmonizing renewable energy subsidies through cross-border transfers. But while Cogen Europe and other renewable energy organizations would have preferred complete unbundling of vertically-integrated generators like E.ON, member states retained the option for administrative unbundling–keeping vertically-integrated ownership but separating day-to-day operations–in the final legislative package. Both the Commission and Council opposed attempts by the Parliament to force ownership unbundling on the energy sector, despite concerns that mere legal unbundling would not prevent legacy firms from discriminating against new technologies or generators.

These qualitative results corroborate the inferences drawn from quantitative measures of firms' expressed interests. As chapter 3 predicted, firms participating in a highly networked sector like energy have complex and multifaceted interests. Consequently, firms which may not agree in one area nevertheless may share interests in outcomes elsewhere. Furthermore, firms' interests aren't confined to the narrow sector of the energy system in which they most directly participate. Rather, they encompass developments across a range of sub-sectors, reflecting the role of the network in transmitting the consequences of policy change.

The 2010 Energy Strategy White Paper

In contrast to the 2006 Green Paper, which foreshadowed concrete policy proposals, the 2010 Energy Strategy white paper sought guidance on potential future changes to EU policy. Those changes were, first and foremost, intended to ensure the achievement of the 2010 goals set out in the Third Climate and Energy package. But they also reflected the perceived need for longer-term energy strategy, particularly in light of the failure of the COP-15 climate talks, held in Copenhagen in late 2009, to achieve any international momentum on global emissions reduction. Hence the interests expressed here are more broadly indicative of concerns about how the European Union's policy regime will affect international competitiveness when the EU remains a lone actor in emissions control.

Shell Energy Europe, as a major producer of fossil fuels, clearly has primary interests in preserving and expanding markets for its energy products. But in its response to the 2010 Energy Strategy white paper, Shell supported a diverse range of policies reflective of both its interests as a energy producer and a long-term strategy for benefiting from Europe's shift to a lower-emissions economy. First and foremost, of course, Shell advocated for increased use of natural gas as "the quickest and cheapest way to reduce CO_2 emissions". Shell also sees natural gas as a natural complement to expanded renewable energy production, primarily as a means of balancing the intermittency of renewable energy and ensuring electric grid stability.

Beyond its primary energy interests, however, Shell also suggests a range of other changes. It supports full ownership unbundling of gas transmission infrastructure in order to increase the competitiveness of Europe's gas markets. It also calls for Europe-wide coordination of measures to allocate capacity at major transmission bottlenecks, preferably in the form of capacity auctions that reinforce market competition. Finally, over the longer term, Shell advocates for harmonization of gas network regulation to the extent that it compensates for market failures. It views each of these developments as crucial to the development of price-competitive European markets in gas. It also sees them as vital to diversifying Europe's gas supply and increasing European energy security.

Vestas Wind Systems presents a very different picture. As a globally-dominant wind turbine firm, Vestas has very specific interests in the expansion of wind energy markets in Europe, and in European wind industry competitiveness worldwide.

This is consistent with its response to the call for public comment, where it first and foremost encourages the Commission to accelerate implementation of the 2008 Renewable Energy Directive. In support of this goal, however, Vestas pushes for full unbundling of transmission infrastructure, an expanded offshore power grid to serve offshore wind generation opportunities, and secure financing for research and development in to both renewable energy and transmission technologies. As with Cogen Europe and Eurometaux in 2006, Vestas clearly views infrastructure investment as vital to increasing the capacity of Europe's energy system to support cost-effective renewable energy adoption.

Vestas' advocacy for infrastructure investment and planning is shared by major grid operators. Both **National Grid** (in the UK) and **TenneT** (in Germany) face impending offshore wind energy deployments in the North Sea. While Vestas' primary concern is ensuring the necessary grids to service large offshore wind farms, the network operators emphasize instead the need integrated planning of grid design and deployment to ensure that offshore and onshore grids inter-operate. They are also shared by major legacy firms such as **Vattenfall**. Even though Vattenfall expresses concern about the aggressive incorporation of intermittent energy (and its destabilizing effect on the power grid), it shares the desire for an improved regulatory and investment environment for large-scale grid infrastructure investment.

Finally, the 2010 consultation had significant participation from two interest groups that had been absent in 2006: the social partners to the major energy sectors; and the construction industry. **Glass for Europe** represents an interesting case of an energy-intensive manufacturer in that sector. As noted above, the metals industry, another energy-intensive sector, was primarily concerned about the price of energy in Europe and its effect on economic competitiveness. Eurometaux and its counterparts were deeply concerned about energy policies that prioritized objectives other than price and supply. In contrast, Glass for Europe, representing 90% of European glass production, identified opportunities in the aggressive pursuit of building energy efficiency. Its response advocated for mandatory targets for energy efficiency as a solution to emissions reduction, energy security, and economic competitiveness. It further saw markets for energy-efficient solutions as a way to prime European competitiveness in "green" industry. These positions were broadly consistent with the construction sector at large, which would benefit from aggressive programs to retrofit existing buildings with energy-efficient lighting, glazing, and heating solutions. For instance, the **European Construction Industry Federation** recommended that European policy couple energy efficiency investments and with policies to expand the use of smart grid technologies and active demand-side management of energy consumption. These detailed interests coincide with the broader quantitative claims, that construction had significant long-term interests in energy efficiency improvements, made in section 6.4.1.

These positions are largely shared by **Orgalime**, the trade association for the European engineering industries. They emphasize, first and foremost, the risks posed to their firms by unstable and expensive energy supplies. But, acknowledging the opportunity present in a low-emissions systems transformation, they favor explicit steps to support and deploy highly energy-efficient smart grid technologies. To that end, they support the Commission's call for both a stable regulatory framework that fosters an integrated and intelligent European power grid; and a research and development process focused on building energy-efficient solutions for end consumers that empower end users to improve energy efficiency directly. Finally, like the major grid operators and legacy energy firms, they encourage the harmonization of renewable energy subsidy schemes in order to encourage building renewable energy capacity in the most geographically optimal location, rather than in the countries with the most generous subsidy schemes.

In contrast to the engineers' general optimism about opportunities to be had in a low-emissions energy systems transformation, the **Social Partners** in the European Electricity, Gas and Extractive Industries focused primarily on the risks to employment in Europe's transition to a low-emissions economy. Each call for an increased focus on the social dimension of EU policy through more focus on job re-training for those workers displaced through the switch to low-emissions energy sources. This concern about employment reflects a similar concern among industry associations representing major heavy industries, including **Eurometaux**.[2]

In summary, the 2010 White Paper on European Energy Strategy received a much broader set of responses, permitting a more nuanced view of European interest group positioning on EU climate and energy policy. Once again, we notice significant overlap among the expressed interests of major sectors. Grid operators and renewable energy firms both favor greater regulatory stability and coordination as Europe adopts even greater amounts of renewable energy. Those interests are shared by the engineering firms that will design and supply the infrastructure for ensuring grid stability and improving energy efficiency. In contrast, while large fossil fuel firms remain focused primarily on market liberalization as the best way to ensure secure and cost-efficient energy supplies, they do recognize the complementary role their products (especially gas) will play in a renewable energy-based energy system. These positions all reflect similar preferences expressed by interest groups in the same sectors prior to the the passage of the Third Climate and Energy Package.

[2] The contrast here between the these social partners and the Danish LO is instructive. The Danish LO represents a consortium of labor unions in the Danish economy, including the metalworkers. In 2010, the LO signed on to the Danish Government's aggressive plan for a 50% share of renewable energy by 2050. Interviews with the LO in early 2011 indicated that the success of Denmark's renewable energy technology firms was instrumental in reducing the skepticism of workers in energy-intensive sectors like steel: the increased employment of metalworkers, and the demand for their products in renewable energy industries, raised the possibility for new avenues of employment in these emerging sectors.

We also note that the areas receiving the most interest appear to be those for which the Third Climate and Energy package fell short of initial hopes. Support for harmonization of European renewable energy support schemes, and the coordinated investment in large power grids, was present in the 2006 public consultation cycle as well. As chapter 5 will show, the legislative process cut short some of these goals despite the support of the European Parliament. Member state interests in sovereign energy policy pushed against the standardization of EU-wide subsidy schemes for renewable energy. Coordinated grid regulation was ultimately implemented through a consultation process among national regulators, rather than via the Parliament's preferred solution of a single European regulator. Whether these expressed interests on the part of EU firms will persist into a new cycle of European regulatory reform born of the shortcomings of the past remains to be seen. The evolution of policy positions from 2006-2010 suggests this will occur. Regardless, it points, as we have argued elsewhere, to an emerging constituency among major economic actors for further harmonization of national energy policies.

6.5 Implications

In summary, major European economic actors expressed climate and energy policy interests that often shared much in common with firms in other sectors and locations in the energy system. Those interests were grounded in the opportunities that a low-emissions energy systems transformation created for realizing material benefits from industrial change. Those benefits opened up the possibility of bridging political cleavages over the narrow issue of emissions reduction itself.

Hence the European Commission, in pursuing the reform of Europe's climate and energy policy suite, could adopt a strategy of issue linkage. By yoking support for emissions reduction to the creation of material returns to climate and energy policy, the Commission could attempt to ground Europe's policy in more concrete support than environmental aspirations alone offered. That gave the policy added weight which, as chapter 5 showed, helped carry it through the legislative process relatively in tact. Conversely, the role of narrow environmental motivations was minimized. In doing so, the Commission chose policy instruments that maximized neither environmental efficacy, as preferred by the environmental lobby; nor economic efficiency, as recommended by economic theory. Instead, its multifaceted policy targeted specific kinds of regulatory, technical, and market changes, some with arms-length approaches (like emissions trading), others with very targeted interventions (specifying the regulatory harmonization of worker training programs).

