



Energy system transformation and long-term interest constellations in Denmark: can agency beat structure?



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ABSTRACT

Since the oil crises in the 1970s, Denmark's energy system has evolved from import- and fossil fuel-dependency to self-sufficiency with a high share of renewable energy. This transformation has been supported by co-evolving energy policies. A policy shift in 2001 brought a temporary halt to the transformation, which resumed after a return in policy in 2008. Applying public choice- and path-dependency perspectives, this article analyses the development of the Danish energy system and co-evolving policies. Initial structural characteristics have strong explanatory power for the long-term policy trend: de-central ownership, and entrepreneurship have given local-level actors leverage as a political constituency. Over time de-central small-scale solutions (like windpower and district heating) secured generous state aid. Local-level actors provided technology solutions offering broad opportunities. One consequence was strong support for de-central technology solutions. The first policy shift is explained by a new government that advocated dismantling state regulation, subsidies and taxes, supported by a new political majority. The second policy shift is explained by mobilization of interests that had grown to include actors that generally supported de-regulation but saw their commercial interests threatened. The Danish model has inspired similar transformations elsewhere and offers lessons on how to overcome resistance to change.

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1. Introduction

The challenges posed by climate change necessitate a global transition away from carbon-dependent energy systems. Denmark stands out as a robust transition case, with its energy system shifting from nearly full fossil-fuel dependency some forty years ago to a renewable energy share of around 25% in 2014, mainly bioenergy and windpower [1,2]. The transformation of the electricity and heat supply system has been comprehensive. The share of renewables in Danish electricity consumption reached 60% by 2014, with windpower alone responsible for about 40% [3]. Denmark qualifies as a puzzling study object also because of the undoubted trend anomaly in the years 2002–2007, when investments in renewables (including windpower capacity) saw a dramatic fall. This followed a policy shift executed by the liberal-conservative coalition government in power from 2001, headed by Prime Minister Fogh Rasmussen. Then, after re-election in 2005, his second government undertook a political turnabout that brought the low-carbon energy transition back on track and paved the way for the broad 2012 Parliament

agreement on making Denmark's energy system 100% renewable by 2050 [4].

This study analyses the Danish energy system transition case, focusing on *public policy* as a factor co-evolving with other system factors. What explains the two energy policy shifts observed in the early 2000s—the first one derailing the Danish energy system transition and the second one bringing it back on track? We apply two explanatory approaches, inspired by the public choice- and the path-dependency-literatures. The former pays attention to specific mechanisms applying in public policy decisions: interaction between societal constituencies and policy-makers, and institutional conditions providing leverage for specific constituencies in policy decisions. Policy shifts will follow from shifts in policy preferences, interactions and institutional conditions. The path-dependency perspective is useful for uncovering mechanisms that may reinforce the leverage of specific constituencies over time to explain policy trends. Within this perspective, policy shifts are explained by critical junctures with externally generated pressure for change.

The Danish policy shifts indicate the existence of forces that could restrict reform-eager politicians' room for manoeuvre—a challenge facing many jurisdictions around the world. This article

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concludes a discussion the potential for learning from the case of Denmark.

The Danish energy transition has been analyzed by different scholars applying different approaches. Several historic analyses explain the establishment of and path dependency of the Danish, or other structural explanations of the Danish energy system outcome e.g., [5,6–8]. Other analysts have looked at policy influence, through a technology lens or for example through rational choice perspectives [9,10]. These analyses have usually been done as explicit or implicit diachronic or cross-case comparisons, and mainly focusing on windpower (e.g., [8,9–11]), albeit there are examples of wider analyses from a more constructivist perspective [12]. While building on these studies, this article expands in several regards. It accounts for the historical development in the entire non-transport energy system (the evolution of district heating and electric power sub-systems). Further, it expands in time, by adding more recent developments to the Danish tale. Additionally, the article analyses the establishment of the Danish energy sector's structure by use of complementary perspectives, from a structural and agency basis. This requires a long term account that maps the sociotechnical system paired with the political developments and by adding new understanding about the room for agency and change in an institutionalised energy governance system, responding to calls for further analysis [13: 20f]. Such complementary analysis fills a gap in the literature by highlighting the interaction between structural factors and individual choice.

2. Analytical framework, methods and data

Public choice theory focuses on decision-makers and policy managers, the choices they make, and the factors that influence those choices [14]. Actors—typically politicians and government officials—are viewed as rational, self-interested utility-maximizing agents who normally seek office or maximize budgets [15], and this perspective examines how such individual motivations affect the outcomes of their collective decision-making [16]. These individuals and groups decide the course of action on the basis of consequential logic, in the sense that action depends on anticipations regarding the future effects of actions [17]. As actors can only anticipate such futures, not predict them perfectly, they may be characterized as only boundedly rational [18]. They will maximize utility (seek to remain in office) by consciously providing advantages to interests they believe will help them in their cause [14]. Electoral systems and polity, including supportive and opposing interest-group constellations and alliances, thus shape preferences and the course of action, based on the 'rules of the game' [19].

