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Public policy as a part of transforming energy systems: framing bioenergy in Finnish energy policy

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ABSTRACT

Government interventions have been identified as important for energy systems change, because they can either facilitate or hinder transitions toward more sustainable energy systems. This article analyses how bioenergy options have been framed in Finnish policy strategies and how the framing has changed over time. The empirical material includes the content of 15 government programmes and nine national energy/climate strategies. On the basis of this assessment, both the link between bioenergy framings in strategies and the actual transformation of Finnish bioenergy systems are explored.

On the basis of bioenergy framings, the development of energy policy can be divided into three phases: support for domestic energy sources in 1979–1991, support for wood- and industry-based bioenergy in 1992–1998, and diversified bioenergy in the context of climate change in 1999–2010. For two decades, primarily wood-based bioenergy was supported despite alternative technological developments occurring elsewhere. After the turn of the millennium, the importance of climate policy increased and alternative bioenergy sources were raised on the government policy agenda, also resulting in some new policy instruments. Rather than adopting a visionary outlook to guide system transformation, climate and energy policy has strengthened those technological options that have been selected elsewhere. If public policies are to enhance the shift toward low-carbon, sustainable energy systems, they would need to be more comprehensive, be more consistent over time, and emphasise energy use more.

1. Introduction

It is still unclear how public policy really addresses the discrepancy between climate change and energy systems based on rising energy consumption and fossil fuel domination. Government intervention through policymaking has been identified as an important factor for energy systems change, because it can to some extent facilitate transitions toward more sustainable directions by correcting market failures (Lovio et al., 2011; Rotmans et al., 2001; Unruh, 2000). Yet, once established, government institutions are also characterised by stability and persistence in the face of change (Unruh, 2000).

Strategies are typically used to outline the policy instrument package for a given government policy domain. While the content of policy strategies may not always lead to changes in the outputs or outcomes of policies (Brunsson, 1993), it is relevant for several reasons. First, it contains the promises of policymakers to stakeholders. Second, successes in creating new directions for energy policy may lead to new established regulatory systems that are difficult to change in the face of future problems. Third, government intervention can also influence the meanings attributed to technology (Klein and Kleinman, 2002) and to choices undertaken by private organisations and individuals, by tying technological artefacts and behaviour patterns to policy problems and goals. These factors together mean that the kinds of new options constructed in policy strategies matter.

Although most Western countries have shared the same energy policy goals for decades – namely, inexpensive energy, security of supply, and environmental protection – they have realised their energy policies differently (Lafferty and Ruud, 2008). National energy systems have distinct characteristics stemming from the cultural conditions, natural resources, and organisational structure influencing the political decisions made. Many attempts have been made to increase the share of renewable energy. Apart from some triumphant expansions of wind power, bioenergy has been the most significant form of renewable energy, because it has most

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easily fitted within the dominant energy systems. Finland is a case in point, being among the three EU-25 countries in which bioenergy accounts for a quarter of total energy consumption.[2]

The Ministry of Employment and the Economy (until 2008, the Ministry of Trade and Industry) is the primary actor in Finnish energy policy. It holds, directly and through its subordinate agencies, significant expertise and power in energy, climate, and innovation policy (Ruostetsaari, 2010). It also has duties related to the supervision of the electricity and natural gas markets and of energy companies in which the government is the majority shareholder. The Ministry of Finance and the Ministry of the Environment also influence energy policy, through control over economic policy instruments and environmental issues, respectively. Although around 120 companies operate power production plants, the three largest companies own about half of the total installed capacity. Government, energy-intensive industry, and municipalities are major shareholders in the largest companies, and these companies have been claimed to be powerful actors in energy policy (Ruostetsaari, 2010). Finnish energy policy is highly industry-oriented, and the forest industry has had a significant role as a user of energy and natural resources and as an energy provider and a developer of new bioenergy technologies (Kivimaa, 2008).

This article primarily examines the construction of bioenergy options in policy strategies. Its purpose is to study not the options physically created but how strategies frame and describe technological options, focusing on different perceptions and justifications regarding bioenergy. The focus is placed on bioenergy, because it is the only renewable energy source that has been an explicit part of Finnish energy policy since the late 1970s. The idea is to examine the evolution of the 'winning'[3] technological frame over time, while other studies have analysed the tensions between multiple frames at a given point in time (e.g., Kerkkänen, 2010).

The article addresses the following research questions:

- How have bioenergy options been framed in Finnish policy strategies, and how has the framing changed over time?
- How has bioenergy framing in strategies contributed to the transformation of Finnish bioenergy systems?
- Can a deeper understanding of change and stability in policy framing improve our knowledge of the dynamics of technologies and socio-technical systems?

The first question is addressed through an analysis of 24 public policy documents. The second question is answered by combining the findings concerning the first question with an analysis of policy instruments and the findings of other studies on Finnish bioenergy systems. Responding to the third question involves a conceptual analysis of the empirical findings in the context of the rapidly expanding body of literature on the dynamics of technologies and, in particular, socio-technical systems.

The research framework is presented in Section 2. In Section 3, the findings of the strategy content analysis are presented. Section 4 discusses the findings, first, on the basis of change and stability in the framings; second, linking the framing in strategies to actual developments; and, third, in comparison to other, related research. Conclusions are presented in Section 5.

[2] In 2007, Sweden had 26.5%, Latvia 25.5%, and Finland 24.9% of biomass in final energy consumption (source: European Biomass Association Statistics, 2009: http://www.aebiom.org/?p=319#more-319, accessed on 14.4.2010).