This result has two implications for the politics of climate and energy policy. First, it illustrates the powerful role that legacy energy systems can play in stabilizing support for emissions policy. The path-dependent nature of large physical networks like energy constrains the set of choices policymakers face when embarking on emissions reduction. Moving the trajectory of such a system towards a low-emissions path while preserving its ability to serve industrial society confronts policymakers with hard choices about technological, regulatory, and market reforms. But the results here suggest that those constraints don't merely impose barriers. Rather, they may also reveal opportunities for grounding policy in the material benefits that such a transformation might bring. Furthermore, since the network works to transmit the effects of change, those benefits may be widespread, and may serve multiple, unrelated constituencies. Hence, for instance, the commonality of interest in network investment and reform among the energy-intensive and renewable energy industries. These groups share little common interest in low-emissions energy sources. But they mutually benefit from a hardened electricity grid.

By extension, however, while the European Union's relative success suggests the *possibility* of successful national strategies, it likely says little about how to implement such a strategy outside the EU. As this chapter has discussed, European policy strategy draws heavily on both opportunities and shortcomings contingent on the European energy system itself. The particular strength of Europe's high-tech manufacturing sector, the exposure of central and eastern Europe to Russian energy geopolitics, the relative lack of indigenous energy resources, and other factors all facilitated the political linkage of emissions reduction to energy systems reform. Other energy systems, in other economies, will face different opportunities and constraints.

The United States provides a salient comparison. Like the EU, the US is a highly federal political entity with an array of competing economic and political pressures. Unlike the EU, however, the US has repeatedly failed to implement any significant climate change policy. Furthermore, despite specific appeals to energy security, energy costs, and other factors, major economic interests (including the American Chamber of Commerce) remain as of 2013 militantly opposed to serious climate policy. [3]

Much of this derives directly from the structure of the American energy system. As an advanced industrial economy, the US faces costs similar to those borne by Europe, but its energy system creates far fewer opportunities for real benefits. Unlike Europe, the US has long enjoyed the benefits of market integration; electricity and gas markets already span state borders, and power routinely moves long distances from major producing regions to population centers. Hence market integration may deliver little marginal benefit. Moreover, almost all of this power is generated using domestic energy resources–chiefly coal and, more recently, natural gas. Those resources are comparatively vast. To the extent that the US has an energy security problem, that problem is (1) relatively small, (2) concentrated in petroleum for transportation, a much harder problem to solve than electricity production, and (3) therefore functions

[3]We note, of course, that this problem is over-determined. The US also has a federal system in which minority interests have, as of 2012, become extraordinarily good at using institutional rules to block policy progress. The usual caveats about exchangeability between the US and EU also apply.

largely as a rationale for expanding domestic petroleum production, at some environmental cost, in areas like the Gulf Coast or Alaska. Finally, the US, as a relatively closed economy, has less to gain from export-led growth in high-tech low-emissions manufactures than the small, open economies of Denmark or Spain.

Hence the structural conditions that supported the Commission's success in Europe work to undermine the opportunity for similar bargains in the United States. Europe's fragmented energy markets, and declining internal energy reserves, and comparative advantage in goods like wind turbines facilitate the linkage of emissions control to economic opportunity. That linkage promotes political support even among firms otherwise uninterested in climate policy itself. In the US, in contrast, these motivations are either much weaker or entirely nonexistent. The comparative difficulty of securing firms' support–documented by Skocpol (2013) and others–reflects the tenuous near-term link between America's climate policy choices and their economic possibilities. Linkage politics and energy systems transformation point to the means of securing support for complex industrial policy; but they ultimately succeed or fail in the context of the structural background of legacy energy systems.

6.6 Conclusions: the role of the energy system in structuring interests and policy

This extended discussion of the politics of European climate policy has emphasized a relatively straightforward insight: that the transformation of modern energy systems is first and foremost a complex industrial problem. That it has environmental objectives does not necessitate that its political foundations be primarily environmental. Indeed, given the enormous cost and complexity of a low-emissions energy systems transformation, it would seem reasonable to posit that they should not be: the diffuse aspirations of the environmental movement face serious problems organizing sustained, acute opposition to highly motivated economic interests with a major stake in fossil fuels.

But this may not doom the project of emissions reduction. The process of industrial transformation will potentially create a range of benefits. Those benefits include the returns to fixing legacy problems lurking in existing means of producing, distributing, and using energy; and in capitalizing on new opportunities for technological innovation, employment, and growth. To stabilize politics, as the European example suggests, these potential benefits need not exceed the cost of systems transformation itself. Rather, they only need accrue to acute interests in ways sufficient to incentivize their support for long-term policy continuity. As this chapter in particular has demonstrated, even interests fatally undermined by long-term climate policy–principally fossil fuels–nevertheless found reasons to support technological research and development, power grid investment, and other components of Europe's climate and energy policy suite. In doing so they explicitly identified the benefits of those actions as their primary motivations.

The sum total of these chapters raise a concern, however: are there limits to a strategy of issue linkage. Advocates for a maximalist version of issue linkage–often termed "green growth"–argue that climate investments will return *more* in narrow economic benefits than they impose in costs. As Zysman and Huberty (2013) show, existing arguments for this maximalist case fall well short of their aspirations. Hence climate policy built on a political strategy of issue linkage should still be vulnerable, even if less so than alternatives grounded in appeals to environmental stewardship. Under enough pressure, whether from economics or the geopolitics of energy, the coalition borne of issue linkage may well fall apart. The next chapter chronicles just this breakdown in Europe, as the EU's climate ambitions collide with the reality of ongoing economic stagnation.

6.7 Appendix: data and methodological approach

This appendix provides the formal description of a new method for studying economic policy interests through data made available by public consultation processes. This method conceives of public consultation as a process of *framing* and *response*. This permits direct analogy between public consultation processes and Bayesian mixture models of text. Given this analogy, such models can be used to both discover the set of policy domains covered by a public consultation process, and to map responses onto those policy domains. I build a set of measurements and measurement tests on this modeling approach that permits scaleable measurement of firm interests in a complex issue space. Section 6.7.4 then describes implementation of this modeling approach, and the data that supports it.

6.7.1 Public consultation as a stylized framing process

Public consultation in the European Union can be thought of as a framing process that defines an issue space within which respondents voice positions on policy strategies. The consultations considered here begin with specific policy proposals from the European Commission: a unified energy strategy for Europe, as in 2006; or a long-term expansion of the scope of European energy policy, as in 2010. Firm responses are encouraged to address these issues directly.[4]

We can abstract the framing process thusly: A policy actor ρ introduces a policy proposal discussing policy domains $d \in D$. Respondents $r \in R$ each select a set of

[4]Responses to the consultations considered here are free-form, resulting in a degree of variation. Responses to other public consultations have sometimes been constrained further by questionnaires, which impose further framing structure on the policy space.

domains $D_r \subseteq D$ for discussion in their public response, based on the specific issue areas or policy domains in the policy proposal that affect them. The selection problem is, of course, subject to strategic behavior. I discuss that further in section 6.7.6. As I note, to the extent these selection complicates inference, it biases the measurements presented below towards being more conservative about the scope of firm interests and the potential for firm interest overlap.

6.7.2 Semantic topic modeling as an analogy to consultation

This stylized description of public consultation permits a direct analogy to a class of Bayesian mixture models models of text known colloquially as topic models. As pioneered by Blei et al. (2003), Latent Dirichlet Allocation and related topic models attempt to infer the set of topics discussed in a text corpus on the basis of the empirical distribution of words in texts. In simplified form, topic models assume:

1. That semantic "topics" are latent variables in a corpus of documents
2. That each document contain a mixture of topics
3. That topics are defined as a distribution over words in a vocabulary

The challenge is then to estimate both the topics themselves (defined as distributions over words) and the mixtures of topics as they appear in a document corpus (defined as distributions over topics for each document). Blei et al. (2003) treat this problem as a Bayesian process based on a Dirichlet prior over each document's topic distribution and each topic's vocabulary distribution. Inferring the posterior distributions from empirically-observed variation in term distributions in the topic corpus can then occur via a variety of sampling and estimation procedures.

For illustration, consider a corpus discussing energy and climate issues and covering *emissions*, *energy security*, and *technological innovation*. The first topic would have a term distribution dominated by words like *emissions, greenhouse, reduction,* , the second by *supply, security, import, price*, and the third by *research, technology, innovation, develop*. The relative attention paid by each document in the corpus to each of these topics is then inferred by the document's observed distribution over the topic vocabularies.

In practice, Latent Dirichlet Allocation and its descendents have been shown to generate semantically-coherent topics (Boyd-Graber et al., 2009) for summarizing huge document corpora. More recently, political scientists have applied topic modeling to study judicial processes (Quinn et al., 2010), the agendas of elected policymakers (Grimmer, 2010), and patterns of censorship in Chinese social media (King et al 2012). Many of these approaches have imposed additional structure on the statistical model of actors, including the explicit treatment of time (Blei and Lafferty, 2006), and the document-author relationship (Grimmer, 2010). Each of these amount to imposing additional hierarchical structure on the Dirichlet process assumed by LDA and related models.