We expect from this perspective that *Danish energy policies are adapted to the incumbent government's support base (their constituency) and that the first policy shift observed in the early 2000s reflected that the new parliament majority and government catered to a different constituency than the previous government. The second policy shift may thus within this perspective represent an underestimation of the political reactions from important constituencies to the first policy shift (bounded rationality).*

By contrast, the *path-dependency perspective* takes a long-term approach in explaining stability and incremental change [20–22], and focuses on how positive feedback may prevent radical changes in policy [23]. Initial political decisions will institutionalize commitments [24] to specific sets of actors (interest groups) that advocate particular technical solutions, augmenting the political leverage of these actors if the solutions diffuse, at the expense of actors that promote alternative solutions. The majority of actors in this way tend to have interests in keeping the established energy system, as this generates benefits, in sum leading to such a loop of positive feedback. Specific actors and solutions at an early stage

(previous decisions) thus constitute a core mechanism that affects subsequent policy decisions [22,23,25,26], gradually creating a path that limits divergent political choices when solutions diffuse and are adapted to by an increasing number of agents in the system. [7,27]. Political processes over time are seen as self-reinforcing sequences of positive feedback that 'lock in' institutional settings by increasing the likelihood of certain policy choices while reducing the likelihood of others [27,28].

Deep policy change or a path break, like the first Danish policy shift in the early 2000s, will be an anomaly within this perspective. *We expect this shift to be explained by the concept of 'critical juncture' [20,21,29], where exogenous or endogenous factors challenge the dominant technical solution and thus the institutionalized power of agents committed to this solution [26,30].* Firm institutionalization of commitments to the solution that was challenged will result in heavy resistance to change, and explain why policy was changed again a few years later by a government led by the same prime minister. Thus, our main expectation from this perspective is that *policy changes will be incremental and adapted to the technical solutions that had diffused in the energy system.*

The study employs case-study methodology, with long-term Danish energy policy as the main case and policy shifts in the early 2000s as embedded subcases. Selected theory has assisted the development of research questions and expectations, thus defining the relevant data to be collected for analysis.

The two perspectives invite different but partly overlapping kinds of data for explaining the policy change and rebound in 2002 and 2007. Employing the public choice perspective, necessitates mapping key actors in Danish energy policy around the time of the policy shifts, their core policy preferences, and how various interest groups constitute constituencies for the political parties. The 2001 Fogh Rasmussen I government differed from previous incumbents also in the constellation of party parliamentary support. We investigate differences in energy-policy preferences among the parties and their core constituencies.

The path dependency perspective on the other hand, invites investigation of long-term energy-system processes in Denmark, paired with political developments. It requires data about long-term structural development of the Danish energy sector—general changes and group interests, the share of types of energy carriers, the larger political decisions, and parliamentary structure. We trace initial and consecutive policy processes, asking whether and how initial commitments favoured specific actors and technology solutions that later resisted policy changes, even at critical points of major external and internal pressure for change.

Data sources include research articles, historical energy industry case records, government policy documents, minutes from deliberations in the Parliament, newspaper and newsletter articles, and expert interviews. Semi-structured interviews with representatives from Energistyrelsen, Roskilde University, EA Energy Analyses, and one independent analyst have been used mainly to cross-check other data sources, and are thus to a lesser degree referred to directly.

3. Evolution of the Danish energy system

3.1. Early industry structure and energy sources

The early modern Danish energy-system emerged with a structure of combined heat and power plants (CHP) supplying major urban areas. Smaller decentralized electric power, district heating, and CHP plants supplied smaller rural towns. Municipalities and private local co-operatives were the principal owners. The latter had deep historical roots in rural farming communities and diffused as a more general model for energy supply when indus-

trialization moved people into larger centres [31]. A not-for-profit public service obligation norm dominated Danish energy supply: prices reflected costs, and a surplus in one year would normally be redistributed to customers the following year [32]. The Danish state played a minor role in national energy supply before the 1970s, contrary to the situation in many other European countries. State ownership and central national energy planning were politically contested [32,33]. Successive Social Democratic Party (SDP) governments proposed a state-controlled concession system for the energy sector as part of their general economic and welfare modernization programme. The proposal failed, however, since the party did not hold a majority position in the Parliament. The liberal parties (*Venstre* and *Radikale Venstre*) lent an ear to the local utilities and municipalities which opposed such control [32,34].

The central government had assumed a greater assisting role in energy-system development during World War II, initiating comprehensive investments in transmission grids that connected the local supply systems with a few major regional central steam-power plants [35]. This encouraged industry to self-organize rationalization of the system, spurred by the Danish Electric Utility Association (DEF) [32]: the total number of power plants went from 400 to less than 20 in the period 1940–1970 [35]. However, the number of utilities and private co-operatives did not decrease; they were retained as distribution companies that came to hold joint ownership of the new regional plants, the transmission grids, and new units for the construction of interconnectors and exchange of power with neighbouring countries. Moreover, municipalities and private co-operatives found new investment opportunities in the parallel de-central district heating systems which, by the late 1960s, had connected nearly a third of all Danish residences [31]. The Danish District Heating Association was established in the 1950s for sector self-organization in promoting connection to collective heating systems [31].

Reflecting the country's lack of own energy resources, oil and coal were dominant fuel sources in Danish electricity and heat generation—the former fuelling 90% of national energy consumption by 1970 [34]. Wind-powered electricity generation plants were demonstrated at an early stage, with scientists assisting the establishment of rural mills; in the 1950s, one prototype that informed later successful designs was tested by the DEF, which concluded that the technical efficiency and cost-economics were unattractive [6,36]. Attention was increasingly paid to nuclear power, with Social Democratic Party (SDP) governments of the 1950s establishing state structures to promote this technology: the Atomic Energy Committee in 1955 and the Risø Nuclear Research Centre in 1958. At that time, the utilities opposed such plans, fearing nationalization and state control 'by the backdoor'. The utilities got support from the liberal parties in Parliament, whose support was necessary to the minority government [32,37].

Again, political disagreement prevailed among the political parties as to what development path the Danish energy system should take [5].

