Lessons from (European) Bioenergy Policies -

Results of a literature review for IEA Bioenergy Task 40

Martin Junginger
Copernicus Institute, Van Unnikgebouw, Heidelberglaan 2, NL - 3584 CS Utrecht
Email: h.m.junginger@uu.nl

Paper written for IEA Bioenergy Task 40, following the Task 40/Canbio conference "Realizing the Bioenergy Opportunity", Toronto, Canada; 12-14 September 2007

1. Introduction and scope

In September 2007, IEA Bioenergy Task 40 jointly organized a workshop on 'Realizing the Bioenergy Opportunity" with the Canadian Biomass Association (CanBio) and Bioenergy Focus Ontario. The conference was set against the following background:

- Europe is implementing strategies to achieve GHG emission objectives, including ambitious targets for renewable energy in general and biomass transportation fuels
- Canada too has ambitious plans for biofuels and is currently evaluating a new domestic climate change plan. At the same time, the Canadian forestry industry is undergoing severe pressure from weak markets and high wood costs. Mill closures continue and small communities dependent on forestry are foundering. Canada needs to find a new basis for value creation and socioeconomic growth from wood resources.
- With rapid growth in biomass use in Europe, major investments are being made in Canada for exportable biofuels such as wood pellets and BioOil. Driven by new incentives and fossil fuel prices, production of heat and power is gaining ground domestically.

At the conference, the Canadian biomass utilization and export potential was explored, including the review of provincial approaches to bioenergy, and obstacles to the development of bioenergy/biofuel markets in Canada compared with countries that have comprehensive bioenergy strategies.

As an input to the conference, IEA Bioenergy Task 40 decided to carry out a **short study to identify European bioenergy policies, to identify successful and unsuccessful cases, and to derive lessons for policy makers, by means of a literature review analysis**. The main output of this work was a powerpoint presentation, presented during the Task 40/Canbio conference "Realizing the Bioenergy Opportunity", Toronto, Canada; 12-14 September 2007. This presentation can be downloaded from the IEA 40 website www.bioenergytrade.org. As a follow-up, this paper was written to provide a more comprehensive summary of the literature found, and a full literature overview.

The scope of this study is a literature review of

1. Multinational biomass policy comparisons
2. National biomass policy descriptions and evaluations
3. International comparison of general renewable energy policy evaluations

The focus of the evaluations was on the effectiveness of concrete policy measures. The effect of general long term policy targets (such as 10% biofuels in the EU in 2020) was not specifically evaluated. Furthermore, studies evaluating policy measures to support the production of electricity, heat and transportation fuels from biomass were included in the overview.

The remainder of this paper is organized as follows: in sections 2 and 3, Sweden and the Netherlands, are briefly described as case studies respectively for successful and less successful examples of biomass support policies; section 4 presents the main lessons from five studies focusing on multinational biomass policy comparison; and section 5 a summarizes the main lessons learnt. An overview of all relevant literature can be found at the end the paper.

Finally, it is emphasized that with the exception of the Dutch case study, this study is solely based on existing literature, and that the recommendations for policy makers are mainly based on these studies.

2. Sweden – a success story for biomass heat and electricity[1]

Sweden has been highly successful in introducing biomass as fuel for heat and electricity production, as illustrated in figures 1 & 2.