The framing process considered here does not merit such additional structure. Public consultations do not occur with any regularity, rendering the time dimension uninformative. Because participation is voluntary, the incidence of repeat participation is sparse, such that few respondents build up a large corpus of responses over time. Furthermore, since the sector-level pattern of interests is one outcome under estimation, it would assume one outcome to impose a a sector-firm hierarchy.

With this background, the direct analogy between Latent Dirichlet Allocation and public comment processes becomes clear. Public comment processes frame a policy discussion over a set of policy domains; when responding, respondents select from those domains based on their interests. Policy domains can be thought of as latent variables, defined as distributions over specific policy language (distinguishing a domain on *emissions control* from a domain on *technological innovation*). Hence the framing process effectively generates topics, thought of as pre-existing distributions over terminology and language, that shape how firms respond to policy proposals.

In practice, this permits a modeling approach that directly maps from the language used by respondents to their expressed interests in the policy domains under consideration in the consultation itself. That modeling approach goes as follows:

1. **Document baseline**: Treat the original policy proposal as a corpus of documents, each document constituting a single paragraph assumed to address primarily one policy domain

2. **Topic discovery**: Fit a LDA topic model to this corpus

3. **Topic projection**: Use that model to project firm responses onto topics discovered by LDA, understood as the mixture of topics within each response as estimated by the model

Figure 6.1 provides a schematic overview of the relationship of the framing process to the modeling approach. The modeling process outputs the distribution of each respondent's expressed interests over the policy domains considered in the public consultation process. We can treat this as either a continuous distribution; or as a discrete distribution wherein respondents are treated as being interested in a specific domain if that domain assumes more than a certain proportion of that distribution.

6.7.3 Estimating and testing interest overlap

To return to the central question that motivates this chapter: do firms express overlapping, though perhaps asymmetric, interests in the specifics of European climate and energy policy? Given the distribution of firm interests over topics, we can now estimate this in straightforward fashion.

Consider a public consultation process that covers a set of topics Θ as discovered by modeling the language of the policy proposal itself. Each respondent r is found to have a distribution δ_r of expressed interests over Θ. We can discretize that distribution by treating all topics θ as interests if the value of θ in δ is greater than some threshold τ. Filtering in this manner also helps reduce the incidence of superfluous comment bias, discussed further in section 6.7.6.

We can now measure the overlap among interests between firms as the overlap of sets of interests between pairs of firms. Formally, for any two respondents r_1, r_2, we may define the overlap ω between their sets of expressed interests I_{r_1}, I_{r_2} as the Jaccard index of their interest sets, $\omega_{r_1,r_2} = \frac{|I_{r_1} \cap I_{r_2}|}{|I_{r_1} \cup I_{r_2}|}$.

The reader will notice that we have constrained firms' interests to a pre-defined set. Hence there is now a non-zero probability that the estimated overlap between two respondents results from random chance, rather than actual expressed interest. We wish to test whether the interest overlap we do observe is notable given the possibility of overlap due solely to chance. Take, for example, the limiting case of a model that discovers only one policy domain in the Commission policy strategy. Using that model to project the interests of respondents would yield the implausible conclusion that everyone had exactly the same interests. At the other extreme, the likelihood of interests similarity among two respondents with identical interests in a policy discussion that ranged over a thousand different policy domains would be high. We need some means of accounting for whether the observed overlap is notable or not.

To test for the effects of randomness, we estimate whether the observed overlap ω is non-random by estimating the p value for each ω via Monte Carlo simulation. A pair of respondents r_1, r_2, express m, n of Θ possible interests. We draw N pairs of interests sets, each pair containing m, n interests. The p value for ω_{r_1,r_2} is then the share of those N draws with a Jaccard index greater than the empirically-observed index ω_{r_1,r_2}. Intuitively, smaller p values suggest that the observed overlap between the expressed interests of the two respondents was less likely due to random chance within the constrained selection process imposed by the topic modeling process.

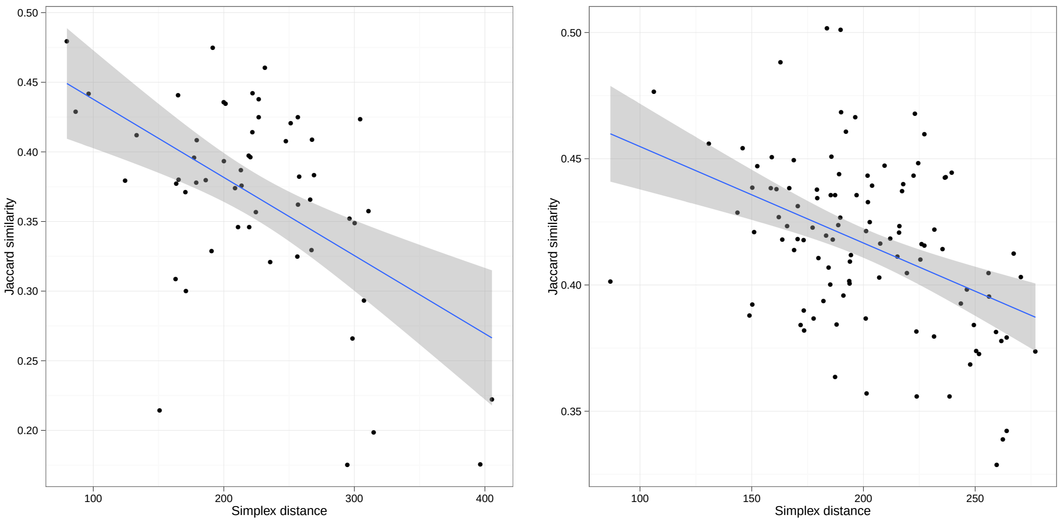
Finally, we must correct for the multiple-comparison problem, wherein for M pairwise comparisons we might expect some subset of those M be rare simply by chance. In this case, we use the Benjamini-Hochberg false discovery rate FDR (Benjamini and Hochberg, 1995) to correct for multiple comparison.

Likewise, we can test whether the observed overlap between firms r_1, r_2 is an outlier among the firms we do observe. Here the p value is the share of all overlaps $\Omega > \omega_{r_1,r_2}$.

Moving from pairwise firm overlap to sector overlap, we can then estimate the overlap in interests among sectors S_1, S_2 as the *mean pairwise Jaccard index* for all possible cross-sector firm pairs. Variance is estimated by bootstrap. Likewise, we can estimate the degree to which these overlaps were novel by estimating for any set of pairwise comparisons the share of FDR less than a threshold $T = 0.1$. Finally, to check for whether the measurement of firm interest similarity was biased by the process of discretizing interests, we check the results by comparing them to firm similarity as measured by distance on the multidimensional simplex, as used by Grimmer (2010). In practice the results are highly correlated, as shown in figure 6.9.

6.7.4 Data and implementation

Data for the original policy proposals come from the official documents published by the European Commission and released as part of the public consultation process (specifically The European Commission (2007) and The European Commission (2010b)). Responses are taken from the publicly-released data files available at the



(a) 2006 (b) 2010

Figure 6.9: Correlation between measures of overlap among sector-level interests. This figure shows the correlation between two measures of sectoral interests: the mean pairwise Jaccard similarity among firms between two sectors; and the mean pairwise simplex distance between firms in two sectors. The Spearman rank correlation measures -0.275 ($p = 0.10$) for 2006 and -0.320 ($p = 0.00$) for 2010.

website of the Directorate-General for Energy.[5] Both the official documents and the responses were scraped from the provided PDF files using the Tesseract OCR suite.[6] Some responses were supplied in languages other than English; these were translated using the Microsoft Bing machine translation webservice.[7] As shown in figure 6.10, response length varied from 200-15000 words for the 2006 consultation; and 400-11000 words for the 2010 consultation. Median document length was 2100 words for 2006, and 1800 words for 2010.

Topic modeling used the implementation of Latent Dirichlet Allocation provided

[5] http://ec.europa.eu/energy/strategies/consultations/archive_en.htm

[6] More detail on Tesseract is available at http://code.google.com/p/tesseract-ocr/.

[7] Machine translation is convenient but imperfect. In particular, it encounters difficulties with grammar and word order. But the methods used here destroy both grammar and word order by representing texts as a bag-of-words. Hence the material impact of this form of translation error are limited. Note that as of 2012, the Bing translation webservice (and other commercial competitors) has much stricter usage caps than applied when the translations were originally conducted. Bing translation code is supplied at http://github.com/markhuberty/bing_translate.