[3] Winning refers to a frame wherein mutual consensus has been relatively well achieved among the various actors and that therefore is reflected in strategies adopted by the government.

2. The research approach: framing of bioenergy options in policy strategies

2.1. Framing as an analytical concept

Framing, used here for analysis, has become a key concept in the social sciences, because how an issue is framed largely determines what should be done. A 'frame is an account of ordering that makes sense in the domain of policy and that describes the move from diffuse worries to actionable beliefs,' according to Hajer and Laws (2006). Frames define problems, diagnose causes, make moral interpretations, and suggest action (Entman, 1993).

Framing of energy policy has been defined as referring to the underlying assumptions that policy is based on and the ways in which policy constructs, emphasises, and links specific issues (Scrase and Ockwell, 2010). There are several traditions in framing analyses. Many have analysed the impact of framing, often focusing on a single document or even a particular choice by a single decision-maker, as in the seminal work by Tversky and Kahneman (1981). Others have focused on the contest of alternative frames within a specific policy domain (e.g., Nilsson, 2005). While many studies have shown the effects of framing (Tversky and Kahneman, 1981), Druckman (2004) has concluded that '[e]lite competition and heterogeneous discussions limit and often eliminate framing effects'. Since the Finnish energy policy elite have been found to be powerful, stable, and homogenous (Ruostetsaari, 2010), the consensus framing, examined here, can be expected to have effects.

Framing in the context of policy domains can contribute to the social shaping of technological options (e.g., Jørgensen et al., 2009; Klein and Kleinman, 2002). This may occur in at least two ways. Firstly, policy strategies can describe the favoured or 'optimal' technological solutions or system components that may or may not be supported through targeted mixes of policy instruments. In this context, states may be allowed 'to precisely dictate the artifact development or [policy] may provide a supportive environment for particular kinds of developments' (Klein and Kleinman, 2002: 42). For example, the EU climate and energy package quite specifically enlists technological solutions to address CO_2 emissions, such as renewable fuels for vehicles (rather than a wider policy to influence transport-related choices).

Secondly, policies can frame the context for certain technological or system solutions described in the strategies. For example, nuclear power was introduced in Finland as an environment-friendly alternative to hydropower that negatively influences fish stocks in rapids (Myllyntaus, 1991). At a later stage, nuclear power became framed as a necessity for maintaining domestic security of supply and self-sufficiency and even later as a solution for climate change mitigation (Kerkkänen, 2010; Lehtonen and Martiskainen, 2010).

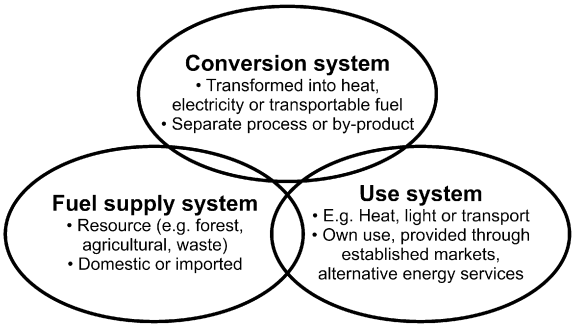

Fig. 1. Sub-systems of a bioenergy system: Each sub-system consists of actors, technologies, and rules (political, legal, and economic).

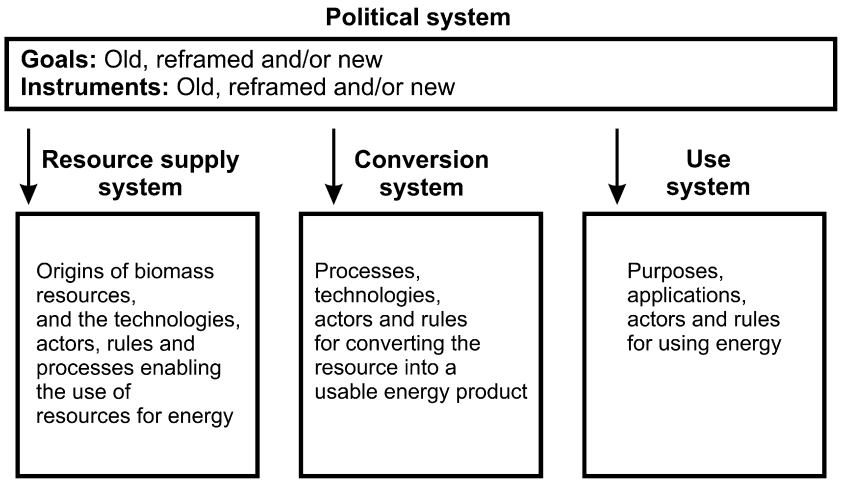

Fig. 2. Analytical framework.

2.2. Framing of bioenergy systems

Socio-technical systems can be defined as constellations of technologies, social networks, actors, institutions, and rules (Markard and Truffer, 2006; Raven, 2007). A bioenergy system may, accordingly, be regarded as part of a larger socio-technical energy system that is linked to other socio-technical systems.