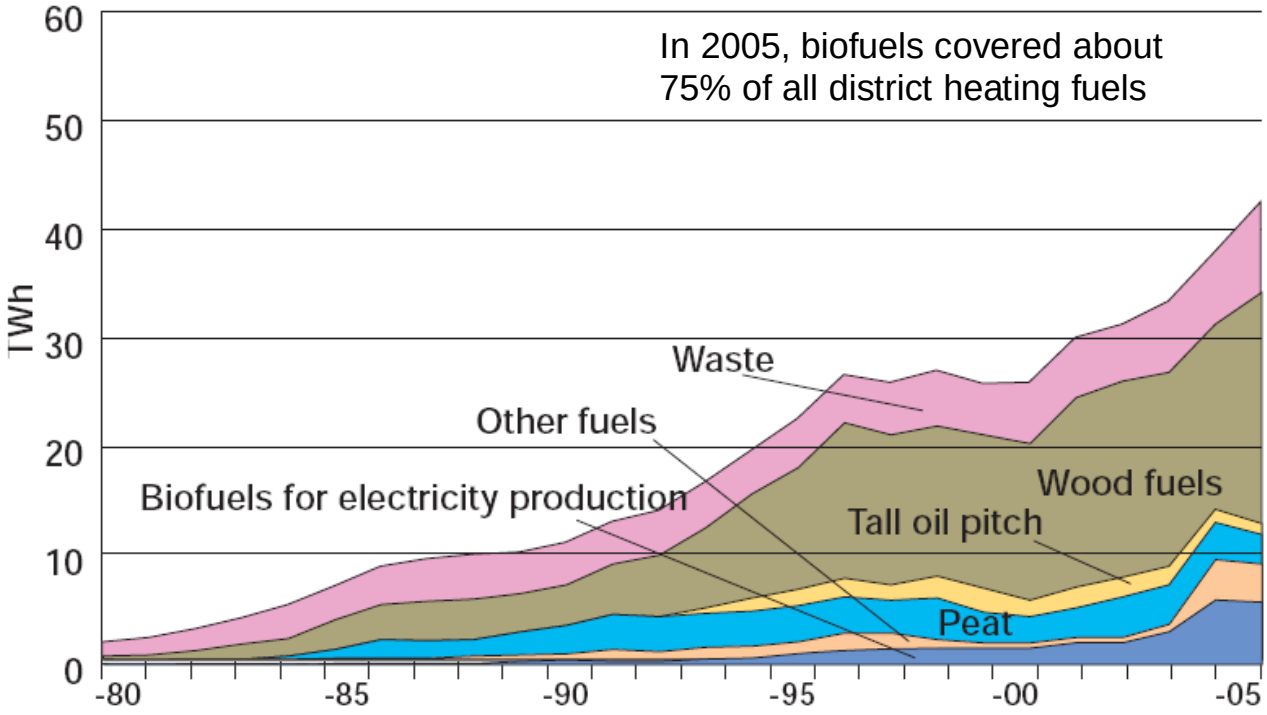

Figure 1. **Input of biofuel, peat and other fuels for district heating in Sweden 1980-2005. Source: Energy in Sweden, 2006**

[1] This section is based on information from Thornley (2007), Parikka, (2006) and Eriksson (2004).

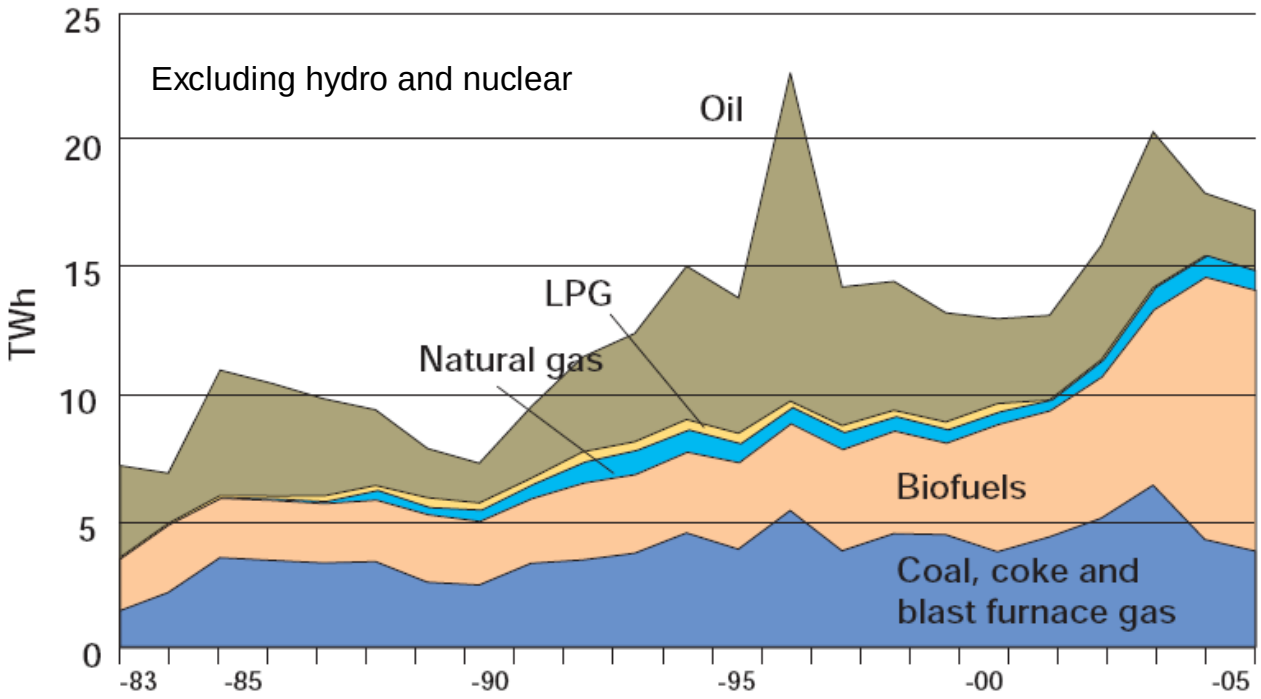

Figure 2. **Fuel input for electricity production in Sweden by source (excluding hydro and nuclear) 1983-2005. Energy in Sweden, 2006**

This success was initially the result of a combination of exogenous success factors:

- High levels of available forestry resources
- A strong forest products industry, both large-scale user of biomass and supplier to other sectors
- Existence of an established network of district heating crucial for Sweden's high level of bioenergy implementation.

However, even in this context, policy instruments were required to support and guide the development of biomass as an energy source for heat and electricity. The most important regulations supporting this development were:

- 1970- present, (rising) energy taxes
- 1991 Carbon Tax & Energy Tax, focus on heat
- 1997 – 2002 Investment subsidies
- 2000 Carbon tax increases
- 2003 Technology-independent Green Electricity Certificate system introduced
- 2004 Tax on electricity for Households and Services
- 2004 Reduced CHP Tax

Overall, Thornley et al (2007) conclude that "*it appears that taxation has been a very effective policy instrument in increasing biomass utilization in Sweden throughout the 1990's. This has particularly been the case in the heat sector, but, following market liberalization, significant increases in the electricity sector have also been noted. It should be noted in this respect that the Swedish tax regime is long established and comprises multiple layers of VAT, energy and CO_2 taxes, increasing the effectiveness of tax increases. There is also a complex and frequently modified system of allocating rebates to certain industries that has enabled the tax to be augmented as required to encourage biomass use at the expense of fossil fuels, while maintaining competitive industrial advantage*."