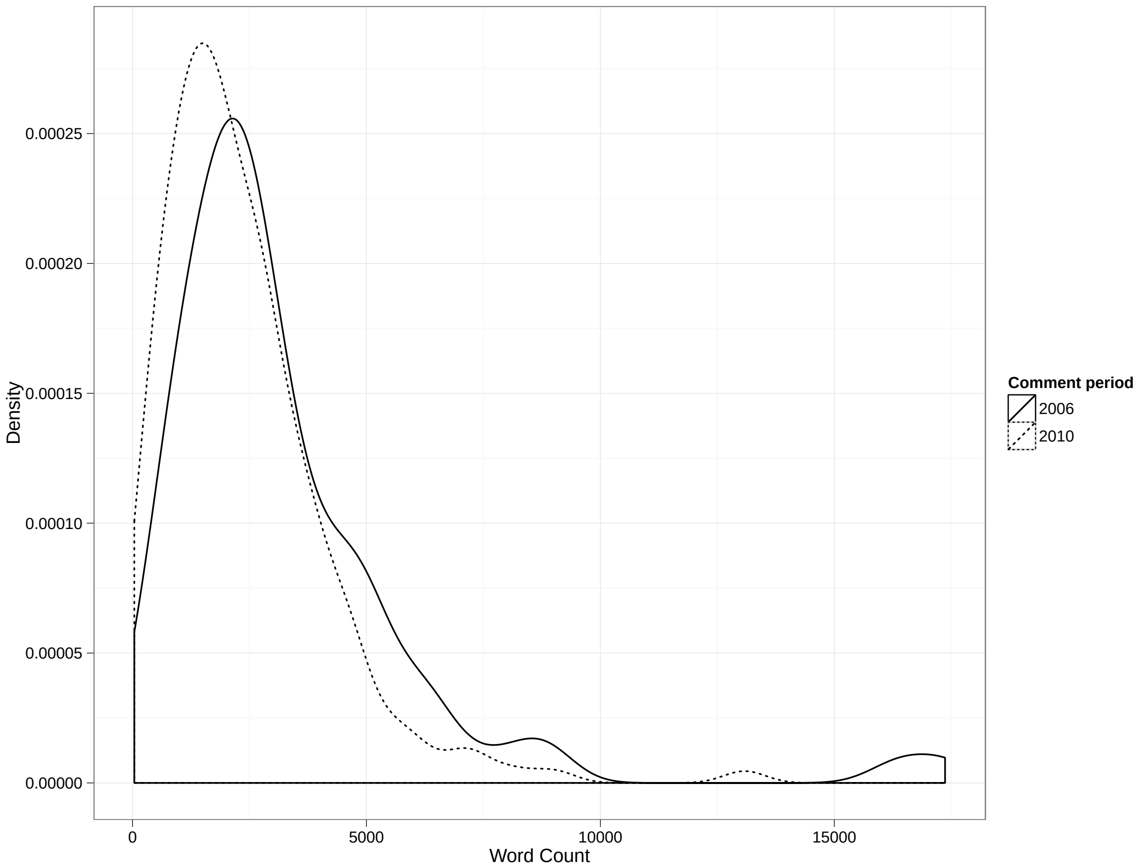


Figure 6.10: Distribution of respondent document lengths by comment period.

in the `topicmodels` package for R (Grün and Hornik, 2011). Standard preprocessing of the text–case standardization, stopword and punctuation removal, and feature selection via term frequency-inverse document frequency criteria–preceded modeling. Topic models were fit to each Commission document. Models were selected to maximize the log likelihood of the model in a randomly held-out 10% of each policy proposal.[8] These models were then used to generate estimates of expressed interests for respondents. Expressed interests were discretized by selecting interests for each respondent that composed more than the median topic share of any topic for any respondent.

[8]Model choice depends on the initial randomization. Hence we choose 100 initializations at random and fit a model under each initialization to maximize the log-likelihood of a randomly held-out subset. The number of topics was chosen based on plurality voting across all 100 initializations.

6.7.5 Robustness checks

This analysis makes three conceptual assumptions about the relationship of the estimated topics to firms' actual interests. Each assumption merits discussion:

1. It does not attempt to estimate the semantic polarity (positive or negative sentiment) of firm's orientation towards a topic. Instead, we assume that positive interest and expressed interest are well-correlated.

2. It does not distinguish between statements about the past state of the world, and preferences for future changes.

3. It assumes that we don't need to account for the degree to which a firm discusses a given policy domain, only that they do discuss it.

The first assumption reflects the difficulty of accurately estimating sentence polarity. Polarity relies heavily on contextual clues. Modeling those clues poses deep analytic problems for natural language processing. Some methods for polarity analysis rely on pre-tagged sentiment indexes like OpinionFinder (Wilson et al., 2005). But these methods face limits when confronted with a clearly polar sentence that nevertheless lacks clearly polar adverbs or adjectives, as in "this policy will not work". Inspection of several documents indicates that firms' topic emphasis appears to largely reflect areas they would like to see implemented, rather than explicit discouragement of specific policy aims. But this remains a potential area for improvement in the methods employed here. It also reinforces the importance of careful reading of a sample documents, as done in section 6.4.2, to corroborate the modeling assumptions employed here.

The second assumption–that we need not distinguish between statements about the present, versus preferences for the future, was tested by first screening for "modal", or future-oriented, statements in each text. Each text was parsed into discrete sentences. Only sentences with "modal" or aspirational statements–defined as sentences employing words like "would", "could", "should", "plan", "must", and other signifiers of future preferences–were retained.[9] I then re-estimated the posterior predictive topic distributions for these future-oriented documents. As figure 6.11 shows, the resulting topic distributions were closely correlated. Pearson correlations between the topic distributions for the full document, and for the modal documents, exceeded 0.8 for both public consultation processes.

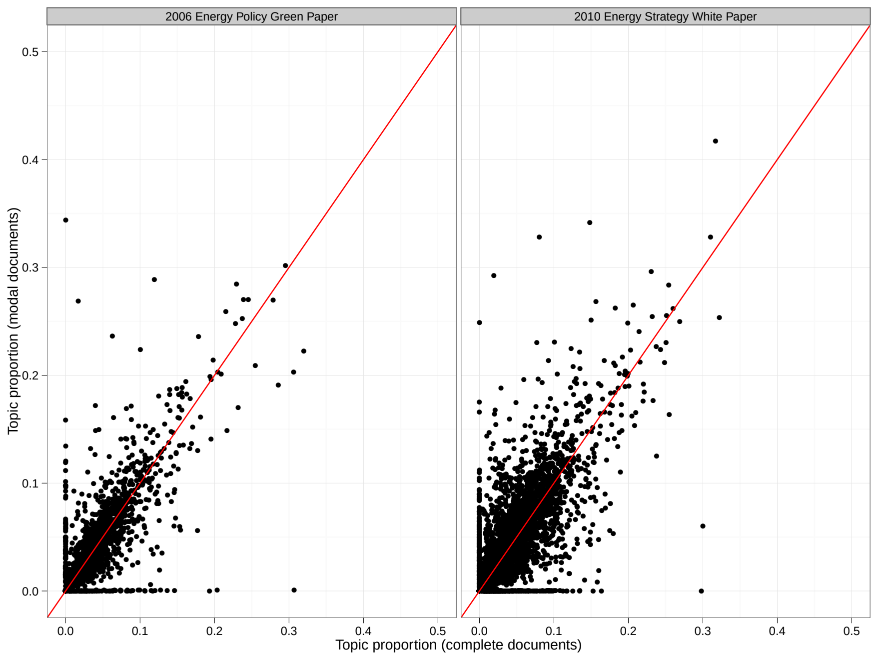


Figure 6.11: Correlation of topic distributions between complete responses and their modal subsets. Modal subsets refer to the subset of sentences in a response that contain modal words indicating future preferences. Each point represents the proportion of a response from a single firm corresponding to a single topic.

[9]A more sophisticated version of this procedure was also tried. Each sentence was tagged with a part-of-speech tagger using the Penn Treebank (Marcus et al., 1993). Tag frequencies were then counted by sentence. A classifier algorithm (either a support vector machine, random forest, or lasso regression) was then trained to map tag frequencies to a sample of sentences hand-labeled as either "present" or "future". The effective accuracy of this method did not improve substantially on simple classification with modal words. In practice, the only reliably predictive coefficient was in fact the modal tag, indicating that modal word presence was a good proxy.

The third assumption–that topic proportion is superfluous information for estimating the similarity of firm interests–is difficult to test without some external benchmark of firm interest intensity. Recall that section 6.7.3 justified discretizing estimates of firm interests as a means of discarding "superfluous" or perfunctory commentary. In the limit, the assumption is reasonable: a firm which never mentions nuclear power in its response likely has no position on the matter. Likewise, a firm that only discusses nuclear power strongly signals very narrowly defined interests. But the middle ground between these extremes is more ambiguous.

As section 6.7.3 discussed, we can test this proposition by comparing estimates of interest overlap among firms using a discrete (Jaccard) versus a continuous (multidimensional simplex) measure of overlap. If overlap estimates diverge between these two measures, it would signal potential problems emerging from throwing away rank-order information and low-salience interests. But we do not observe this divergence in either the 2006 or 2010 outcomes. Figure 6.9 shows the correlation between the Jaccard and simplex measures of similarity for both 2006 and 2010; both are well-correlated. Hence estimating firm interests as discrete entities does not, in this case, appear to corrupt the inferences we are trying to draw about firm interest behavior.

6.7.6 Sampling and selection issues

Participation in public consultation is of course neither mandatory nor is it the only means at firms' disposal for influencing policy outcomes. This raises the question of whether and how firms' responses are skewed through selection bias. We need to consider two separate selection issues:

1. Is the *sample of firms* skewed?

2. Do firms skew *what they say*

For the purposes of this chapter, I argue that the sample is skewed, but in ways that are reasonably obvious for this policy domain. Furthermore, while firms probably do behave strategically when deciding what to say in response to calls for comment, I argue that many consequences of this strategic behavior aren't relevant to the conclusions drawn here.