A bioenergy system can be divided into three interlinked sub-systems: fuel supply, conversion, and use (Neij and Åstrand, 2006), as shown in Fig. 1. In the fuel supply system, technologies, actors, and institutions interact in order that a biomass resource can be collected, transported, and processed in such a way that it may be used as fuel. In Finland, the main potential resources in the bioenergy fuel supply system are forest-based, agricultural, waste, and imported (Antikainen et al., 2007). In the future, the potential biomass resources may expand, for example, to include aquatic plants. Various conversion technologies (for example, gasification) are used through which biomass resources can be transformed directly into heat and power or into transportable fuels. The conversion technologies and processes are highly dependent on the type of fuel and the intended use. The conversion system may also be characterised on the basis of its energy conversion as a separate process or a by-product of another process, such as pulp-making. The use system comprises, for example, heat, electricity, and transport operations that may be carried out by the producer (own use) or through the markets.

A policy framing of problems and goals that bioenergy is supposed to address may be general, potentially comprising many or all bioenergy options. Alternatively, it may be specific, pointing to just one specific option or a group of options, for example, on the basis of fuel source selection.

2.3. Methods

Policy goals and instruments exist on many levels, ranging from a high level of abstraction through programme-level operationalisation to specific on-the-ground measures (Howlett, 2009). Here the purpose is to pay attention to both general, abstract aims and programme-level goals for bioenergy. The analytical framework expands from that outlined by Kern and Howlett (2009) (Fig. 2). The empirical material covers 15 Finnish government programmes (1972–2007), four national energy strategies (for 1979, 1982, 1992, and 1997), an action plan for renewable energy (1999), a climate strategy (2001), two climate and energy strategies (2005 and 2008), and a foresight report on climate and energy policy (2009).

The empirical analysis was carried out by coding the empirical material by means of a spreadsheet similarly to what is done by Meyer and Avery (2009). The government programmes were coded sentence-specifically: all sentences included in the same paragraph as the word 'energy' were coded. The coding scheme took into account the mode of a sentence and its location within the document and the related paragraph.[4] In addition, references to policy domains, policy aims, justifications, and different bioenergy options and technologies were noted. The coding of energy and climate strategies too was done via a spreadsheet but employed a different analytical style, because these documents focused solely on energy and climate and were fairly long pieces of text. The coding scheme took into account the reasoning, objectives, and mechanisms presented in the strategies, as well as references to other policy domains, on a general level and in relation to specific bioenergy sources. In a subsequent stage, the coded information from both types of documents was processed into a table used to examine whether the goals and instruments presented in the documents were old, reframed, or new in comparison to the previous document. In addition, the aims and means to promote different bioenergy options were inserted in a longitudinal table. The coding was complemented by reading each policy document several times to ensure that the overall picture was consistent with the meanings conveyed by the pieces.

In further analysis of the bioenergy options presented in policy documents, the various system components were examined (Fig. 1). Attention was paid to how bioenergy is framed in terms of sub-systems: which sub-systems were selected and made salient (Entman, 1993) and which aspects were not described.

3. Construction of bioenergy options in the energy policy strategies of Finland in 1970–2010

On the basis of the analysis of bioenergy framings, the development of energy policy can be divided into four phases: the start of official energy policy in the 1970s, support for domestic energy sources in 1979–1991, support for wood- and industry-based bioenergy in 1992–1998, and diversified bioenergy in 1999–2010. Other categorisations are possible, based on general policy goals. Despite Finnish energy policy being government-led (Ruostetsaari, 2010), the change between bioenergy eras does not correlate with

[4] Also document-related information such as year of publication and document length was taken into account.

Table 1
Framing of bioenergy in Finnish energy policy strategies.

Selected elements in the framing of bioenergy options			
	Support for domestic energy sources (incl. bioenergy) from the 1970s until 1991	Support for wood- and industry-based bioenergy in 1992–1998	Diversified bioenergy in the context of climate change in the 2000s
Main energy policy goals	- Security of supply - Inexpensive supply for industry - Self-sufficiency in energy - Employment - Regional concerns	- Security of supply - Competitive price for industry - Self-sufficiency in energy - Environmental acceptability, incl. in terms of CO_2 emissions - Regional policy	- Climate-related commitments - Security of supply - Reasonable price for industry - Self-sufficiency in energy - Employment
Sub-system emphasised	- Resource supply	- Resource supply - Parts of conversion and supply	- Resource supply - Conversion - Use
Resource supply	- Focus on wood - In addition, forest industry waste, straw, and municipal waste	- Wood - Forest-industry by-products	- Municipal waste and landfill gas - Field biomass, reed canary grass, methane, manure, etc. - Wood, wood chips, thinnings, and logging waste - Forest-industry by-products
Purposes of use	- Non-commercial use within industrial plants, on farms, or in waste management	- Industrial processes - Small heating plants and district heating - (Transport fuels)	- Transport fuels - Heating plants and district heating - Building-specific heating - Electricity - Industrial use
Conversion technology	- CHP	- CHP - Black liquor combustion and gasification	- CHP and co-firing of wood and peat - Gasification and biorefineries - Biogas - Pellets - Distributed generation
Key actors	- The forest industry - Private forestry	- The forest industry - The rural population	- The forest industry - Farms and micro-businesses
Policy instruments	- R&D support - Subsidies for domestic fuels - Tax exemption for domestic fuels - Education and advice	- R&D support - Subsidies for domestic fuels - Tax exemption for renewable energy *(reframed)* - Agricultural and forest policies *(new)* - Proposed lower taxation of bio-based transport fuels *(new)*	- R&D support - Information and advice - Extension of tax exemption for renewable energy to recycled fuels *(reframed)* - Targeted investment subsidies *(reframed)* - Emissions trading *(new)* - Regulations on waste management *(new)* - Innovation policy instruments and SHOKs *(new)* - Feed-in tariffs *(new)*

any major changes in the composition of coalition governments where political parties are concerned.