3.2. Major changes in the 1970s

The 1970s saw significant changes to the role of the central government in Danish energy supply. First, the Danish state assumed a prominent ownership role in the emerging indigenous oil and gas supply industry. The utilities were unable to hinder the establishment of a new state-owned gas supply company, Dansk Naturgas A/S (later DONG) in 1972 [31]. After negotiations between the state and the utilities, however, municipal ownership control was allowed over natural gas distribution. Five regional co-owned distribution companies were established, consistent with the Danish

ownership model for distribution of heat and power [34: 84].

Second, what really brought stronger control to the Danish state was the international oil embargo of 1973 that hit import-dependent Denmark hard, increasing the political support for central policies aimed at reducing oil dependency. Nuclear power became increasingly relevant, now supported by the electric utilities and a Parliament majority in the early 1970s of predominantly pro-nuclear parties: the Conservative Party, *Venstre* and SPD [31]. Only *Radikale Venstre* and the Socialist Party held clear anti-nuclear positions.

However, the 1973 elections changed the Danish Parliament fundamentally: incumbent parties lost massive votes, and five additional parties (three of them new) gained seats. With the new political situation, broad political compromises were needed for policy execution, also on energy policies. A firmly anti-nuclear grassroots movement organized and linked up with scientists envisioning a different energy future based on decentralized renewable energy solutions like windpower and biogas [6,38]. In 1975, the Danish Organization for renewable energy (OVE) was established to promote this development.

Minority SPD governments between 1975 and 1982 initiated a new era of central energy planning aimed at reducing the country's oil import dependency. The first national energy plan of 1976 noted various options: energy savings through combined heat and power, a new natural gas system, fuel conversion to coal, and several nuclear power plants by 1995. A central state permit system was introduced for power plants/transmission lines and the new Danish Energy Agency was granted extensive powers to direct the construction of plants, and prescribe specific fuels and fuel stocks to reduce oil imports. In return, local utilities received favourable price regulations [34: 78]: the long-existing not-for-profit norm in Danish electricity production was codified in the new act by specifying relevant costs for tariff-setting [39].

Windpower was not mentioned as an option in the first energy plan, prompting the Parliament Energy Policy Committee to request a redrafting [6]. Seizing the opportunity, anti-nuclear and pro-renewables scientists at the country's technical universities responded by drafting an Alternative Energy Plan outlining how a future with considerable deployment of windpower was techno-economically feasible [6].

This gave important inputs to the national debate, making the government decide to include development of large-scale wind-turbines in the national energy research programme to be co-administered by the utility association—by many seen as a tactic to delay windpower while nuclear power advanced [6,10]. In 1978, the government followed up with a grant for establishing a test centre also for locally-initiated small-scale wind-turbines at Risø National Laboratory, after an initiative taken by one of its engineers [6,37]. A parallel investment support programme provided additional incentives among farmers and local co-operatives who organized in the Danish Wind Turbine Owners' Association to co-ordinate responses towards public authorities, the utilities and wind-turbine producers [34].

The second international oil crisis from 1979 spurred new policy responses that expanded the influence of the central state. Collective heating systems were to be extended and a separate Ministry for Energy was established, empowered to instruct fuel use and supervise/revise new regional plans detailing areas to be heated by various energy carriers [32]. New household energy excise taxes were imposed, to finance investments in renewable energy and energy efficiency: windpower investors were entitled a subsidy for 30% of total investment costs [6]. The second energy plan in 1981 envisaged a greater share for renewable electricity by the year 2000, but retained nuclear power as an option.

3.3. The 1980s and 1990s: settling the policy trend

The 1982 elections marked the start of a period (1982–1993) with multi-party cabinets headed by the Conservative Party with Venstre as a permanent partner and other centrist parties as shifting partners—the latter as guarantors for upholding the 1979 parliament agreement.

A new wind-turbine industry cluster evolved, based on user-producer dynamics between local investors, new turbine manufacturing companies and other technology supplier companies, with the Risø Wind Power Test Centre central in co-designing and verifying turbine prototypes [6]. New organizations facilitated co-operative efforts in technology development and policy lobbying, like the Danish Wind Turbine Manufacturers' Association and the Nordic Folk Centre for Renewable Energy. The latter evolved as the principal co-ordinator of R&D in local small-scale renewable energy and energy-efficiency solutions; it gained state support from 1983 after recommendations from the Danish Federation for Small and Medium-Sized Enterprises [38].

In the middle of the decade, the Parliament decided to replace investment support to windpower with support to production; generators were granted a minimum support per kWh delivered to the grid, amounting to 85% of the household end-use tariff [34]. To avoid high profits for a few speculative investors, and thus maintain political and public legitimacy in the subsidies, geographical limitations were placed on ownership (owners had to live within a certain distance from and in the same municipality as the turbine; and there were restrictions as to how much capacity they could own) [6]. To compensate for the lower demand for turbines caused by this measure, the government signed the first of a series of agreements with the major utilities, instructing them to invest in windpower.¹ Consolidating the emerging industry, the Parliament in 1985 voted to scrap plans for nuclear power. A majority was secured, since the SDP had now changed its stance.

Fuel oil- and coal taxes, multiplied during the decade, served to stimulate indigenous energy sources and the expansion of the new natural gas supply system. A 1986 agreement between the government, the SDP in the Parliament, and the utilities increased the number of large power plants to run on natural gas and decentral CHP units to run on natural gas and bioenergy [31]. Higher demand for efficient heat solutions spurred national innovation and new industrial clusters specializing in manufacturing pumps, thermostats and boilers; control and optimization technology; installation and consultation services [40].