Furthermore, they conclude: "*Investment subsidies have been effective at initiating development of new wood/wood waste capacity. Taxation has been very effective at supporting the bioenergy, including the heat sector, but needs to be set at a suitably high level and periodically reviewed. The taxes introduced have been more effective at maximising bioenergy output from existing plant than instigating new capacity. Trading Certificates are expected to have a positive impact on the sector but there has been insufficient experience so far to verify this.*"

Based on Thornley et al. (2007) and Eriksson et al. (2004), we also conclude that **continuity and the complementary character of the various policy measures** have been key factors behind the Swedish biomass success story.

3. The Netherlands – increasing electricity production from biomass due to or in despite of policy?[2]

Compared to the Swedish situation, biomass use for energy was relatively low in the Netherlands up until the mid-1990s. The bulk production of heat and electricity was based on the incineration of the organic fraction of municipal solid waste (MSW). However, since 1996, co-firing of biomass in coal (and gas-)fired power plants took off, and contributed in 2005 and 2006 about half of the total biomass use for energy in the Netherlands (see figure 3)

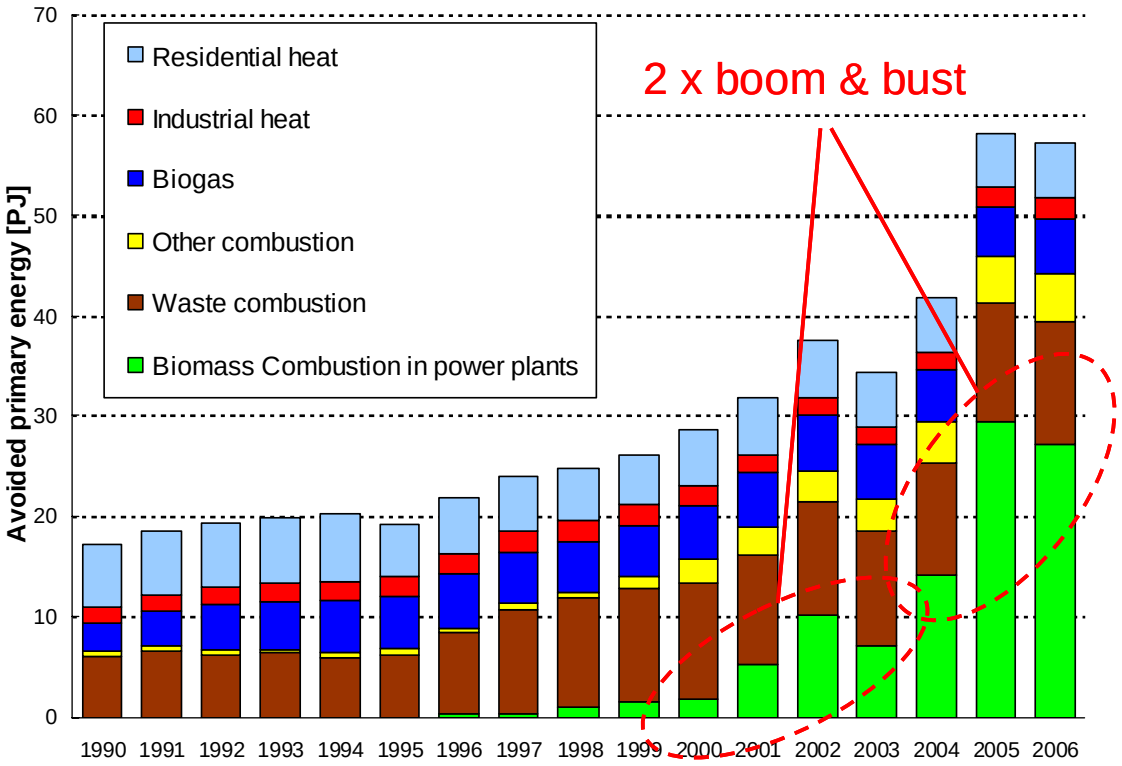

Figure 3. **Use of biomass for heat and electricity in the Netherlands 1990-2006. Data source: CBS/Statline, 2007.**

[2] This section is mainly based on Junginger et al. (2004), Wagener (2005) and Junginger et al. (2006)

This growth was undoubtedly initiated and supported by policy measures. Below, the most important support measures are listed (see also Junginger et al. 2004 & 2006 for more details):

- R&D support programmes (1995-ongoing)
- Investment subsidies,1996-2003
- Electricity tax exemption (REB) (generic) + production feed-in tariff support 1999 – 2003, phased out in 2002-2003 period
- MEP Feed-in tariffs 2003-2007: very specific (size of installation, type of biomass); may change for new plants each year MEP feed-in tariffs radically reduced in 2005, abolished for new plants in August 2006, and to be replaced in April 2008 by a new system

Since the mid 1990s, the most important policy instruments driving the further development of renewable energy sources have been the generic REB tax exemption for renewable electricity, and the MEP feed-in tariffs. Under both regimes, biomass received generous support (60-80 €/MWh produced under the REB, up to 61 €/MWh under the MEP, depending on the biomass source).