3.1. Energy policy in the wake of the oil crisis

Energy policy was mentioned for the first time in a Finnish government programme in 1972 (Paasio II Cabinet, 1972). The government stated that it would start 'renewing the country's energy policy and drafting a holistic transport policy plan'. It is not surprising that energy policy had not been stressed in previous government programmes, since the earlier programmes were politically less important, lacked detail, and were short – often consisting of only one or two paragraphs.

In 1979, the first national energy policy plan aimed 'to promote domestic energy – first and foremost, the production and use of wood and peat' (MTI, 1979: 7). Domestic fuels were thought of as alternative fuels to be used in combined heat and power (CHP) plants. The driving force of energy policy was '[s]ecuring the reliability of energy management according to the goals set for national security and economic activity' (MTI, 1979: 4). There was only a brief reference to the environment. Three biofuel supplies were mentioned: 'Intensifying the energy use of municipal waste and straw jointly with the enhancement of wood and peat combustion' (MTI, 1979: 9).[5] The policy measures proposed were generic for domestic energy and did not favour any particular forms of bioenergy. They included subsidies, low-interest loans for construction and renovation, designing of energy taxation and tariffs, and targeting of research to favour domestic energy sources.

3.2. The energy policy of the 1980s: domestic energy sources and growing concern over air pollution

The next two government programmes (Koivisto II Cabinet, 1979; Sorsa III Cabinet, 1982) addressed energy policy briefly and did not mention bioenergy specifically. The second national energy policy plan, in 1982, dealt with alternative bioenergy options to some extent, but only the fuel supply side was addressed (MTI,

[5] In Finland, peat was previously regarded as a slowly renewable bioenergy source. This article covers renewable bioenergy sources with peat excluded, in keeping with the EU's definition (see Directive, 2009/28/EC).

1982). Wood-based energy was brought forward as the most important source, together with peat (see Table 1). Energy from waste liquors of the forest industry, energy from waste, and straw and biogas from agriculture were not seen as commercial products, and the shares of the two latter sources were envisioned as accounting for, at maximum, 1% of the total in the 1980s. In addition to policy instruments already existing at the time, an exemption from the electricity tax for electricity produced from bioenergy was established.

Subsequent government programmes continued to emphasise the promotion of wood-based energy – mainly to support private forestry (Aho Cabinet, 1991; Sorsa IV Cabinet, 1983). The main goal of energy policy remained unchanged: '[t]he government will secure energy supply for the industry at a competitive price' (Aho Cabinet, 1991). In the late 1980s, the economic and security-of-supply goals of energy policy were complemented with stronger regional and environmental goals. Following the Convention on Long-rangeTransboundary Air Pollution and its protocols, reducing sulphur dioxide and nitrogen oxide emissions were brought to the energy policy agenda (Holkeri Cabinet, 1987).

3.3. Support for wood-based energy and industry-based bioenergy in the 1990s

The Energy Strategy of 1992 (MTI, 1992: 28) stressed that '[t]he use of domestic bioenergy succeeds best when the user gets it as a by-product of other activity'. This meant that the strategy aimed 'to increase the energy use of wood in industrial processes' (MTI, 1992: 29). That was to be achieved via financial support for development and demonstration, wherein gasification and pressurised combustion of black liquor were seen as promising technologies. Concurrently, the strategy was also '[a]iming that wood chips be used as extensively as possible in the small heating plants of population centres' (MTI, 1992: 29), by increasing information provision and advice and refocusing employment and agricultural support. Importantly, lower CO_2 emissions appeared for the first time as an explicit goal of energy policy: 'The acceptability of bioenergy when compared to fossil fuels is based on fewer emissions, domestic origin, and renewability […] [U]se also has regionally positive socio- and employment-political meaning' (MTI, 1992: 28). The strategy mentioned as a new instrument a lower tax rate on biomass-based transport fuels – although their use at this stage was insignificant.

A new energy strategy (MTI, 1997) in 1997 did not bring major changes to bioenergy options or to the general energy policy. It focused again on wood-based energy: 'The aim is specifically to increase the use of wood in energy production so that it becomes a significant fuel in district heating centers and heating plants where natural gas is not available' (MTI, 1997: 11). The aim of reducing CO_2 emissions was specified more precisely, and the requirement to honour international agreements was mentioned. Regarding energy taxation, the strategy stated that 'the basic structure already implemented will be maintained in national energy taxation, and the competitive position of industry and commerce will not be […] weakened', referring to a shift in the electricity tax based on consumption made in 1997 (MTI, 1997: 10). The 1990s largely continued the policy choices of the 1980s (see Table 1).

3.4. New-millennium energy policy: Diversity of bioenergy sources in the context of climate change mitigation

The 1999 Action Plan for Renewable Energy (MTI, 1999) began an era in which new bioenergy options were more extensively outlined. It intended to go beyond the aims of the 1997 energy strategy. Wood was still the prime bioenergy source, but also waste and field biomass received some attention. The plan stressed that the 'promoting actions of the programme concentrate also on increasing the energy use of recycled fuels' (MTI, 1999: 12).

When Lipponen's second Cabinet was formed, an agreement to develop a climate strategy, to meet the Kyoto commitments, was included in the government programme. The preconditions for how Finland was to achieve its commitments were clearly stated in the following sentence: 'The commitments will be met in such a way that the necessary measures would neither weaken the economy nor promote unemployment, but would support a reduction of the national debt' (Lipponen's II Cabinet, 1999). Regarding bioenergy, the programme included merely general aims to promote bioenergy and increase the production of CHP from domestic fuels.