In the late 1980s, Radikale Venstre decided to withdraw from the political alliance with the SDP that had turned left under the chairmanship of Svend Auken, joining instead a government led by the Conservative Party [12]. The energy minister representing Radikale Venstre in 1990 presented the third Danish energy plan, *Energi 2000*. Here, combatting climate change was elevated as concern for continued policies to stimulate the development of renewable energy. The plan set CO₂-emission reduction of 20% and a 10% share for windpower as targets for 2005, and proposed CO₂ taxes, controversial within the other government parties. Elections the same year brought losses for Radikale Venstre, which withdrew from government. Seeking to curtail the CO₂ tax, the new Conservative Party energy minister was overruled by the Parliament [12].

From 1993 to 2001, the SDP headed a series of coalition governments. Radikale Venstre again shifted alliances and joined in, after Auken had been ousted as party chair. Auken was given leadership over a merged Environment- and Energy Ministry with

extended budgets. During his term, the Parliament agreed on new policies that gave a further boost to the ongoing energy transition, reinforcing both the decentralized structure of the energy sector and the state's right to instruct power and district heating plants to use renewables and natural gas [5,33]. Windpower demand was increased by a new feed-in tariff system that granted independent renewable electricity producers priority grid access and a fixed guaranteed tariff based on production costs [39]. New government–utilities agreements instructed the latter to make major investments—in 1998 extended to also five 150 MW offshore windmill parks, in turn a follow-up of the 1996 agreement on the fourth energy plan, *Energi 21*, to cover 50% of Danish electricity consumption with offshore windpower by 2030. Under the negotiation of the 1997 Kyoto Protocol, Denmark accepted the very ambitious goal of reducing its CO₂ emissions by 21% by 2012.

The Danish energy system saw a gradual transformation from the 1970s towards the 2000s—from high energy import-dependency to self-sufficiency, with the share of renewables growing from negligible to 15% of total electricity supply in 2000—11.6% from windpower alone. At that point, 60% of the electricity was generated in energy-efficient CHP plants (up from 20% in 1980), a third of it in hundreds of decentralized plants scattered around the country [41]. The share of renewable energy in these plants (bioenergy) rose from around 15% in 1980 to nearly 40% by 2000; and 60% of Danish households were connected to district heating networks.

Denmark's energy and climate policies were generally established through wide party-political agreement reached in the Parliament, necessary since elections gave parliamentary seats to many small parties, making minority governments a normal situation. Strong central planning, state ownership in the natural gas industry and high energy taxes/subsidies were policy instruments heavily favoured by the SDP, in line with its general economic- and welfare policy orientation. Also parties to the left of the SPD shared this general policy orientation. The Conservative Party, with major businesses, capital and land-owners as major constituencies, was main opponent of this policy line. The third major party, Venstre, traditionally catering to the interests of the sizeable community of farmers vis-à-vis land-owners and the state, opted for de-central industry self-regulation and was thus sceptical of SPD centralization policies. Also Radikale Venstre, which attracted votes from small farmers and liberal intellectuals, favoured policies in line with a societal model based on decentralized economic development, catering heavily to the co-operative movement that had played a major role in Danish rural community development. In environmental policy, Radikale Venstre and parties to the left of the SDP were the strongest opponents of nuclear power and proponents of renewable energy industry development, until also the SDP changed its stance and advocated large-scale development of the natural gas and renewable energy industries as motors of economic growth. The Conservative Party and Venstre were more sceptical to environmental policies that favoured specific renewable-energy technologies over the country's existing—and affordable—coal technology.

In this period Denmark maintained a significant local basis for its heat and electricity sectors, run on a not-for-profit norm. A mixture of municipal and private shareholder and co-operative ownership of local distribution companies prevailed, adapted to the comprehensive central planning regime for oil substitution that also provided generous subsidies to de-central entrepreneurship in renewable-energy technologies [42]. The public accepted high energy taxes, but also made use of policy opportunities to invest in the new renewable-energy technologies: around 150,000 individuals held ownership shares in wind-turbines in the early 1990s [43]. The incumbent central power utilities adapted to policy development by replacing oil with coal and natural gas. Initially sceptical

¹ The first agreement instructed the utilities to install 100 MW windpower by 1992. New agreements during the decade added another 100 MW by 1996, and a third, 200 MW more by 1999.

of being instructed by the state to invest in windpower technology, enthusiasm for the technology increased as the utilities gained experience and saw how technology costs fell in new generations of higher-capacity turbines.

4. Energy and climate policy shifts

An important backdrop for the post 2000 policy shifts was neo-liberal governance ideas diffusing since the early 1980s. These ideas held that state regulation and taxes crippled economic growth and welfare, and that de-regulation, tax cuts and competition to promote economic efficiency would be needed. Reforms based on these ideas spread also to the energy sector, and were taken up by neighbouring Nordic countries and the EU in connection with the creation of an internal energy market [44]. The reforms would include removing local supply monopolies, providing greater commercial freedom for suppliers and competition among them to attract consumers who could now switch suppliers, unbundling of supply and transmission services to secure non-discriminatory access to energy networks, and adapting national state aid to EU guidelines. This challenged various parts of Danish energy system governance: the not-for-profit norm, the local energy system ownership model and central planning orientation, and the generous state support system to promote further development of renewable energy industries.