However, the REB system was rapidly phased out within six months in 2002-2003, and the MEP system abolished for new capacity in 2006. In both cases, it had become apparent that the costs were much higher than anticipated. Under the REB-system, it became clear that also renewable electricity produced abroad was eligible for the tax exemption, and thus large imports of electricity occurred. While under the MEP-regime, only domestically produced electricity from biomass was eligible for the feed-in tariff, the increasing availability of biomass through international trade enabled several Dutch utilities (and especially Essent) to co-fire increasing amounts of biomass. In both cases, this lead to temporarily lower co-firing (see figure 3) and distrust in the industry. At the time of writing, it was rumored that a new regime for renewable electricity production will be installed in April 2008, which is likely to include a tender system for large-scale electricity production from biomass. Thus, it is expected that electricity volumes produced through biomass co-firing will again be lower in 2007compared to 2005 levels.

So while governmental policy was surely a strong driver behind the overall increase of biomass co-firing in the Netherlands, it was (and currently is) also a barrier for the further investments. As Martijn Wagener (Essent) put it in 2005: "*Currently, the issue for co-firing in The Netherlands is not the need for a secure supply but a secure demand*."

Summarizing, we conclude that both **(sufficiently high) tax breaks and feed-in tariffs were able to initiate strong growth of biomass utilization for electricity production, but that (the lack of) continuity of policy support plays a vital role for a steady growth of the biomass sector.**

We also note that other aspects have played a role in the successful diffusion of co-firing biomass in the Netherlands which we do not discuss here (see Raven (2004) for a comprehensive historic analysis). For example, most recently the introduction of sustainable biomass production criteria is high on the policy agenda in the Netherlands, which may be coupled to the height of policy support. We note that for these policy developments, all stakeholders (including the industry) have been involved, hopefully leading to a more continuous policy regime.

4. Policy lessons derived from the literature

During the literature review, numerous studies were found describing either the specific biomass policies in a single country, or comparing policies in several countries for all renewable energy sources. For both, a comprehensive overview is given in appendix 1. In the following sub-sections, we focus on four recent studies, all of which compare and discuss biomass support policies in different regions. The aim is not to reproduce all lessons for policy makers from these studies (as they also often overlap), but limited to a selection of these lessons. For full details, we refer the reader to the original studies.

4.1 Selected lessons from Faaij (2006)

Faaij (2006) discusses the main developments in the policy and strategy of the EU member countries, including some of the European frontrunners in the bioenergy field; key drivers, specific national policies, policy instruments deployed and technological choices. He notes: "*All EU-15 countries implemented policies for supporting bioenergy. These include the deployment of compensation schemes, tax deduction (in some cases specifically aimed at biofuels), feed-in tariffs, tax incentives, energy tax exemption, bidding schemes, CO_2-tax and quota. Precise targets on the national level differ strongly however and are hard to compare because of differences in definitions and fuels in or excluded (such as MSW and peat).The same is true for the level of (financial) support provided through the various programs and instruments. The different countries clearly have chosen very different approaches in developing and deploying various bio-energy options. Partly this is caused by the natural conditions (type of resources and crops, climate) and the structure of the energy system, and also by the specific political priorities linked to the agricultural and forestry sectors in those countries.*

The frontrunner position of Sweden and Finland is to a large extent directly explained by the strong position of the forestry sector and the available (and leading) capabilities of innovations in this area. A key explanatory factor as to why France focuses on biofuels and production of heat is the excess of (nuclear) electricity production capacity, making electricity production an uninteresting alternative. Also for Sweden this argument is important, because support for bioenergy has especially been granted to production of heat (by means of a CO_2-tax fossil fuels for heat generation). For Sweden, this situation may change once nuclear power generation capacity will, as targeted, be decreased. Both Germany and France have a key political as well as cultural interests in their agricultural sectors, explaining the high support levels for rapeseed production as well as ethanol production from surplus cereal production. The activities and recent policy and RD&D initiatives in Spain, the UK and the Netherlands seem to reflect the interest in the longer term (i.e. after 2012 for which the Kyoto targets were formulated) when desired GHG emission reductions will require far more dramatic contributions from all renewables than projected so far."

He concludes: "*What is striking considering the development of bioenergy is that policy measures, targets and choices proved to be of vital importance for the success of its development. Roughly said, the nineties were a decade where much was achieved for bio-energy, but the focus was on in national programs and contexts. The stronger the national policy in terms of support and legal embedding, the more substantial the results were. The Swedish carbon tax and subsequent development of the biomass (including SRC-Willow production) and CHP markets, German financial support for bio-diesel and CHP, the Danish straw utilization program, Austrian CHP program and the Finnish industrial approach on advanced boiler concepts to name a few, paid off and led to strong positions for those respective countries and industries present.*"

4.2 Selected lessons from Cooper and Thornley (2007)

Cooper and Thornley (2007) have carried out a comparative evaluation of bioenergy policy in a small number of representative countries in Europe (UK, Germany, Italy and Sweden), analyzing:

- What types of policy instruments had been used in each country
- How successful have these policies been at stimulating bioenergy development, by looking at the evidence base in each country of how many and what type of projects were actually initiated
- Any unexpected/unwanted impacts of certain policy instruments
- The reasons why certain instruments had not been successful
- The reasons why successful policy instruments have been successful in particular circumstances and to identify any lessons that can be learned from this

Based on their analysis from these case studies, they present the following findings and recommendations (summarized and further elaborated by Thornley (2007)):