Respondents and selective response

The selection of firms is almost certainly skewed. As tables 6.1 and 6.2 show, respondents represent a broad cross-section of sectors. However, several obvious geographic biases exist. The most notable omission in both 2006 and 2010 is Electricitè de France (EDF), the large integrated electricity utility at the heart of the French electrical system. This is particularly notable because the Third Climate and Energy package was in many ways highly favorable to EDF. Most notably, it did not include the Commission's original proposal to force the breakup of vertically-integrated firms like EDF. But EDF's absence is likely due to its particular relationship to the French government. As one of the few "national champions" that survive from France's postwar industrial policy, EDF has close ties to the French state. In turn, France holds an effective veto in the European Council, ensuring that EDF's interests are specifically represented.[10] EDF thus has relatively little incentive to participate in public consultation, even if the policies under consideration will affect it directly, because it has other, very powerful channels of influence. Elsewhere, major vertically-integrated utilities from other countries–such as E.ON and Energie Baden-Würtemburg from Germany–are well-represented in the respondent sample. Moreover, their stated preferences–for various forms of market opening, but against the formal breakup of vertically-

[10]For a long discussion of the relationship between the preferences of EDF and the French state in earlier periods of European energy policy making, see Eising (2002). He notes that both EDF and the French government changed bargaining positions quickly in order to ensure leverage against stronger supporters of liberalization, particularly the United Kingdom.

integrated entities–are consistent with the known preferences of France and EDF.

Separately, western European firms are over-represented compared with their eastern European colleagues. This is particularly true in for the period directly preceding the passage of the Third Climate and Energy Package. This likely reflects relatively less sophisticated firms with less-developed roots in Brussels.

Strategic disclosure of firm interests

Hence firm participation is likely skewed, but the ways in which it is skewed are reasonably clear on inspection. Whether firms' responses are skewed is a more difficult problem to assess. Firms may act strategically in choosing both which positions to disclose, and how to describe those positions. Taking firm statements at face value, despite the potential for strategic disclosure, may lead to invalid inferences about firms' true preferences. Broockman (2012) demonstrates that overlooking this issue has introduced bias into studies of private sector interests with respect to the United States Medicare program: *contra* earlier authors, he shows that firms did not in fact support Medicare. Instead, what support they did voice has to be understood as a strategic response to the overwhelming pressure to pass Medicare in the mid-1960s. In that environment, firms' strategic interest lay in shaping what law did pass, rather than a futile attempt to achieve their true preference, the maintenance of the status quo.

In the public comment processes studied here, some firms and business associations display evidence of strategic disclosure. The American Chamber of Commerce responded to both the 2006 and 2010 strategy papers with language that was (1) broadly supportive of the Commission, (2) cautionary about aggressive pursuit of renewable energy or emissions reduction, (3) very supportive of improved energy security and new source exploration, and (4) generally in favor of improved efficiency.

These positions contrast with those the Chamber took in the United States around the same time. There, the Chamber strongly opposed the Democratic Party's attempt to pass a climate change bill. This opposition took one of two forms: either outright blockage, or alternative proposals (such as a carbon tax) that were known to be politically impossible. The Chamber was also far more openly skeptical of the underlying climate science. Its then head of energy policy openly cast doubt on the science behind climate change. Invoking the famous standoff between biological evolution and Biblical creationism, he called for a "Scopes trial" to expose the flaws behind climate science and the corruption of the scientists that generated it (Krauss and Galbraith, 2009; Burnham, 2009).

The different positions taken by the Chamber on opposite sides of the Atlantic at approximately the same time provide a material example of strategic interest group behavior. The European climate policy context in 2008 was very different from the American: it was less tolerant of outright climate denial, it already had a cap-and-trade system in place, and there was strong momentum behind taking additional steps to reduce emissions and reform energy markets. Given these differences, it's unsurprising that the Chamber adopted different positions: seeking to limit what it perceived to be further damage in Europe, while stopping policy outright in the United States.

However, this form of strategic behavior arguably does not matter for the inferences drawn here. The problem of strategic disclosure identified by Broockman (2012) matters if we wish to attribute *agency*: in his case, it weakens earlier arguments that firms desired and lobbied for, rather than either opposed or merely tolerated, a Medicare-style program of old age health insurance. But nothing in this chapter should be construed as stating that any given firm or sector (and in particular the sectors most closely associated with fossil fuels) necessarily sponsored or otherwise drove the climate policy process.

Rather, the interest group behavior studied here reflects how firms positioned themselves given both existing EU policy and the Commission's decision to pursue policy reforms. Whether ostensible opponents like the American Chamber of Commerce would actually have preferred a very different policy isn't relevant to the arguments here: that wasn't the policy context on the table. Instead, we are interested in what firms saw as in their interest given the context at hand; and whether the structure of those interests opened up the possibility of cross-sector coalition-building. Indeed, the central contention of the arguments here does not require that these firms all wanted comprehensive climate policy. Instead, firms merely need to find some benefit in one more more instruments used to effect a low-emissions energy systems transformation. Whether firms' stated interests in that context actually reflected their first-best desires, or merely a position adopted for strategic reasons, would matter if we had asserted that these interests reflected firm *sponsorship* of subsequent EU policy. But this chapter only sets out to show that the landscape of firm interests were amenable to a specific kind of policy design.

7 Conclusions: the limits to linkage

7.1 Introduction

The European Union is held up as an example of "making policy for climate's sake" (Nelson and Vladeck, 2013). That may be. But this dissertation has shown that designing policy *for* the climate means building policy *with* industries traditionally ambivalent about it. The vital role played by energy in modern industrial society, the complexity of a transition to a new low-emissions energy system, and the costs incurred during that transition make it politically difficult, and technically unwise, to treat climate *goals* and environmental *means* as inseparable. The political cleavages wrought by strategies that do so complicate the passage of climate policy, and undermine its sustainability over time.

Instead, I have argued that successful policy regimes have found ways to couple long-term climate goals to concentrated near-term economic benefits. Those benefits flow from the tasks required to transform legacy energy systems. They may include resolving old problems, improving service quality through new infrastructure investments, supporting economic competitiveness through low-emissions research and development, or improving energy security. The real and tangible benefits that come from these tasks help inculcate new constituents with an economic stake in environmental goals. Consequently, the survival of climate policy need not depend solely on the environmental good will of firms and citizens–an unlikely prospect in any event. Instead, these new constituents become advocates for policy continuity through the economic benefits such policies bring, and not just the environmental salvation they promise.

While this dissertation has focused on the European Union, climate policies built on issue linkage have become increasingly common. In South Korea, the Presidential Commission on Green Growth explicitly linked solutions to South Korea's environmental problems–of which climate change is one–to policies that will set the stage for the next wave of economic development (Jones and Yoo, 2011). In the United States, California has repeatedly asserted a link between its knowledge-based, innovation-driven economy, and its stance on renewable energy adoption and emissions control (State of California, 2010). China has become a leading exporter of photovoltaic solar cells, though exactly how that international prowess will affect domestic decisions remains uncertain. These and other examples point to states *attempting* to found environmental policy on economic grounds. But for every South Korea or California, there are far more states where policy has fallen short, if it was even contemplated at all.

What, then, are the limits to linkage? Despite the growing popularity of linkage strategies for climate policy, issue linkage does not fully resolve the fundamental tension at the heart of long-run climate change politics. As currently understood, the low-emissions energy system of the future offers no material improvement over the fossil fuel systems of today. Issue linkage succeeds as a political strategy by concentrating what benefits might flow from a low-emissions energy systems transformation, and drawing political support from those who enjoy those benefits. But writ large, that transformation does not offer economic benefits over and above the capabilities of today's fossil fuel energy systems. The cost of systems transformation remains a cost to bear for the climate, rather than an investment in near-term, absolute gains in material prosperity.

This conclusion outlines two cases that point to the limits of linkage. The European Union, to date a paragon of climate action, now faces prolonged economic stagnation and financial instability. As the EU prepares for the next phase of reforms to its climate policy framework, those economic difficulties have limited both the economic capacity and the political will to take further action. Issue linkage could help buffer the costs of transition when times were good; but the severity of the economic downturn is testing its capacity to hold a coalition of industrial actors together.

In contrast, the United States points to the difficulty of employing issue linkage when the underlying energy system offers little support. In contrast to the EU, the American energy system embodies relatively fewer benefits for climate policy advocates to call on. This relatively inhospitable context created real problems for issue linkage strategies as the United States Congress attempted to pass a comprehensive climate change policy in 2009. Whether those problems can be overcome remains uncertain.

Finally, what of the more extreme version of issue linkage–the idea that low-emissions energy marks the start of a new industrial revolution, on par with those earlier energy transitions discussed in chapter 2? If true, this development might render issue linkage unnecessary. Instead of fretting over the cost of transformation, countries would pursue it for the absolute economic advantage promised by new alternative energy sources.

7.2 The power of linkage

This dissertation began by noting the three central political problems endemic to climate change mitigation: the scope of the investment, the diffuseness of the reward, and the unyielding timeframe. Effective climate change mitigation requires substantial investments, now and for the foreseeable future, to ensure global environmental stability. Though the real damages of unchecked climate change lie decades off, the physical process of climate change demands that those investments begin today. The cost and scale of that investment, its acute impact on specific sectors, encourages strong opposition. Without equally strong advocacy from policy beneficiaries, passing and implementing policy proves difficult. And the more difficult it proves, the more time passes, and the greater the cost–and more uncertain the effect–of future climate action becomes.

Issue linkage offered a solution to only one of these problems. By structuring a low-emissions energy systems transformation to generate acute benefits, policymakers might be able to build industrial coalitions supportive of policy action. Those coalitions would have a greater chance of success against well-motivated opponents than coalitions motivated by environmental stewardship alone. Yoking climate change mitigation to the material challenges and opportunities of energy investment thus promised a political strategy with better prospects for garnering support.