Svend Auken, the incumbent Minister of Energy and Climate, was clearly opposed to such neo-liberal governance ideas but acknowledged that Denmark would have to follow EU requirements [12]. He supported the EU Commission in its general reform ideas but also managed to upload the idea that the state could impose public service obligations (PSO) on its energy industries in order to secure supply, consumer and environmental protection—points that were included in the EU 1996 Electricity Directive (ibid.). Adaptive moves by the Danish Parliament included a decision in 1995 to allow utilities to make a profit in one year without charging lower electricity prices the next year, if that could be achieved through cost reductions and not a tariff increase [39]. This immediately attracted Sweden's Vattenfall to bid for shares in a Danish municipal utility [42,31], in turn putting pressure on the Danish Parliament who adopted a 'panic act', whereby profits from the sale would be annulled by deduction of state transfers to the municipality. The government referred to the sale as 'robbery of Danish energy consumers' [39]. In 1996, the Parliament adopted a new electricity law that allowed large consumers to trade electricity freely, and instituted the PSO system by changes to the renewable energy support system. Support would no longer come from state subsidies but from a PSO levy on consumers, who would be obliged to buy a specific share of renewable electricity to a fixed minimum price [12].

Further reforms in 1999 instituted unbundling of transmission and supply. Adapting to plans of the European Commission, the Parliament also agreed to the gradual replacement of fixed minimum tariffs for renewable energy, through a system of tradable renewable-electricity certificates from 2003 [45,39].

With the 2001 elections came fundamental neo-liberal changes to Denmark's political landscape, with majority voting power in the Parliament secured for parties to the middle-right. Anders Fogh Rasmussen formed a coalition government that included also the Conservative Party, with support from the right-wing *Dansk Folkeparti*.

The new government started economic policy reforms in line with the new neo-liberal ideas that fit well with the programmes of the parties now in power: tax breaks, removal of regulatory intervention on Danish businesses, and cost-cutting in the central bureaucracy. An important part of the reforms was the downscal-

ing of national climate-policy ambitions. The government included ministers highly sceptical to the science of climate change, and established in 2002 a new Environmental Assessment Institute, to be headed by the controversial climate-sceptical political scientist Bjørn Lomborg. The leverage accorded to the Ministry of the Environment in the period 1993–2001 was now scaled down: the Ministry of the Environment and Energy split again; energy policy was moved to the Ministry of Economics and Industry; and there were massive budget-cuts for the new Ministry of the Environment and the Energy Agency.

Energy policies were increasingly adapted to the new liberal agenda. The 1996 'panic act' was dismantled [42]. Danish municipalities could now sell their utilities and retain the revenues without fearing cuts in transfers from the state. During the decade, changes in ownership structures ensued, whereby Swedish Vattenfall and the Danish state-owned petroleum company Dong acquired the bulk of national central plants and several local distribution companies. This sent the Danish energy system on a centralization-like track of greater ownership control by large companies—similar to that seen across Europe [46].

Plans for a renewable certificate system were scrapped—a move widely accepted by the Parliament, as the EU would no longer mandate such a system. The level of support to new windpower was scaled down, with a total DKK 2 billion recorded as saved on the budget. Massive budget cuts were agreed for market introduction and R&D programmes in renewable energy, energy efficiency and fuel conversion [47]. The programme for offshore windpower was discontinued, beyond the two offshore parks already commissioned under agreements made with the electric power industry [48]. Economic support to institutions tasked with disseminating information and co-ordinating local small-scale energy-efficiency and renewable-energy initiatives was slashed: support to the Nordic Folk Centre for Renewable Energy and to independent local energy and environment offices was removed as posts on the budget.

The government was harshly criticized by the opposition parties in the Parliament. Broad criticism also came from the environmental movement and from industry associations representing renewable-energy interests. The Danish Wind Power Producer Association in particular criticized the decision to cut the offshore programme and R&D expenditure, maintaining that it was critical for Danish industry to have sufficient home-based demonstration capacity for developing new-generation windpower technology [49]. The Association of Small- and Medium-sized Enterprises (*Håndværksrådet*), representing 20,000 Danish companies, was highly critical to the government, in particular regarding the cuts in support to the Nordic Folk Centre for Renewable Energy, which it saw as an important force behind the Danish windpower industry and development within biofuels, hydrogen and wave power [50]. The Danish Technology Council criticized the policy as being shortsighted and for representing a possible obstacle to energy technology development more broadly in Denmark [51]. The Danish Engineering Association (IDA) joined in the criticism, pointing to the lack of an industrial perspective in energy policy, and that reinstalling support from the state would be needed if the country's industry were not to lose contracts worth billions of Danish kroner [52]. In 2006, IDA published an Energy Plan for 2030 as an alternative to the lack of a government strategy [53]. According to the IDA Plan, Denmark could cut its GHG emissions by 60% by 2030 (compared to 1990) through energy savings and renewable energy, and that realization of the Plan could provide massive potentials for export of energy technologies. The main policy messages were that the government should extend its energy savings agreements with industry, set up an energy savings funds, massively increase public expenditure on R&D and demonstration of technology, re-install feed-in-tariffs for renewable energy, and support the establish-

ment of organizational arrangements that would increase citizens' participation and co-ownership more broadly in renewable energy and energy-efficiency investments, inspired by the success of the windpower co-operatives.

Also CEOs representing individual major Danish industry conglomerates publicly branded the government's environmental and energy policy as reactionary and lacking in vision. In summer 2006 the energy technology companies Grundfos and Danfoss held talks with the Socialist Party on how to build an industry-friendly climate policy, admitting the oddity of allying with left-wing parties but acknowledging that 'they were the ones who had understood what it was all about' [54]. This was clearly aimed at Bendt Bendtsen, Minister of Economics and Industry, a major culprit in the slashing of renewable energy support and representing the Conservative Party, traditionally supported by big industry in Denmark. Bendtsen quickly accepted the invitation from Danfoss to hold a speech at the inauguration of a new wave-energy test centre owned and operated by Nordisk Folkecenter for Renewable Energy, where he stated: 'This can be the start of a new wind-generator success story for Denmark' [54].