The first climate strategy was prepared subsequently (MTI, 2001). It continued the multifaceted approach to bioenergy. It stressed increasing the use of waste for energy and listed a range of instruments to support this. It, for example, proposed 'assessing the extension of tax support to recycled fuel' (MTI, 2001: 52). Initiating large-scale use of wood chips and the development of field biomass and agricultural biogas were mentioned also. Industry-based bioenergy was brought up in both the action plan and the strategy, but its promotion was perceived as not needing additional measures. The strategy did not put forward new instruments, apart from listing waste-energy-related measures. It aimed to achieve its goals mainly through the Action Plan for Renewable Energy and two alternative scenarios: energy production principally based on natural gas and on nuclear power.

Vanhanen's Cabinet (2003) further emphasised 'increasing the utilisation of waste as raw material and energy'. In addition, increasing the energy use of wood was mentioned once more. The Cabinet continued along the lines of the previous government, stating that '[t]he aim of government energy policy is to secure the supply of competitive energy and at the same time fulfil the requirements set by international environmental commitments'.

The new Climate and Energy Strategy in 2005 (MTI, 2005) continued to mention bioenergy based on four types of resource. Specific targets were set only for agriculture-based bioenergy through the increase of reed canary grass: '50,000 ha production area by 2010 and 100,000 ha production area by 2015′ (MTI, 2005: 64). Energy policy was increasingly based on conditions set by the EU. The main mechanism for meeting the Kyoto CO_2 emissions reduction target was to continue domestic investments in bioenergy. Emissions' trading was expected to improve the competitiveness of renewable energy sources considerably, and, therefore, it was not seen as necessary to propose new promotional measures.

Vanhanen's II Cabinet (2007) made climate change more prominent than it had been previously. Already the preface of the programme acknowledged that '[c]limate change and globalisation reinforce the inter-dependence between nations and citizens' (Vanhanen's II Cabinet, 2007: 4). The details were elaborated upon in Chapter 8, labelled 'Climate and energy policy'. The Vanhanen II government programme was also the first government programme to explicitly elaborate on bioenergy and concretely discuss ways to promote it. The programme stressed that power and heating plants utilising fossil fuel 'must be supplemented with low-emission alternatives such as bio-power plants and woodchip or bio-oil boilers' (Vanhanen's II Cabinet, 2007: 29). It placed a great deal of emphasis on increasing agriculture-based energy production, while simultaneously recognising that the greatest potential was still in the additional use of forest-based bioenergy. It also reframed energy policy by mentioning climate and environmental goals before the other energy policy goals. The new instruments proposed included tax exemptions, investment support, feed-in

tariffs, and advice systems for agriculture-based bioenergy. In addition, the programme set, for the first time, an aim of moving over to biomass-based transport fuels. The programme also outlined additional instruments for energy policy related to public procurement and building regulations.

The climate and energy strategy from 2008 (TEM, 2008) continued statement of the environmental goals of energy policy first and promotion of agriculture-based bioenergy and biofuels for transport through several measures – the latter due to EU requirement for a minimum share of biofuels in transport. It aimed at '[p]romoting the production of energy plants and the use of bioenergy from agricultural by-flows and manure' (TEM, 2008: 39). In addition, it explicitly aimed 'to increase the use of forest chips in energy production and as a raw material in industry from 3.6 million fixed cubic metres in 2006 to over 12 million fixed cubic metres by 2020' (TEM, 2008: 37). An acknowledgement was made that room exists for new solutions and technological development in relation to industry-based bioenergy. Energy from waste was not mentioned at all. New instruments included increasing the funding for R&D and innovation, Strategic Centres of Excellence (SHOKs), public procurement, and possible feed-in tariffs.

The policy documents of the last decade clearly started to be more detailed in terms of bioenergy conversion and supply, focusing also on smaller-scale applications through biogas, distributed generation, and house-specific heating solutions (see Table 1). In addition, a number of conversion and energy use options were identified – together multiplying the number of potential bioenergy options.

4. Discussion

4.1. The persistence of dominant arguments, complemented by some reframing

Self-sufficiency in and security of energy supply were the key goals of energy policy in the first Finnish energy strategy adopted in 1979. These goals persisted for the subsequent 30 years, as in many other European countries (Lafferty and Ruud, 2008). A minor reframing occurred in relation to a third major goal: securing a relatively low-priced energy supply for industry. The price condition was changed from 'inexpensive' in the 1980s through 'competitive' in the 1990s to 'reasonable' in the new millennium (see Table 1). In addition, some layering of policy goals took place through employment and regional concerns appearing on the energy policy agenda fairly early and environmental goals being added first through air emissions in the early 1990s and subsequently via reference to CO_2 emissions. A major reframing of energy policy goals did not take place until the late 2000s, when climate policy goals were raised to the top of the official energy policy agenda.