Hence issue linkage strategies may work because they address one of the three major barriers to effective climate change mitigation. They likely won't reduce the cost of emissions reduction, and they can't relieve the tight timeframe for action. But they do help maximize and concentrate the material benefits created by a low-emissions energy systems transformation. In doing so, they lay the groundwork for supportive policy coalitions grounded in economic benefits, rather than mere environmental aspirations. Political science suggests that such policy coalitions will likely be more durable, more capable of collective action, and less likely to erode over time than alternatives reliant on non-material goals alone.

7.3 The limits to linkage

By implication, however, linkage only promises a means of building political coalitions more durable to the cost of climate change mitigation. It does not solve the underlying tension that makes climate politics difficult in the first place. That tension originates with the implicit opportunity cost of investing in long-term environmental stability versus short-term economic prosperity. That trade-off exists not for lack of policy will, but because of the relative technical capabilities of fossil fuels and low-emissions power, and the lack of obvious and acute *absolute* material benefits in switching from one to the other.

Hence even a climate change mitigation strategy built on issue linkage remains vulnerable. Two vulnerabilities merit particular attention, especially as they become apparent in the policy experience of the European Union and the United States. First, can issue linkage survive the business cycle? Will strategies that delivered targeted benefits to constituents in relatively good times survive the fiscal retrenchment brought by economic difficulty? Or will climate policy, even when designed to create economic constituents, still fall low on the priority list? Second, can issue linkage work in the context of legacy energy systems that offer fewer obvious benefits to systems transformation? Chapter 3 argued that issue linkage depends on a supportive policy environment. How supportive must it be?

For the first, the EU suggests the danger of economic stagnation to a policy strategy of issue linkage. For the second, the US experience with climate policy illustrates the difficulty that legacy energy systems pose when they undermine, rather than augment, the ability to tie climate action to economic returns. Both examples point to the limits of linkage–both to the changing circumstances within a polity, and to the variation in circumstances across them.

7.3.1 The European Union and the cost of economic stagnation

The study of European climate policy presented in chapters 4-6 focused on the development of European climate policy through its most recent overall in 2008. Since 2010, however, European climate policy has stagnated, if not reversed. Emissions lie 16% below 1990 levels, on their way to the 20% target. Renewable energy adoption has proceeded apace, with average annual growth rates of around 4% (The European Commission, 2013b). But emissions reduction has come largely through reduced economic activity, as Europe endures its worst economic performance since the Great Depression; and renewable energy growth lags behind the 6% per annum required to meet the 20% target for 2020 (The European Commission, 2013a). Europe's recent progress on its goals has come at a pace, and through a method, insufficient and unattractive for long-run policy.

In this context, three developments merit specific attention. First, economic stagnation has reduced the capacity for the EU to engage in energy-related investment. Second, that same economic stagnation has depressed the long-term price of emissions in the Emissions Trading System, reducing its effectiveness as both a subsidy regime and an emissions control mechanism. Third, changes in the national policy of several member states–most notably Germany–will likely slow European progress on emissions in the near term. Each of these developments undermine Europe's policy regime without actually dismantling it.

First, economic stagnation. After the 2008-2009 financial crisis, Europe slid into a prolonged economic recession. The policy response was weak, and little fiscal or monetary stimulus occurred in the EU as a whole. The so-called PIGS (Portugal, Ireland, Greece, and Spain) incurred high unemployment and worsening fiscal balances. They subsequently engaged in harsh austerity as a condition of fiscal support from the Eurozone core. Unemployment in the EU periphery spiked into the double. Fiscal austerity appears to have worsened primary balances as well as economic growth: the United Kingdom, which had avoided the fate of the PIGS, endured a double-dip recession consequence of very severe budgetary austerity.

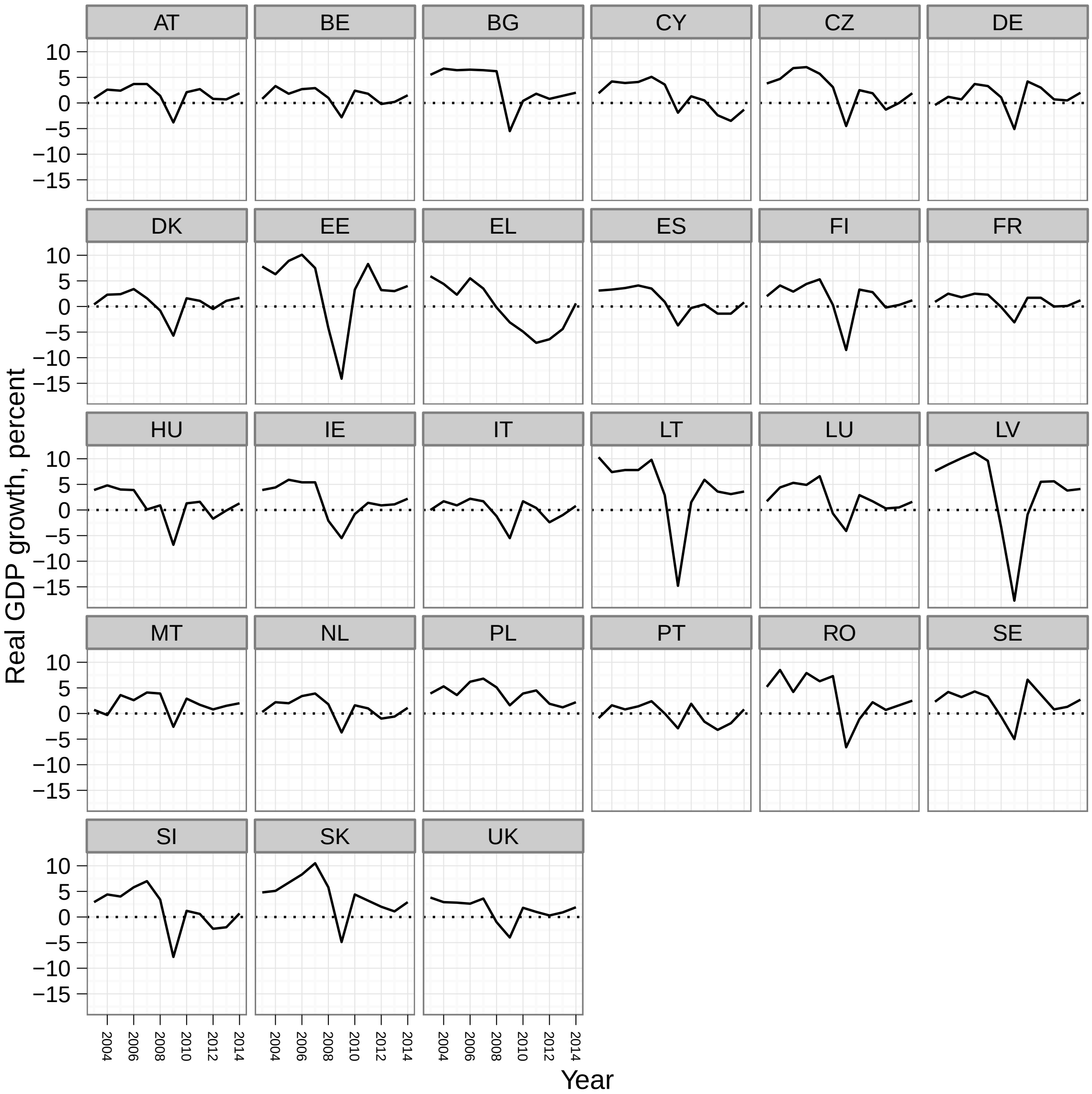


Figure 7.1: Economic growth in the European Union around the financial crisis. All data show real GDP growth per annum. Source: Eurostat.

These developments had two effects on European climate policy. First, they limited the resources–public or private–available for investment in low-emissions infrastructure and technology. Feed-in tariffs to subsidize the adoption of renewable energy were cut in Germany, Spain, and the United Kingdom.[1] Appeals by European Energy Commissioner Gerhard Öttinger for member state contributions to investments in cross-border interconnector capacity worth €1 trillion fell largely on deaf ears. Forced to choose between continued investment in low-emissions technology, and provision of more basic governmental services in the face of budgetary austerity, many states have chosen the latter.

Second, prolonged economic stagnation reduced demand for emissions permits under the Emissions Trading Scheme. Factories and power plants sitting idle for lack of demand had little use for the permits they already owned, and no reason to buy additional permits. Weak demand and excess supply depressed permit prices to a low of €2.13 per ton in early 2013, down from €30 per ton in 2008. At that price, the ETS could fulfill neither of its two primary functions. Low prices weakened incentives for alternative energy adoption, energy efficiency investments, and other climate change mitigation measures. Low permit prices also undermined the second role of the ETS, that of shadow budget. The scale fiscal transfer accomplished through free permit allocation, discussed in detail in chapter 4, fell with the value of the allocated permits.