- **Continuity of policy instruments** is critical in supporting any bioenergy industry. The work demonstrated that uncertainty and lack of continuity in energy policy is a key issue that applies to biomass and all other renewables. The timescale over which national governments may change, frequently frustrates long term policy commitments and this is an area where **a strong lead from the European Commission and Parliament is extremely beneficial**. The Renewable Energy Source directive and Biomass Action Plan are steps in the right direction, which must be built on and consolidated. **Uniformity with respect to definitions of biomass, waste and renewables** could also be led at the European level and could help create a level European playing field in the sector.
- Policy instruments should be used to specifically guide investment in the country's preferred form(s) of bioenergy, i.e. electricity, CHP and/ or cofiring.
- **Fixed prices** are a prime way to kick-start a bioenergy industry. To sustain activity, premiums for bioenergy need to be sufficiently generous to take account of capital and fuel supply costs.
- **Investment subsidies** can help a bioenergy industry in its initial stages and temporarily reduce costs, but will not generally attract long term investment. However, for countries lacking in biomass fuel supply, investment subsidies are an important means to encourage and support the growth of biomass.
- **Trading certificates** generate investment in bioenergy, but the degree of investment will depend on the obligation and if it is weighted to specifically favor bioenergy.
- **Taxation** has a degree of effectiveness, but generally is best used alongside another stronger mechanism. For taxation alone to be effective it needs to be at a high level, increased incrementally and long term.
- **The way forward**: Long-term EC directives & policy targets on RES and biomass are beneficial, but Member States need to have a clear vision (on resources, sectors and technologies appropriate to them) and ensure appropriate targeting of resources and prevent unnecessary policy & legislative shifts as the industry grows
- **Specific targeting per technology** is to be preferred over open competition between various renewables or with fossil-fuel based electricity

4.3 Selected lessons from Faber et al. (2006)

Faber et al. (2006) analyze current European trends in bio-energy policies related to electricity and heat production. Their focus is on European legislation and its implementation in the Member States, and their work is partly based on the country reports made by EUBIONET participants. As a case study, German bio-energy and waste policies are considered in more detail, and the major effects of recent changes in these policy areas are assessed.

Especially by comparing Germany and the Netherlands (but also other European countries), they note that *large inter-European trade flows* occur, caused by:

1. Different definitions of biomass (e.g. organic fraction of waste)
2. Difference in subsidies (mainly feed-in-tariffs), causing price differentials between 4-58 €/tonne (agricultural residues) and even 10-84 €/tonne (contaminated wood) between the Netherlands and Germany, and thus exports and imports of biomass driven solely or mainly by tariff differentials.
3. Effects of different national legislation (landfill ban, emission permits)

Their main conclusion is that **reducing the differences between EU Member States' bio-energy support policies could lead to a more predictable and rational market for biomass in Europe**.

On the topic of *feed-in tariffs or quota obligations*, they note that within Europe, both systems enjoy popularity (see also Figure 4). They report that a review carried out by the European Commission shows that feed-in tariffs result in higher growth of bio-energy than is the case in countries opting only for quota obligations, although economists say both systems will work equally well in the long term. They report that the industry prefers feed-in tariffs, as "in countries with feed-in tariffs they can calculate the business case of a bio-energy project in a few hours, while in countries with quota obligations it is very difficult for investors to make such predictions, leading to a 'wait-and-see' attitude." They conclude that **therefore feed-in tariffs may work faster than quota obligations**.

Furthermore, they note"*The Biofuels Directive is leading to a considerable increase in demand for biomass for conversion to biofuels. Many Member States have recently set ambitious goals for biofuel use, which will lead to a considerable increase in demand for biomass. In the UK and the Netherlands there is already competition for products like palm oil, tallow and other fats. In the near future it may become feasible to produce biofuels from wood and wet biomass that is currently used to generate heat and electricity. In that case even greater competition will emerge between biofuel policies and bio-energy policies. In some countries like Austria and the Netherlands there is also debate on competition with other biomass-using sectors like oleo chemistry (oils & fats) and the chipboard and paper industries. This topic needs further attention. A level playing field for different biomass users is necessary*". They conclude that **competition between the transport, energy and other sectors will become more problematic. A fair and level playing field for all biomass users would make such competition work in the right direction**.

Finally, Faber et al (2006) note that "*in some countries there is a debate about the sustainability of biomass supply (CO_2 balance, emissions and biodiversity effects). It is positive that in the EU Biomass Action Plan the need for sustainability guarantees is addressed".*

4.4 Selected Lessons from Hunt et al. (2006)

In 2006, the Worldwatch Institute published a comprehensive report on biofuels for transportation, covering the global potential and implications for sustainable agriculture and energy in the 21st century. The effort was lead by Suzanne Hunt, supported by fourteen lead researchers and numerous contributors. The lessons below are extracted from part 6 "the policy framework". Note that they specifically are focusing solely on policy for biofuels for transportation.

As in previous studies, Hunt et al (2006) observe that "*it is clear that* ***long-term governmental and stakeholder commitments to biofuels are critical; that a combination of policies is needed to drive the market and development of necessary infrastructure, and that policies must be consistent and flexible enough to tackle new challenges as they arise***."