The late 1970s could be described as a short era of ferment for diverse bioenergy framings, among which wood-based energy soon began to stabilise in the 1980s. Wood-based energy – as a domestic energy source – was selected in the strategies as the dominant bioenergy alternative. Straw and municipal waste were briefly mentioned, but they were not seen as commercial alternatives and were completely excluded from the strategies for most of the 1990s. The strategies also referred to industry-based bioenergy, which was perceived to need no political support apart from extensive R&D funding. Yet it received indirect support, as many of the policy documents stated that domestic forest resources were to be used first for the needs of the forest industry and only the surplus could be used for other purposes, such as direct energy production. Although the framing of energy policy goals changed somewhat in the 1990s when air emissions were brought to the agenda, this did not result in a reframing of bioenergy, This was largely because sulphur and nitrogen emissions did not significantly involve bioenergy – apart from in creation of a minor advantage over fossil fuels (Helynen, 2004) – and climate change, according to Ojala (2006), was seen as an unavoidable consequence of energy production and use, rather than as a problem that should be consciously tackled in the preparation of government energy policy in the 1990s.

In the late 1990s, reduction in CO_2 emissions became a specific environmental goal and then gradually the most important one, largely because of international pressure – contributing to a new era of ferment in the bioenergy system constructed by policies. At the turn of the millennium, energy from waste and landfill gas were the first alternative forms of bioenergy to receive extensive attention, supported by new policy instruments. From 2005 onward, the focus of the policy strategies shifted to agriculture-based bioenergy. Through the programme of Vanhanen's second Cabinet in 2007, mitigation of climate change became one of the most important policy aims and certainly the most stressed general goal of Finnish energy policy. In less than a decade, climate change moved from being a sub-item of energy policy, which was originally a part of trade and commerce policy, to being one of the most important issues in the government programme (Kivimaa and Mickwitz, 2009). During this period, government policies were framed as implementation of international and EU climate policies (Kivimaa and Mickwitz, 2009), and the Cabinets did not have ambitions to go beyond the EU aims nationally or to work for tighter EU goals. In this, Finland's policy differs from that of, for example, Germany, the Netherlands, and the United Kingdom (Mickwitz et al., 2009). While climate policy gave a new justification for bioenergy, the stalling of the forest industry's growth in the new millennium also gave space for alternative bioenergy options.

Table 1 illustrates the phases of development in the framing of bioenergy options. Bioenergy was long framed in policy strategies merely in terms of the resource and fuel supply system – i.e., harvesting wood for energy and producing bioenergy as a by-product of the forest industry. The use of bioenergy was sporadically referred to, mainly in relation to heat and the use of energy by its producer. Alternative framings properly involving all three subsystems – resource supply, conversion, and use – emerged in the last decade. During this development, the justifications for bioenergy changed from regional- and economy-based to climate-based. The shift toward agriculture-based bioenergy has also been strengthened in response to structural changes in agriculture that require a search for new survival strategies (Huttunen, 2009).

Despite the above-mentioned reframing, the forest industry remained the actor specifically identified in all of the phases. The other actors identified changed from forest-owners to farms and micro-businesses. This is related to the development in which linkages with agricultural policy have become stronger, partly because of a similar development in the EU (Huttunen, 2009). Thus, the interaction between agricultural and energy policy is a relatively recent phenomenon.

While climate and energy strategies incorporate elements of many other policy domains, such as employment, agricultural, and environmental policies, the framing of strategies in different policy domains differs. For example, the Report on Agricultural Policy (MAF, 2005), submitted to Parliament in 2005, identified the same bioenergy resources as the 2005 Climate and Energy Strategy but was much less focused on climate change and framed agriculture-based bioenergy mainly as supporting the vitality of the countryside, a goal that was not part of the energy policy. The National Forest Programme (MAF, 2008), in contrast, was quite similar in framing to the 2008 Climate and Energy Strategy, highlighting climate change and the competitiveness of the forest industry.

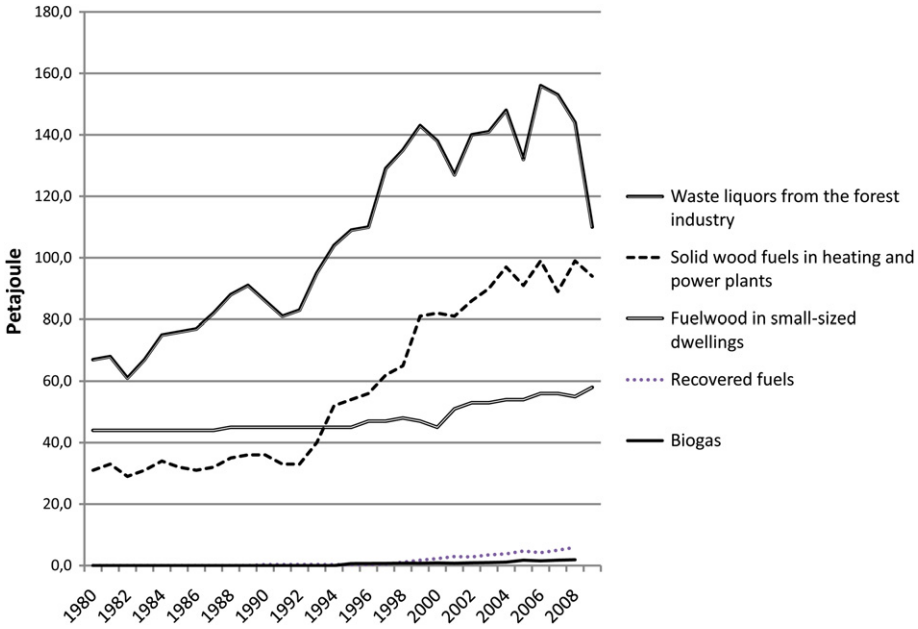

Fig. 3. Bioenergy-based fuel consumption in energy generation, 1980–2008 (sources: Finnish Forest Research Institute, 2009; Statistics Finland, 2010).