Then came the second policy turning point. At the Venstre party congress 23 September 2006, Fogh Rasmussen announced a fully metamorphosed energy and environment agenda, repeating the message even more strongly a few days later at the anniversary of the Danish Industry Association and in his opening speech at the Parliament on 3 October [55,56]. He justified the new policy line by explaining that it would ensure supplies of renewable energy for the future, when Danish North Sea oil and gas production would come to an end.

An ally within the government for this metamorphosis was Connie Hedegaard from the Conservative Party, who entered the government as Minister for the Environment in 2004, re-appointed after the 2005 general elections led Fogh Rasmussen to form his second cabinet. Hedegaard noted the climate-change concerns and support for renewable energy in the electorate and actively sought to elevate this on the cabinet agenda, pinpointing how export potentials could be further augmented in the international wind-technology market, where Danish industries already had a strong position [54]. Unexpected assistance came from outside the country. The EU had started planning of a package of climate and energy policies that framed support for renewable energy as a solution not only to climate problems, but also to security of supply and industrial growth and employment issues. And US President Bush expressed admiration for Denmark's energy policy achievements at his meeting with Fogh Rasmussen at Camp David in June 2006 [54]. Asked to explain to students at Stanford University the reason behind Denmark's success in decoupling energy use and economic growth, Fogh Rasmussen replied: 'through a mixture of state investments and taxes, I am sorry to say' – amusing the Danish delegation, who could recall his attacks on government renewable energy policies in the 1990s (*ibid.*).

Hedegaard received support from Fogh Rasmussen when she proposed that the 2009 UN Climate Summit should be held in Copenhagen. The two also set about preparing new and more ambitious EU climate and renewable energy policies and in persuading other EU countries to accept binding targets for renewables and GHG emissions reductions. Both actively promoted a 30% target for GHG cuts by 2020 [57]. Broader support in the government for this line came from the Minister of Finance, who now stated that Denmark could earn billions on the EU's new and ambitious climate goals [54].

Elections in 2007 left the parliamentary majority constellation intact. Fogh Rasmussen formed his third government that started implementing its transformed energy and climate policy from 2008 based on new, broad agreement in the Parliament. State support for energy R&D increased to unprecedented levels and higher support

levels were adopted for renewable energy. Catering more directly to the local level, the new renewable energy law gave members of the local population priority rights to acquiring 20% ownership of new windpower plants; there was generous compensation for landowners, and involved municipalities would be entitled to state funding for projects aimed at improving local recreational values and information projects to promote acceptance as regards developing local renewable energy resources. The offshore windpower park programme was re-introduced on the budget, and a new tendering system attracted the interest of Dong, E.ON and Vattenfall.

The effects of the policy shifts in 2001 and 2008 regarding windpower investments are shown in Fig. 1. Wider effects were documented in 2015 in a study commissioned by the Danish Industry Federation/the Danish Energy Industry Association [40]. These included a massive reduction in energy intensity ensuing from energy savings and CHP, low energy prices before taxes and duties, strong growth and high employment in energy technology manufacturing and energy services sectors. Products from these sectors (including windpower technology, district heat and energy optimisation solutions) accounted for 20% of total Danish exports of goods in 2013 [40].

5. Explaining the Danish energy path and policy shifts

5.1. The Public Choice Perspective: agent-based explanation of the policy shift

The expectation from the public choice theory was that the first policy shift in 2001 would reflect the new parliament majority and government catering to a different constituency than the previous government. This proposition is robustly supported. Denmark's 2001 elections changed the political situation with a majority position for parties to the right in Danish politics. The underlying preferences of these parties could play a greater role in policy execution after being suppressed during the long period when broad coalition agreements and horse-trading had been needed in the Parliament. Such broad political agreements were simply not necessary in the new political situation, with the election resulting in a majority parliamentary support for new political directions. This, at least temporarily, enabled radical changes in policy, as the parties in the new government were free to cater more directly to their main constituencies and perceived election mandate.

The political parties of the new government had their main support from a different constituency than the previous one. Their new liberal economic agenda focusing on tax cuts and dismantling state regulations was well adapted to demands from the Danish business community. The government parties both received financial support from the major Danish business and employer organisations and wealthy individuals [59]. Parts of the highly regulated energy industry also favoured deregulation and an end to central state interference with their business. The Danish Electric Utility Association saw opportunities in greater commercial freedom and had long been a sceptic to the massive subsidies to renewable energy, with its production asset based mainly in fossil fuels [12]. Removal of energy and environmental regulations were thus obvious candidates for immediate policy reform. Here, direct state planning, regulations and taxation had been given such a comprehensive scope during the 1990s, while external pressure for de-regulation was added on from the EU Commission. Whereas the former government had sought to contain this pressure, the EU policy line fitted the aims of the new government who could see the EU Commission as an ally. Summing up, the public choice perspective can explain the fundamental shift in energy policies in terms of two main factors: a change in expressed preferences by the parties in

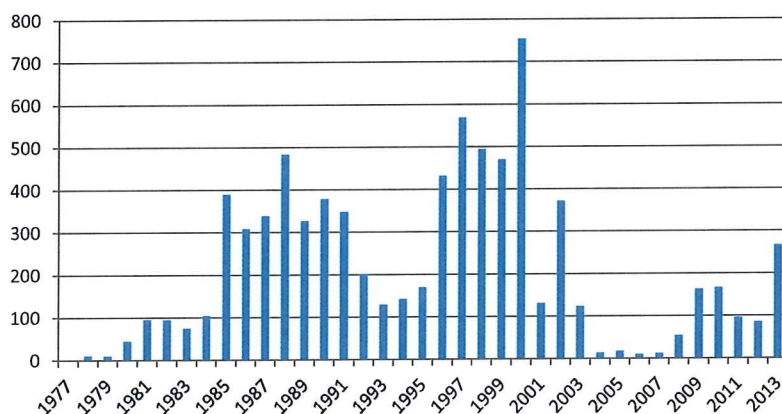


Fig. 1. Annual number of turbines installed in Denmark.