Furthermore they state clearly that fossil fuels such as oil still receive massive policy support in countries such as China and the U.S, and also warn about competition from advanced fossil fuel options. Furthermore, they highlight the importance of policy measures safeguarding the sustainability of biomass production, trade and use "*For biofuel to play a greater role in the transport sector, the* ***playing field must be leveled through the gradual elimination of subsidies for petroleum-based fuels****. As the price of oil increases, biofuels will become more cost-competitive, making it easier for them to compete with conventional fuels. However, the same can be said for unconventional liquid fossil fuel resources such as tar sands, which could become a large part of the future energy mix if the price of oil is high enough and associated costs of land use, water, and other environmental resources are not taken into account. This real possibility highlights the importance of also incorporating external security, social, and environmental costs (climate change in particular) into the price of energy."*

On the latter point, they elaborate further and highlight the need for (policies introducing) standards and certification schemes: *"A lack of environmental oversight can result in backlash if rapid biofuel expansion leads to unsustainable production practices. The lack of a global commodity market for biofuels may slow supply growth. And the absence of international standards and/or certification schemes creates uncertainty for equipment and technology suppliers and may impede international trade*." Summarizing a very complex discussion, they conclude that "*While there are many possible targets and outcomes associated with an increase in bioenergy trade, several are particularly critical.* ***Trade in biomass and biofuels should, among other things: foster a stable and reliable demand for the services of rural communities, provide a source of additional income and employment for exporting countries, contribute to the sustainable management of natural resources, fulfill GHG emissions reduction targets in a cost-effective manner, and diversify the world's fuel mix****. Achieving these diverse goals—particularly in a sustainable manner—may best be done through implementation of a sound standards and certification framework."*

In addition, they note that the following barriers on the domestic and international level require policy and/or institutional reforms as well:

- If the oil industry controls the supply and distribution of biofuels, this may lead to price manipulation.
- Unreliable supply and demand for biofuels can create uncertainty and impede market development.
- The lack of a global commodity market for biofuels may slow supply growth.
- The absence of international standards and/or certification schemes creates uncertainty for equipment and technology suppliers and may impede international trade.

4.5 Selected Lessons from Kautto (2007)

Kautto (2007) assessed the performance of the support systems in the EU-25 (Cyprus and Malta not included) over the period 1990-2002 to deliver green electricity, i.e. how effectively different policy instruments had stimulated electricity production from biomass and biogas. She followed a 5-step methodology based on the PRETIR project. In order to provide contrasts, she highlights the most successful and unsuccessful instruments and bioelectricity/country combinations. The success was measured using several quantitative criteria, such as the absolute increase in bioelectricity production and production capacity compared tot the EU-15/25.

Kautto (2007) shows that the most successful Member State/bioelectricity combinations were Germany, the United Kingdom, Spain and Finland, as their increase in bioelectricity production absolute increase more than 10% of EU-15 absolute increase. Italy did not meet this particular criterion but was the first to fill the other quantitative criteria. Greece, Luxembourg and Portugal as well as the new Member States can, in principal, be considered to represent 'unsuccessful' examples.

Regarding the effectiveness of feed-in tariffs, she points out that feed-in tariff systems are the main mechanism in three countries out of five successful MS/bioelectricity countries (Germany, Spain and Italy), but this instrument is also applied in Greece, Luxembourg, Portugal and in the majority of the new MS. The level of bioelectricity support alone varies greatly between countries, and tariffs depend on issues such as start-up date, source of electricity or the type of technology, size of the facility or a time of generation. There is evidence that those countries, which have chosen to implement stable, long-term feed-in tariffs, also have the highest RE deployment rates.

Kautto concludes that **rather than a single instrument being responsible for favorable development, bioenergy development is typically reliant upon the synergistic effects of several success factors.** She finds that "*the assessment of performance of a RES policy mechanism is a challenging task as multiple factors have to be taken into account. It is necessary to assess the effectiveness of the policy instruments in a manner that has a significant degree of comparability in order to show relative outcomes between different countries*"… "*mapping of the framework conditions for development in the form of various success and risk factors was fundamental*". In table 1, an overview is given of main barriers and drivers for bioenergy development.

Table 1. Main barriers and drivers for bioenergy development. Source: Kautto (2005) and Kautto (2007) .

Critical factors	Risk factors	Success factors
Political	lack of coherent political support	specific bioenergy targets and policies
Legislative	complex support system, insufficient and non-technology specific tariffs and prices, lack of long term security	favorable and long-term guaranteed tariffs and prices, transparent and simple support system, EU accession requirements (new MS)
Structural	support for nuclear power, dependency on fossil fuels, excess of power capacity	well-established forestry industry and existing forestry infrastructure
Financial & fiscal	lack of investment support	availability of investment subsidies, favorable taxation measures
Administrative	authorization procedures complex and lengthy	short and simple authorization procedures
Technological	limited transmission network capacity	longstanding bioenergy RD&D
Cognitive	low environmental awareness and public awareness concerning RES	high environmental awareness
Biomass issues	uncertainties related to feedstock supply, competitive uses of biomass	availability of feedstock supply

5. Final summary of policy recommendations

Based on the literature review, we summarize:

1. When formulating new and (hopefully) long-term support policies for bioenergy, not only a clear target should be set. In addition, it should be accompanied by a clear vision regarding the resources that should be utilized, the sectors (of industry and agriculture) that should be involved, and the appropriate technologies linked to the resources and sectors.

2. To reach the long-term policy targets, concrete financial support types have to be developed. The ideal type of policy support system(feed-in tariffs, quota obligations, tax breaks etc.) depends strongly on the specific situation (e.g. maturity of the technology, distance between current situation and the policy target, number of relevant industries present, etc.). In general, the financial height should be sufficient to enable the competition with the (fossil) energy alternatives, but should also not be too high, to avoid freerider-effects. Also, it is recommended to clearly state from the beginning whether subsidies are temporarily only, and if so, how and when they will be (gradually) reduced.