Thus, energy policy may have both rivalling and synergistic frames with respect to other policy domains. A reframing of policy may be stimulated by integration of two previously separate policy domains with slightly differing aims. The latest bioenergy policy is a result of two politically strong lobbies: the forest-industry lobby and the rural-regional lobby advanced by the Centre Party and the Central Union of Agricultural Producers and Forest Owners (MTK).

4.2. The contribution of bioenergy framings in policy strategies to the evolution of the Finnish bioenergy system

Following a top-down policy model, policy strategies would result in the (re)design of policy instruments that influence technological innovation and adoption and, in energy production, fuel use and emissions. In practice, policy and technology often develop in interplay with each other, and anticipation of policy development is important for many eco-innovation processes (Kivimaa, 2008; Mickwitz et al., 2008; Norberg-Bohm, 1999). By taking this into account, one can explore the contribution of bioenergy framing to actual bioenergy systems.

Generally, instruments outlined in the strategies and those actually implemented have not been completely consistent with each other. For example, energy and electricity taxes were reformed several times during the 1990s (Vehmas, 2005) without this being stated in the strategies. Rather, the 1997 Energy Strategy merely mentioned the recent reform and a goal of maintaining the current structure. Similarly, the 2008 Climate and Energy Strategy mentioned the Strategic Centres of Excellence that were set up prior to the strategy. The development of Finnish energy policy has mostly followed a sort of layering – wherein new goals and instruments have been added on top of existing ones – similar to that of Dutch energy policy (see Kern and Howlett, 2009). At times, also conversion and drift have occurred, when new or modified instruments have been introduced without changes to the goals of energy policy, or vice versa.

Although the main instruments of Finnish bioenergy policy have stayed the same – namely, R&D and investment support, energy tax exemptions and rebates, and information provision – some new instruments have been introduced and others have been modified to be more targeted at specific bioenergy sources. After the 2005 climate and energy strategy, first, support for cultivated energy plants and, later, more general support for investments in agriculture-based bioenergy production were mentioned as new uses for selected items in the Ministry of Agriculture and Forestry's budgetary appropriations.[6] In addition, a new bioenergy production subsidy, five million euros per annum, was launched in 2008 with an aim of creating pilot installations using agriculture- and waste-based biomass and resulting in 6–10 large biogas plants. Also, the appropriation for subsidising the harvesting and chipping of energy wood has increased from around two million euros in 2005 to 13 million euros for 2011.[7] Finally, a feed-in tariff for renewable energy will commence, in 2011, supporting both biogas and wood-fuel plants.[8]

In 1970–2008, the production of bioenergy almost doubled. In the early 1980s, black liquor and other concentrated liquors from industry became the main bioenergy resource (see Fig. 3). The use of industry-based bioenergy increased significantly despite having fairly little emphasis in energy policy apart from targeted R&D programmes in the late 1980s and early 1990s. However, the increase in industry-based bioenergy was simultaneously driven by non-policy factors, such as economic benefits for industry and long-term R&D work, along with policies demanding reduction in sulphur emissions and supporting the viability of the domestic forest industry (Kivimaa, 2008).

The use of solid wood fuels in heating and power plants also grew in 1970–2008, simultaneously with the increasing policy emphasis on wood-based energy in the 1990s. The majority of fuels originated from bark, but the use of wood chips increased over the last decade, replacing that of more industry-based fuels, such as sawdust. Although there was policy emphasis on wood chips already in the 1990s, the actual development followed later. The use of wood for local heat production has also been mentioned in

[6] Budget proposals of the Finnish Government for 2005–2011.
[7] Budget proposal of the Finnish Government for 2011, 10 September 2010.
[8] Act 1396/2010 on production subsidies for electricity produced from renewable energy sources, 30 December 2010.

the government strategies since 1992, and the number of small-scale heating plants has indeed increased quickly since the mid-1990s (Åkerman et al., 2010). The aggregate energy produced by these plants is marginal in the context of the whole bioenergy system, but their existence has changed practices in the forestry and energy sectors and the development has been important for local forest-owners and communities (Åkerman et al., 2010).

Given the relative success of wood-based bioenergy, a question arises as to whether other bioenergy options would have been more successful had they been made salient earlier in the history of energy policy. For example, farm-scale energy production was envisioned already in the early 1990s by agricultural actors, some of whom were frustrated by the lack of political will in promotion of bioenergy (Huttunen, 2009). As the potential of agriculture- and waste-based bioenergy as a share of total renewable energy has been assessed to be small (Prime Minister's Office, 2009), the contribution of reframed strategies for alternative bioenergy options is more qualitative than quantitative whatever the timing of reframing. Therefore, other than climate policy goals appear more important behind this development (see Huttunen, 2009). In Finland, agriculture and the viability of rural communities have been politically important (MAF, 2005).

4.3. Energy policy framing, technology, and socio-technical systems

Changes in the framing and discourse of energy policy have attracted increasing attention (e.g., Lovell et al., 2009; Nilsson, 2005; Scrase and Ockwell, 2010). Studies have found that, while transition to a low-carbon energy system demands a reframing of energy policy problems and solutions (Scrase and Ockwell, 2010), climate change has often in practice been framed as a problem that can be solved by existing energy technologies and practices rather than requiring a visionary outlook (Lovell et al., 2009). The findings in this paper partly support this argument, by illustrating two somewhat contradictory processes. Climate change has brought new competing technological frames to the Finnish energy policy agenda while, simultaneously, the framing of climate change has been used to support incumbent technological options by reframing the meanings and justifications attributed to these options.