The EU has attempted to respond to these challenges, though without much success. In April 2013, the European Commission proposed to stabilize the ETS permit price by reducing the number of permits in circulation. As of this writing, those changes were rejected by the European Parliament, though negotiations remain ongoing (McGrath, 2013). The vote raised the spectre of a split between traditional political allies in the energy sector and energy intensive industries. The energy sector lobbied for tightened permit caps to preserve both regulatory certainty and the value

[1] For Spain, see Chazan (2010). For the United Kingdom, see Harvey (2012), though the form and degree of cuts remains contested (BBC, 2012). German solar tariffs were cut, but installations continued apace as the German government committed to retiring all of Germany's nuclear plants (Steitz, 2012). For a complete discussion of recent changes in German feed-in tariff policy, see Fulton and Capalino (2011).

of their freely-allocated emissions permits. In contrast, energy intensive industries, facing increased competition from Chinese and American firms (the latter enjoying record-low prices for natural gas) fought any attempt to raise the permit price. Their resistance highlights what Helm et al. (2004) had pointed out: management of the carbon price across the business cycle requires a degree of political insulation usually found in central banks. In this case, the Parliament's rejection of a pro-cyclical increase in the price European firms pay to emit points to the limits of carbon pricing as a viable instrument. Furthermore, having coupled the pricing instrument to a compensation scheme, that choice frays the political bargain as well.

This is not to say that the European project is doomed. Germany's commitment to retire its nuclear power plants by 2022 appears real, and will require substantial expansion in its renewable energy capacity. It also risks, however, near-term expansion in the use of coal and natural gas (Nicola, 2013). Portugal has recently demonstrated that it can accommodate up to 70% renewable power for months at a time, of which about half came from intermittent sources (Koronowski, 2013; Ashton, 2012). At the EU level, the Commission continues to plan for achievement of the 2020 targets, and, as noted above, to look forward to reforms needed for 2030. But over the near term, Europe's linkage strategy still risks falling short as the cost of further investment outstrips the willingness or ability of governments and citizens to pay. The edifice of emissions pricing and market reform would remain, while the core ceased to function.

7.3.2 The United States and the barrier of the energy system

If the EU showcases the limits to linkage under the pressure of changing circumstances, the US illustrates the structural barriers that might arise to linkage strategies in the first place. The United States has routinely failed to adopt comprehensive climate change policy. That failure has occurred regardless of what party held office, or whether it was pursued in good economic times or bad. Moreover, that failure has occurred despite appeals to a strategy of issue linkage to sustain American climate goals. A variety of policy advocates (Jones, 2008; Stepp, 2010, 2011) have argued for a substantive link between American economic prosperity and investments in low-emissions energy systems. Other analysts point out the savings that could be had from remaking America's power grid, whose current state of decrepitude makes the US economy more vulnerable to blackouts, extreme weather events, and equipment failure (Gellings, 2011). Still others, particularly after the terrorist attacks of September 2001, point out the absurdity Americans of buying oil from the Middle East even as they decry the politics and policies those oil dollars help fund (Farquhar, 2009).

By and large, however, these appeals have not contributed to broad support for a coherent approach to a low-emissions energy systems transformation. Instead, as Nelson and Vladeck (2013) show, American policy is a hodgepodge of subsidies, command-and-control mandates, and regulation. Though without the degree of coordination observed in Europe, it is not without success: American emissions have stabilized despite economic recovery (Energy Information Administration, 2012). Yet much of that stabilization depends on the ongoing substitution of natural gas for coal, consequence of the boom in shale gas (Carey, 2012). While fuel switching helps retard the growth in fossil fuel emissions, it does little to resolve state-level issues over renewable energy integration, long-distance grid transmission, and inter-state competition over low fuel prices. It may also undermine investment in renewable energy technologies, by enlarging the "green spark spread" between fossil fuel- and renewable-generated electricity (Wynn, 2011). Cheap gas, in concert with budgetary austerity, has also pressured US states to restrict or eliminate their mandates for renewable energy adoption (Martin, 2013).

Against this background, recent attempts to formalize a federal approach to climate change policy point to a different set of limits to linkage. The 2009 American Clean Energy and Security (ACES) Act would have set up a carbon trading market in the United States, and used the revenues from that market to both support renewable energy investment and buffer transition costs for the fossil fuel industry and export-oriented sectors. The bill passed the United States House of Representatives 219-212, on a nearly party-line vote. The bill was never brought to a vote in the Senate. Subsequent proposals for a federal clean energy standard have also found little traction.[2]

The reasons for this policy failure are complex and arguably over-determined. Institutional dysfunction, unrelated to either climate change or energy policy, certainly played a role. ACES failed in the Senate in part due to filibuster threats from the Republican minority (Chaddock, 2010). This was part of a broader trend towards increased use of the filibuster that now affects almost every aspect of the Senate's business (Talev, 2007; Marziani and Liss, 2010). In that sense, the most recent failure of American climate change legislation is over-determined–it certainly bears the taint of the more general institutional paralysis that has gripped Washington, D.C. in the early 21st century.

Climate change has also become wrapped up in the broader polarization of American interests groups and the party system. This had led not just to agreements over policy *means*, but to polarization of opinion on whether policy problems exist at all. In the run-up to the ACES vote, climate change skepticism became common among conservative voters and political action groups, and was echoed by Republican Congressional representatives (Nordhaus and Shellenberger, 2009; Dunlap and McCright, 2008). The head of climate and energy policy for the American Chamber of Commerce called for a "Scopes trial" to expose fraudulent climate science (Krauss and Galbraith,

[2]Senator Jeff Bingaman introduced the Clean Energy Standard Act (Senate Bill 2146) in 2012, which would have mandated a clean energy portfolio standard targeting 84% renewable energy consumption in electricity production by 2035. It died in committee.

2009; Burnham, 2009). The Competitive Enterprise Institute, a conservative economic think tank, ran ads throughout the Washington D.C. area with the slogan "CO_2: they call it pollution, we call it life!", based on the discredited notion that increased atmospheric CO_2 concentrations would improve plant growth. The American Enterprise Institute has floated a revenue-neutral emissions tax as superior to a cap-and-trade system, but in doing so came under fire from other conservative groups opposed to new taxes of any form (Hassett et al., 2007; Hargreaves, 2012). This context exacerbated the political difficulty of passing any form of low-emissions policy, as the political debate devolved into partisan conflict rather than bargaining over policy instruments. This again, echoed broader themes in American politics that could be found in health, fiscal, defense, and other environmental policy domains.

Looking beyond these long-term political dynamics, however, climate policy advocates did attempt some version of a political strategy built on issue linkage. President Barack Obama argued that the US should act on emissions control "to truly transform our economy, protect our security, and save planet from the ravages of climate change" (Layzer, 2011). The US Climate Action Partnership (USCAP), which brought major industrial firms and environmental policy groups together to lobby for policy action, marked a concerted attempt to bridge the persistent environment-economy divide. The terms of a prospective bargain were clear: the environmental lobby would get climate protection; and industry would gain a stable policy environment with a predictable emissions price, more regulatory flexibility on conventional low-emissions energy sources like nuclear power, new investments in power grid infrastructure, and federal support for research, development, and piloting of new low-emissions technology.

As Skocpol (2013) and Pooley (2010) point out, though, the bargaining process inside USCAP was highly unequal. Environmental interests had little to offer either the energy sector or the broader industrial economy beyond policy stability–but stability in the form of predictably higher costs and more rapidly depreciated capital. Hence, Skocpol argues, the bargaining process was problematic from the start. Industry could always argue that costs were too high. The absence of tangible benefits left policy supporters bereft of means to build strong supportive lobbies for change. Instead, the fight devolved to arguments over the distribution of costs–fights that ultimately complicated the proposed regulatory regime and undermined its potential effectiveness. That, in turn, fragmented the environmental lobby: both Greenpeace and Friends of the Earth ultimately opposed the bill, along with hundreds of other smaller groups. Given the lack of stable *insider* bargains, the failure to mobilize public opinion for climate action that Skocpol (2013) critiques damaged the cause even more.[3]

But why were benefits so hard to find? The answer lies, in part with the particular structure of the American energy system. Contrasted with Europe, the US lacks many of the obvious benefits the EU called on to justify its climate policy suite. Europe, we will recall, targeted benefits from export-led growth in renewable energy and energy efficiency technologies; reduced intra-European price volatility through market integration; reduced exposure to Russian energy geopolitics; and lower energy prices through increased market competition in the electricity sector. Each of these benefits originated in a particular aspect of either Europe's energy system or the interface between that system and the broader economy.

The rhetorical record shows that American politicians and policy advocates invoked similar benefits to justify climate action. But in the US, many of these benefits were either already realized, or much less attractive. American energy markets

[3]Of course, the problems of public opinion are deeply tied up in the strong partisan divide over climate change itself. That divide, as Harrison and Sundstrom (2007) note, is much less salient in Europe, possibly consequence of the role played by green parties in proportional representation systems. Hence even if mobilization had worked to *pass* climate policy, it's doubtful that it could have sustained climate policy given the broader partisan environment.

are already well-connected within the so-called FERC regions.[4] Cross-border energy trading among the US states, and between the US and Canada, has been the norm for decades. The Federal Energy Regulatory Commission (FERC) already has authority, granted in the 2005 Energy Policy Act, to coordinate the construction of interstate transmission capacity. Hence the major features of the Internal Market Directive were already in place in the US. To the extent that firms wanted these things, the opportunity to link their delivery to support for low-emissions energy had passed.