Data source: Energistyrelsen [58].

government, and the new majority situation in the Parliament that created room for changed policies.

What then about the government policy turnaround in the second policy shift? The first shift was immediately criticized by the opposition parties in the Parliament, environmental and renewable energy organisations and the industries that had most clearly benefited from the policy development before the shift, like Denmark's windmill owner- and wind turbine industry associations. However, opposition evolved as far broader, to include groups that the government parties would normally view as important part of their constituency. The Danish Society of Engineers, the Danish Federation of SMEs, and even some of the largest Danish manufacturing companies joined in to judge the policy shift as business- and economic-growth-unfriendly, attacking at the core of the governing parties' political programmes. From this, we conclude that the bounded rationality assumption should be fully accounted for to give the public choice perspective explanatory power. The broad mobilization against the first policy shift came only after its fuller ramifications for their interests gradually became clear to the constituent groups. The protests spread in the media and the government would have much to lose in terms of voter confidence if not responding to the critique. A fuller understanding of the second policy shift will require setting it in a proper historical context, however, to which we return below.

5.2. Structural explanation for the energy policy turnaround

The path-dependency perspective appears fruitful for explaining the second shift in Danish energy policy, and allows a fuller understanding of the developments over time. The data indicate that the Danish energy system evolved with strong institutional political commitments given to specific interests and technologies. At the very early stage, initial commitments were made to local municipal and private co-operatives, which evolved as main system-shapers based on the ultimate goal of keeping the benefits in the hands of local populations, and this contributed to create and establish a structure to which sector interests increasingly adapted [27]. With responsibility decentralized, the energy system evolved with a patchwork of parallel small-scale electric power and district heating networks—with locally based municipal and private co-operative stakeholders carrying influential interests as owners.

At this stage, political efforts by the Social Democratic Party at putting the state in charge of a more centralized economy-of-scale-driven development were fended off by local players, who formed an important base for liberal parties that were in the position to block majority in the Parliament. Plans for state-driven

introduction of nuclear power, supported by some of the major political parties, were among the centralization projects that were effectively counteracted. After World War II, the power production system was centralised with power distribution and district heating continuing as local decentralised entities. Municipalities and consumer co-operatives retained full ownership control, running the energy system based on a not-for-profit norm to the benefit of the consumers.

Local energy co-operatives, and their political allies in the Parliament, played a central role when the oil crisis of the 1970s came in as a critical juncture for the Danish oil-import dependent energy system [5]. The precarious situation called for central energy policy. Nuclear power was now supported by the big utilities and a great majority in the Parliament. The anti-nuclear movement together with organisations advocating a different development based on the ideas of the local energy co-operatives joined with engineers in envisioning an energy future based on the development of local renewable energy resources. Landslide election results in 1973 augmented their political leverage. The number of parties represented in the Parliament doubled, creating the need for broad parliamentary agreements with the result that nuclear power was put on hold and state support started for development and testing locally developed small-scale wind turbine designs. To govern Denmark out of its oil dependency, the state was admitted strong powers in the further spatial planning of the system, eligible to instruct energy carriers, technologies and fuels in the power and district heating systems.

This critical juncture thus created new institutions without any fundamental dismantling of previous structures, as the new state structures were established on top of and adapted to the existing local-level structures: codification of the not-for-profit principle, retention of local-level ownership (except for the new upstream natural gas industry), support to further local-level development of district heat and energy-efficient CHP. Examples of existing state institutions adapting to the new opportunities was that of the Risø nuclear laboratory that was admitted a new role as test centre for wind power. Through this change, Risø adapted to an emerging innovation cluster and survived when nuclear power at a later point was politically abolished, in line with path-dependency expectations [37].

The emerging local innovation cluster in wind power included manufacturers of agricultural machinery adapting to the opportunities inherent in state subsidies for wind-power, starting up new production lines for wind turbines and related equipment. Demand came from local consumer co-operatives, scaled up when also the international market got their eyes up for Danish turbines. Co-

ordination and diffusion of ideas were professionalised through a set of new organisations for owners of windmills, for manufacturers of turbines and the Nordic Folk Centre for Renewable Energy that got a new role in co-ordinated. By the 1990s, this meant that around 150,000 Danish citizens held ownership shares in wind turbines [43]. Danish manufacturers of wind turbines dominated the emerging international market, creating opportunities for Danish engineers important employment figures locally and nationally.

Similar development clusters evolved connected to state policies for supporting the diffusion of natural gas, local district heat solutions, bioenergy, combined heat and power and other energy efficiency solutions. Based on home market demand, many Danish manufacturing companies developed products in these technology fields that were widely demanded also abroad, creating many new jobs in Denmark. With oil substitution under control because of the transition taking place, this gave positive feedback to the political system deciding that planning for nuclear power was no longer needed, in turn followed by extended political and economic support to the new development clusters.