Reframing the context of incumbent technologies and sub-systems is possible because social and environmental characteristics are not inherent in technology itself but are shaped during R&D processes and in the applications of technology to society (Jørgensen et al., 2009; Klein and Kleinman, 2002). The analysis of strategies shows that the framing of bioenergy has shifted from primarily energy-security-based to climate-based. The strengthening of climate goals in energy policy has added a positive environmental characteristic to bioenergy – although many bioenergy technologies have also adverse effects on the environment (Antikainen et al., 2007). Policy strategies have contributed to attributing environmental meanings to bioenergy by serving as written intermediaries (Callon, 1991) in the socio-technical energy system.

Environmental meanings attributed to technology are time-bounded (Kivimaa, 2008) and may be altered through changes in technology or in framing. The prevalence of the dominant wood-based bioenergy path in Finnish energy policy, however, gives rise to an interpretation that environmental framing of energy policy is often used more to strengthen technologies selected in another context than to change the technological options constructed by policy. Therefore, framing of new policy problems and goals is in the short run more likely to change the meanings attributed to dominant technologies than it is to create new ones, since technological development takes time. However, when strategies have recognised new technological options, such as transport biofuels or biogas plants, they have given an institutional 'protective space' (Smith and Raven, unpublished) to niches for which it has not yet been viable to enter the mainstream on their own. In a longer time perspective, many studies have shown that consistent, predictable, and reliable policy signals can induce innovations (Mickwitz et al., 2008).

A focus on specific products and processes has been seen as too limited in relation to the climate challenge – the reason calls have been made for transitions to more sustainable socio-technical systems, highlighting the innovation system perspective in all policymaking (Lovio et al., 2011; Smith et al., 2010). Although policy strategies do not on their own lead to system transformations, they contribute to the context in which new potential socio-technical systems are created: '[S]ocial aspirations that are becoming embedded in an institutional order typically first need to engage at the macro-level of the landscape of general opinion, legislation and so on, before they can become effective in seeding transition' (Berkhout et al., 2004). Still, the analysis here showed that policy framing seldom has a perspective encompassing the whole socio-technical system or all components of a sub-system, such as bioenergy. The exclusion of some system components or mere focus on the supply side, also noted elsewhere (Åstrand and Neij, 2006; Scrase and Ockwell, 2010), limits the likelihood of effects promoting system transformations. The systemic approach to policy, furthermore, stresses market creation and commercialisation (Kivimaa, 2008).

5. Conclusions

This article has examined, by combining system and framing perspectives, the development of Finnish energy policy strategies from the oil crises of the 1970s until 2010. Throughout this time, self-sufficiency and security of energy supply have been the key policy goals. The price of energy for industry has also been crucial, with the goal phrased as securing 'a low price' in the 1970s, 'inexpensive energy' in the 1980s, 'competitive' pricing in the 1990s, and 'reasonable' pricing in the new millennium. The only major change in the main energy policy goals involves the emergence of climate change mitigation, which has later become the most emphasised of the stated priorities.

The findings showed that a reframing of energy policy goals does not inevitably lead to new technological options being promoted in the strategies. Rather, it may change the meanings given to existing, dominant technologies. Early on, forest-based options dominated Finnish bioenergy policy, at one point excluding all other bioenergy options from strategies. Moreover, not only has the bioenergy framing been dominated by forest-based options, but it has also been based on centralised, large-scale energy production through the use of by-products of the forest industry. Because of this link, bioenergy policy has supported incumbent firms more than entrepreneurship. However, a major reframing may initiate an era of ferment. After the turn of the millennium, the number of competing technological frames multiplied as options based on agricultural raw materials and waste were added to the energy policy agenda. In addition, the framing of bioenergy in Finnish policy strategies changed from solely focused on the fuel supply system to also recognising different uses, largely following EU demands concerning transport biofuels.

The reframing of policy programmes has changed the policy instruments for bioenergy somewhat but not yet affected much of the actual bioenergy systems. The difference between bioenergy options framed in policy programmes and actual technologies dominating the system can largely be explained by four factors. First, the role of government intervention is often to support those options that are politically desirable but cannot succeed in the market without government intervention. Second, despite the

prominence of climate policy discussion in recent times and it being framed as the main reason to promote bioenergy in different contexts, many other political goals are behind energy policy decisions. Third, it takes much longer to develop new technologies and new paths than to reframe existing ones. Fourth, the reframing has not hitherto been sufficiently radical, especially given the strong path dependencies of the existing systems.

The findings indicate that, rather than adopting a visionary outlook to guide system transformation, climate and energy policy strengthened those technological options that have been selected elsewhere and are often based on existing conditions. Yet analyses of the evolution of policy framing can assist in identifying the key turning points in system transformation, when an option becomes first 'protected' by policy and when it moves from a niche to the mainstream.

Recent innovation and 'green' growth policies now emphasise demand and user-driven innovation much more than before. In line with this, energy policies should emphasise the system of use and its actors, uses, and networks to a much greater extent. Increased focus on fuel resources and the supply system will not change energy systems if the bottlenecks are related to use and distribution. Similarly, many significant possibilities may be forgone if biofuel use is seen as just traditional centralised heat and power though profitable options may exist in other areas, such as air fuels. If public policies are to enhance the movement towards low-carbon, sustainable energy systems, they would need to be more comprehensive, consistent over time, and more focused on energy use.

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