3. The unsustainable production and use of biomass and bioenergy carriers should be prevented, e.g. by developing sustainability criteria for biomass production (including topics such as net GHG emission reduction, social and environmental performance etc.), and to ensure compliance with these criteria by e.g. a certification systems.

4. Care should be taken to avoid (policy-induced) competition for the biomass feedstock between:
   a) different biomass-for-energy applications (heat, electricity, transport fuels),
   b) the bioenergy sector and other sectors that use biomass as feedstock (e.g. pulp & paper, feed, food, etc.), and
   c) countries, causing (solely policy-driven) biomass trade flows and unpredictable market developments.

   For all situations, ideally a 'level-playing field' should be created.

5. Perhaps most importantly, as was pointed out numerous times in the studies above, long-term continuity of policy support measures seems to be the single-most important factor determining the success or failure of policy for a successfully developing biomass.

6. Finally, bioenergy support policies are a precondition, but not a guarantee for the successful development of bioenergy. Other critical factors include amongst others the legal, administrative, technological and cognitive framework.

This paper was written within the frame of IEA Bioenergy Task 40. The views and opinions expressed are not necessarily those of IEA Bioenergy Task 40, nor of the members of the IEA Bioenergy Implementing Agreement. Frank Rosillo-Calle is thanked for helpful comments on an earlier draft.

Literature references

Multinational biomass policy comparisons and evaluations used in this paper

Andre P.C. Faaij, 2006, *Bio-energy in Europe: changing technology choices.* Energy Policy 34 (2006) 322–342.

J. (Jasper) Faber, G.C. (Geert) Bergsma, J.T.W. (Jan) Vroonhof, G.E.A. (Geert) Warringa, 2006, *Bio-energy in Europe 2005: Policy trends and issues*. Delft, CE, 2006.

Suzanne Hunt (project leader) et al., 2006, *Biofuels for Transportation: Global Potential and Implications for Sustainable Agriculture and Energy in the 21st Century*, Worldwatch Institute, Washington, DC, 2006.

Deborah Cooper, Patricia Thornley, *The Effectiveness of Policy Instruments in Promoting Bioenergy*. Tyndall Centre, University of Manchester, March 2007.

Patricia Thornley, 2007, *Energy policy to support European biomass development*, Thermalnet Newsletter, July 2007, p 40-41.

Niina Kautto, 2007, Performance analysis of policy mechanisms promoting electricity from from renewable biomass in the EU. Paper presented at the Bioenergy 2007 conference, September 3-6 2007, Jyväskylä. Finland.

Niina Kautto, 2005, Analysis of Policy Options and Implementation Measures Promoting Electricity from Renewable Biomass in the European Union, University of Jyväskylä, Department of Biological and Environmental Science, MSc thesis of environmental sciences April 2005.

Other multinational biomass policy comparisons and evaluations

Donald L. Klass, *Biomass energy in North American policies*, Energy Policy, Vol. 23(12) p. 1035-1048.

Kyi Lwin, *Chapter 5: Policy options and strategies for market development of biomass: an Asian-Pacific perspective*. p. 141-160 in: Bioenergy options for a cleaner environment. Ralph E.H. Sims (ed.) Elseveri Ltd, 2003.

AFB-net Phase IV, *Report on EU Member States Bio-energy Policies, Support Mechanisms and Markets*. ETSU publication RYCE32032AFBBIO, January 1999.

National biomass policy descriptions and evaluations

<u>*EU*</u>

Karin Ericsson, Suvi Huttunen, Lars J. Nilsson, Per Svenningsson, *Bioenergy policy and market development in Finland and Sweden*, Energy Policy 32 (2004) 1707–1721.

Matti Parikka, The role of bioenergy in the national legislation and implementing EU directives, Swedish Eubionet2 report, February 2006.

Kenneth Möllersten, *Policies promoting bioenergy in Sweden: Experiences and outlook*. Contibution to the T38 Workshop "policies and instruments to promote bioenergy and Bioproducts for GHG Mitigation. Side event at the 15th European biomass Conference, berlin germany, May 2007.

Rolf Björheden, *Drivers behind the development of forest energy in Sweden*, Biomass and Bioenergy 30 (2006) 289–295.

Bengt Hillring, *National strategies for stimulating the use of bioenergy: policy instruments in Sweden*. Biomass and Bioenergy, 14 (5/6) 425-437, 1998.

Dan van der Horst, *UK biomass energy since 1990: the mismatch between project types and policy objectives*, Energy Policy 33 (2005) 705–716

Bishnu Raj Upretia, Dan van der Horst, *National renewable energy policy and local opposition in the UK: the failed development of a biomass electricity plant*, Biomass and Bioenergy 26 (2004) 61 – 69

Patricia Thornley, *Increasing biomass based power generation in the UK,* Energy Policy 34 (2006) 2087–2099.

Lars J. Nilsson, Marcin Pisarek, Jerzy Buriak, Anna Oniszk-Poplawska, Pawel Bucko, Karin Ericsson, Lukasz Jaworski, *Energy policy and the role of bioenergy in Poland,* Energy Policy 34 (2006) 2263–2278.

Reinhard Madlener, *Innovation diffusion, public policy, and local initiative: The case of wood-fuelled district heating systems in Austria*, Energy Policy 35 (2007) 1992–2008.

Simona O. Negro, Marko P. Hekkert, Ruud E. Smits, *Explaining the failure of the Dutch innovation system for biomass digestion—A functional analysis*, Energy Policy 35 (2007) 925–938.