Energy security provided similarly weak motivation. The United States has significant domestic coal, oil, and natural gas reserves.[5] To the extent that the US has an energy security problem, it comes mostly from petroleum, of which the US imports approximately 45% of its demand (Energy Information Administration, 2013). Much of that oil, however, comes from relatively stable countries–Canada has been the largest exporter of crude oil to the United States since 2006. Furthermore, given the uses of petroleum, renewable energy may not be the obvious way to solve the energy security problem itself. Petroleum is largely a transportation fuel. Hence even if the US decided that its dependence on foreign petroleum was unacceptable, zero-emissions energy might not be the answer. For instance, an all-electric vehicle fleet fueled by coal- or gas-fired power plants might prove an easier option. US domestic

[4]The FERC power markets aggregate US states into integrated energy systems with shared markets for generation and transmission. There are presently ten FERC regions, of which eight span more than one state. Texas and California are each contained within their own FERC region, owing to their geographic size. Texas is relatively autonomous within its region. California, however, imports significant amounts of power, particularly hydroelectricity, from neighboring states. For more information, see http://www.ferc.gov/market-oversight/mkt-electric/overview.asp

[5]The European Union reports that the US had, as of 2010, approximately 237,000 million tons of proven coal reserves. Germany, the largest of the European coal producers, had only 41 thousand million tons. Europe's top five coal-producing states combined had proven reserves totalling only about a fifth of the American capacity. Europe's primary domestic oil reserves in the North Sea are in decline. In comparison, the International Energy Agency estimates that the US will become the world's largest oil producer by 2017. Prospective shale gas reserves are more comparable: the Energy Information Administration estimates that the US had approximately 39 years' worth of reserves at current consumption rates, compared with 43 years' worth for Europe. But Europe has avoided exploiting domestic shale gas for environmental purposes. For coal, see Europe's Energy Portal (2011). For expanding US oil production, see Rosenthal (2012). For gas, see Energy Information Administration (2011b). For European delays in shale gas exploration, see Scott (2013).

oil production is also estimated to increase substantially by 2030.

If the American energy system yields fewer problems to be solved, it also generates few opportunities to be seized. The US is a much larger, much more closed economy than most of the European member states. In that environment, export-led growth constitutes a much smaller share of economic activity than it might in Denmark or Spain. For comparison, consider that Denmark earns almost ten percent of its export revenue from wind turbines and related products. In comparison, the US in 2010 earned about three tenths of one percent of its export income from wind turbine goods. Coal exports alone ran approximately twenty times this value.[6] The US is thus unlikely to earn the same relative returns to green energy industry; and the lack of such returns those industries may have correspondingly less political power. Furthermore, the decline of manufacturing in the US has made both manufacturing firms and workers less politically powerful. And in any case, the National Association of Manufacturers allied with the American Chamber of Commerce against the ACES climate bill, arguing that its costs far more than they anticipated any uptick in demand for their goods.

Hence, even when major environmental groups set out for a "grand bargain" with industry, the American context relegated them to bargaining largely on costs. European policymakers could call on an array of benefits from energy systems transformation to help build supportive industrial coalitions. The structure of the American energy system–its relative energy security, regulatory and market integration, and weak green industrial capacity–deprived American policymakers and policy advocates of those options. In that context, striking bargains among policy elites that carried the force of economic as well as environmental support proved very difficult. Against

[6]US coal exports in 2010 totaled 82 million tons, at an average price of around $78 per ton. This equates to an approximate export value of $6.4 billion, or around twenty times the $322 million of wind turbines exported by US firms that year. For US coal exports, see Energy Information Administration (2011a). For US wind turbine exports, see the UN COMTRADE statistics for HS-6 code 850231.

the background of intense partisan polarization and institutional paralysis, this lack of upsides to the pursuit of low-emissions energy severely retarded progress.

7.4 Alternatives to linkage: the promise and problem of green growth

The limits to linkage expressed in these two cases have different features, but ultimately a common origin. Issue linkage as a political strategy cannot resolve either the cost or technical barriers to climate change mitigation. Those costs are particularly difficult to bear when the fall acutely on powerful industries and their workers who, in a world without a comprehensive global climate deal, fear lost competitiveness and jobs. Hence so long as the cost problem remains in effect, the fundamental political conundrum of climate change mitigation will also remain. Exactly how this problem will manifest itself will vary with national circumstance. In the EU, economic stagnation undermined the functioning of the ETS even as it diluted the will for policy reform; while in the US, the comparative lack of acute benefits from a low-emissions energy systems transformation undercut attempts to build broad industry-environment coalitions. While their roots are different, these two outcomes ultimate manifest the underlying problem.

Given these barriers, do options exist that would transcend the fundamental tension posed by climate change mitigation? The earlier periods of energy systems transformation discussed in chapter 2 suggested one answer. Each of those transformations occurred, ultimately, for one of two reasons: acute shortages, or novel economic opportunities. Shortages seem unlikely to motivate effective climate change mitigation. Petroleum in particular has occupied the attentions of the Peak Oil community, which warns of declining reserves amidst rising international demand. But Peak

Oil's consequences would fall largely on transportation rather than electricity generation. Global estimated reserves of coal and natural gas are somewhat more generous, though the estimated lifetime of available reserves clearly depends on substitution between different fuels. Regardless, the timeframes estimated for these peaks are wholly incompatible with effective climate change mitigation: most estimates put "peak fossil energy" sometime in the 2030-2040 range, which would imply persistent emissions well above sustainable rates for at least another two decades. Even those timeframes may prove optimistic: technological innovation continues to advance access to deep ocean, shale, and tar sands deposits of oil and natural gas that were though inaccessible ten years ago.

Novel economic opportunity promises a different outcome. If low-emissions energy delivered net economic opportunity–rather than merely some side benefits that might help balance costs–then it would open the opportunity for a low-emissions energy systems transformation to become self-sustaining. The enthusiasm for such an opportunity–broadly termed "green growth"–grew rapidly after 2008, as the financial crisis, ensuing recession, and lackluster international climate negotiations sparked a search for new policy avenues (Jones, 2008; OECD, 2010, 2011).

Unfortunately, this enthusiasm has not led to answers about exactly how a low-emissions energy systems transformation would actually create economic opportunity. In particular, green growth theories have yet to identify what novel economic advantages low-emissions energy might offer over fossil fuels. As Zysman and Huberty (2013), those advantages–and not the actual act of systems transformation itself–lay at the heart of earlier growth-enhancing changes to how economies produced, distributed, and used energy. As with wind turbines or solar cells, there were a lot of jobs and investment dollars to be had in building an electrical grid. But those jobs and investments weren't the transformative part of electrification. Rather, as Perez

(1983) argued, electrification transformed what was possible in the broader economy. It enabled the reorganization of factories, greater flexibility of assembly lines, the restructuring of communication, the creation of a new set of goods and services built on information transmission, and a range of other novel outcomes impossible (or at least very difficult) with coal, gas, or oil alone.

Green growth has yet to grapple with this problem. Instead, most of the investments required for a low-emissions energy systems transformation will go to preserving the functionality of the present system. Smart grids, effective electricity storage, capacity markets, and demand response pricing are all targeted at maintaining reliable, ubiquitous electricity despite the intermittency of wind, solar, and other renewable technologies. They do not, at present, appear to offer novel capabilities that would increase productivity or expand the set of goods and services an industrial society could conceive of producing. Hence while building out a low-emissions energy system founded on these technologies will certainly yield jobs and investment, those investments will remain dependent, to a large degree, on a non-economic motivation to invest in environmentally-favorable goods. Green growth, as presently constituted, does not resolve the basic conflict posed by the opportunity costs of low-emissions investment.

7.5 Conclusions: the future of a low-emissions energy systems transformation

Hence we have now come full circle. This dissertation began by noting the three central political problems in pursuing climate change mitigation: the scope of the investment, the diffuseness of the reward, and the unyielding timeframe. Issue linkage provided a means of concentrating rewards, so as to build political support for the actions needed to avert the damage of unchecked climate change. But linkage has its limits. Whether those limits arise through changing external circumstances, inhospitable starting conditions, or other factors, they all stem from the relative lack of material benefits to offset the costs of emissions reduction. Absent the ability to stabilize political coalitions via targeted benefits from the tasks needed to satisfy a low-emissions energy systems transformation, other options are presently unpromising. Fossil fuel shortages likely loom in the future, given current recovery rates and demand growth, but may come too late to motivate a timely switch to low-emissions energy. Likewise, green growth presently offers few obvious means to the kind of transformative, productivity-enhancing, service-expanding changes that drove earlier systems transformations.

Hence political strategies for implementing and sustaining a low-emissions energy system are likely to be in flux for the foreseeable future. Those that can structure policy to yoke support for emissions reduction to the tasks of systems transformation, likely will. The EU may persist in its current policy structure, without necessarily doing much more by way of its climate ambitions. But that also implies the continued "muddling through" seen in the United States, and processes of policy advancement and retrenchment as observed in Canada and elsewhere. Prospects for the development world are similarly uncertain. While distributed generation may permit electrification of poor countries without the expense of a heavy-duty power grid, that development has yet to take off. In 2013, China will begin an experiment in emissions pricing as a means to control its extremely bad air pollution problem (Liu and ClimateWire, 2013). How that experiment balances China's domestic pollution problems with the political imperatives for economic growth remains unclear.

This conclusion makes the potential for issue linkage through a low-emissions energy systems transformation both compelling and, simultaneously, fraught. In theory, yoking environmental ends to economic benefits can yield broad coalitions supportive of climate policy. But those benefits do not arise in all countries in the same form, nor are they reliable across the business cycle. This implies a fractured international landscape for emissions policy, and halting progress on emissions reduction. Thus in the face of the physical constraints on climate action, the marginal successes of the European Union do not appear to foretell a promising future for successful and timely emissions reduction.

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