When mitigation of climate change emerged as a goal of Danish energy policy in 1990, the well-established structure of state regulatory planning and decentralized implementation made low-carbon solutions a natural choice, again extending political and economic support to renewable energy and energy-efficient solutions. The decade thus brought a further layer of institutional commitments to the path and established a fine-meshed energy system that combined central electricity supply with thousands of decentralized generation units connected to local electricity, district heating and natural gas networks, and with renewable energy increasing its share at the costs of fossil fuels.

A new critical juncture in Danish energy policy came in the late 1990s with external political demands for deregulation, challenging important principles that the policy path was based on: state planning, generous state subsidies, the non-for-profit norm and decentralised ownership. The Social Democratic Party-led government with support of the Parliament took important steps to adapt to this pressure while simultaneously protecting the continuation of these principles, sensitive to the success of Danish policies in transforming the energy system, and the great number of interests that had adapted to their continuation.

As noted, the first Fogh Rasmussen government lacked such sensitivity and abolished the not-for-profit principle in electricity supply (although not for district heating), slashed subsidies and removed support to local-level organizations. According to the path-dependency perspective, policies that challenge a well-established structure or path can be expected to encounter resistance [28,60]—as indeed was the case in Denmark. Reactions to the policy changes were strong and as noted, for the Vogh Rasmussen government, unexpectedly broad, including from a broad set of industrial organisations and companies that accused the government for curtailing industry development and growth.

Summing up, the pressure for energy sector de-regulation starting in the 1990s represented a critical juncture for Denmark that had the potential to fundamentally alter national policies and energy system structure. However, counterforces had by then become too strong for the new government to ignore. From initial political commitments to local-level actors and positive feedback mechanisms spreading this commitment to major parts of the Danish society and industry, the energy policy space had been greatly reduced by the mobilization of the path-incumbent stakeholders, and this fits well with our expectation that the government opted to re-enter the former policy path. The policy reversal is in line with expectations from the path-dependency perspective: the gradual reduction of options and increased number of vested interests in the established structure led to a situation with heavy resistance from a large number of stakeholders adapted to the Danish model.

This has facilitated a long-term transition, and it also shows how strong structural forces can develop, when anchored broadly and deeply, and when the counteracting forces are few.

6. Conclusions

We have seen how the Danish energy system evolved into a highly decentralized system involving strong elements of local ownership transformed with a high share of renewable energy. Co-evolving policies strengthened this path. We have analysed the policy shift in 2001 that derailed Denmark from this path, and then the policy shift only few years later that returned the country to the path. We have found robust support for the proposition from public choice theory that the first policy shift would reflect the new parliament majority and government catering to a different constituency than the previous government. Opposition to the policy shift was broad, including groups that the government parties would normally view as important parts of their constituency, attacking the very core of the governing parties' political programmes. From this, we conclude that it is essential to take the bounded rationality assumption into account, to give explanatory power to the public choice perspective.

Further, we find that the path-dependency perspective can provide a deeper historical explanation of the policy shifts. A critical juncture appeared when the EU pressed for energy de-regulation—challenging Denmark's not-for-profit norm, local ownership, state planning and subsidies that had assisted the energy system on its transformation path. Governments in the 1990s sought to contain the pressure by minor adaptation of policies. The Fogh Rasmussen government in 2001 embarked on full adaptation, which fitted the political party programmes of this government. However, counterforces had by then become too strong for the new government to ignore. From initial political commitments given to local-level actors and positive feedback mechanisms, the energy policy space had been greatly reduced by the mobilization of the path-incumbent stakeholders. The policy reversal is in line with expectations from the path-dependency perspective: the gradual reduction of options and the increased number of vested interests led to a situation of heavy resistance from a large number of stakeholders adapted to the Danish path. When the Fogh Rasmussen government sought to break with this, the sheer number of actors around the country, their level of organization and their importance for the national economy worked together to create a force that could not be ignored in Danish policymaking.

The two perspectives are complementary. Public choice theory can inform the early history that created initial commitments and later policy choices that extended the number of actors that had positive interests in upholding a given path. The path dependency perspective additionally points out that a crucial mechanism was one of aggregated interest structures, where a steadily growing number of stakeholders had interests in keeping to the policy path.

The Danish transition case offers some important lessons. First, if a transition achieves a critical mass of committed interests and institutions, it may assume an *Eigendynamik* that can be difficult to change. The transition gradually gains higher acceptance in society as the number of actors adapting and benefiting increases. As such, the case also offers a compelling case of first-mover advantage—the transition has provided Danish industry and society broadly with new commercial opportunities. Secondly, in line with previous findings [24,61,62], radical policy shifts in a deeply committed institutional setting are likely to encounter significant resistance. Path change is warranted for many energy systems under the threat of climate change, and the Danish case shows that it may be wise to maintain a long-term perspective in policy-making that can lead

to a gradual modification of interest structures, thereby loosening up fossil-fuel based path dependencies.

However, the case also illustrates some of the challenges with the currently diffused neo-liberal energy-market reform model. This model may propel mature energy systems to press forward economic efficiency but face problems as driver of low-carbon transformation. The model puts pressure on important drivers of transition: the not-for-profit norm and local ownership that spurred local innovation, benefit-sharing and local acceptance of the costs involved in the transition. Opportunities shifted towards large corporations that acquired major parts of the Danish supply system, while the number of local co-operatives engaged in renewable energy development fell—as did local enthusiasm and acceptance.

This development has been acknowledged as a problem in Denmark, and steps have been taken to meet it. Former municipally-owned plants acquired by major corporations have recently been re-municipalized, with greater focus on fuel switching to renewables; steps have been taken to increase local benefit-sharing, and support to local small-scale technology development and diffusion has increased. If a low-carbon transformation is indeed the chief aim, an important message should be to show caution in challenging the Danish system for supporting the transition.

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