Bohumira Jehlickova, Richard Morris, *Effectiveness of policy instruments for supporting the use of waste wood as a renewable energy resource in the Czech Republic,* Energy Policy 35 (2007) 577–585.

Americas

Jose Goldemberg, Suani Teixeira Coelho, Oswaldo Lucon, *How adequate policies can push renewables*, Energy Policy 32 (2004) 1141–1146.

J.A. Puppim de Oliveira, *The policymaking process for creating competitive assets for the use of biomass energy: the Brazilian alcohol programme*, Renewable and Sustainable Energy Reviews 6 (2002) 129–140

Suani T. Coelho, Marly F., Bolognini, *Policies to improve biomass electricity generation in Brasil*. Renewable Energy 16 (1999) 996-999.

David Pérez, I. López and I. Berdellans, *Evaluation of energy policy in Cuba using ISED*, Natural Resources Forum 29 (2005) 298–307.

Pradeep J. Tharakana, Timothy A. Volk, Christopher A. Lindsey, Lawrence P. Abrahamson, Edwin H. White, *Evaluating the impact of three incentive programs on the economics of cofiring willow biomass with coal in New York State,* Energy Policy 33 (2005) 337–347.

Evan Hughes, *Biomass co-firing: economics, policy and opportunities,* Biomass and Bioenergy 19 (2000) 457-465

Asia

S. Prasertsana, B. Sajjakulnukit, *Biomass and biogas energy in Thailand: Potential, opportunity and barriers*, Renewable Energy 31 (2006) 599–610.

W.T. Tsai, Y.H. Chou, Y.M. Chang, *Progress in energy utilization from agrowastes in Taiwan,* Renewable and Sustainable Energy Reviews 8 (2004) 461–481.

International comparison of general renewable energy policy evaluations[3]

Support Schemes for Renewable Energy: A Comparative Analysis of Payment Mechanisms in the EU, European Wind Energy Association (Brussels, 2005).

Review of international experience with renewable energy obligation support mechanisms, Linden, N.H. van der; Uyterlinde, M.A. (ECN, Petten (Netherlands)); Vrolijk, C.; Ericsson, K.; Khan, J.; Nilsson, L.J.; Astrand, K.; Wiser, R. ECN-C--05-025 (May 2005).

Renewable Energy Markets and Policies in the United States, Eric Martinot, Ryan Wiser, and Jan Hamrin (Center for Resource Solutions, San Francisco, 2005).

Renewable Energy: Market and Policy Trends in IEA Countries, International Energy Agency (Paris, 2004), 668 pp. This reference compendium is the most comprehensive view of renewable energy

[3] All these documents are available via the website http://www.martinot.info/policies.htm

ever produced for the 26 IEA member countries. For each country, it provides a summary of renewable energy market status, energy supply contribution, R&D trends, market and policy trends, and a chronological description of the policies that have affected renewable energy. Also contains a 60-page overview of these same topics for the group of IEA countries as a whole.

"Renewable energy policies and barriers," Fred Beck and Eric Martinot, Encyclopedia of Energy (Academic Press/Elsevier Science, San Diego, 2004).

National Policy Instruments: Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World, Janet Sawin and Christopher Flavin. Thematic Background Paper for Renewables 2004 conference, Bonn, Germany, June 2004.

Policies for renewable energy in the European Union and its member states: an overview, T. Johansson and W. Turkenburg. Energy for Sustainable Development 8(1): 5-24 (2004).

Renewable Energy Policy, Paul Komar (Diebold Institute for Public Policy Studies, New York, 2004), 182 pp. Policies in the EU and US and analysis of what has worked and what hasn't.

Energy Revolution: Policies for a Sustainable Future, Howard Geller (Island Press, 2003), 289 pp.

Renewable Energy Policies and Market Developments (ECN, Petten, Netherlands, 2003).

"Review of renewable energy development in Europe and the US," T. Stenzel, T. Foxon, and R. Gross (UK Department of Trade and Industry, 2003). A report for the DTI Renewables Innovation Review October 2003, ICCEPT.

Renewable Energy Policy...into the Mainstream, International Energy Agency (Paris, 2002), 53 pp. Basic introduction to renewable energy and its benefits.

Natural Selection: Evolving Choices for Renewable Energy Technology and Policy, United Nations Environment Programme (Paris, 2000), 36 pp. Basic introduction to technologies and policy options.

Other literature quoted

CBS/Statline, 2007, Data on renewable energy production in the Netherlands, available for download at http://statline.cbs.nl

Energy in Sweden, 2006, Swedish Energy Agency, November 2006, p. 68, available for download at www.swedishenergyagency.se

Martijn Wagener, Co-firing in The Netherlands: The need for a secure supply. Document prepared for the IEA Bioenergy EXCo 55 meeting, May 2005, available for download at www.bioenergytrade.org

M. Junginger, S. Agterbosch, A. Faaij, W.C. Turkenburg. Renewable electricity in the Netherlands, Energy Policy 32 (2004), pp. 1053–1073.

M. Junginger, M. de Wit, A Faaij, 2006. Updated country report IEA Bioenergy Task 40 for The Netherlands. Available for download at www.bioenergytrade.org

R. P. J. M. Raven, Implementation of manure digestion and co-combustion in the Dutch electricity regime: a multi-level analysis of market implementation in the Netherlands, Energy Policy, Volume 32, Issue 1, January 2004, Pages 29-39.