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COUNTRY REPORT SWEDEN

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Cover: Biomass, woodchips and pellets have substituted oil in Swedish greenhouses during the last years. Alverbäck's tulip greenhouse outside Stockholm.

Photo: Rebecka Ramstedt

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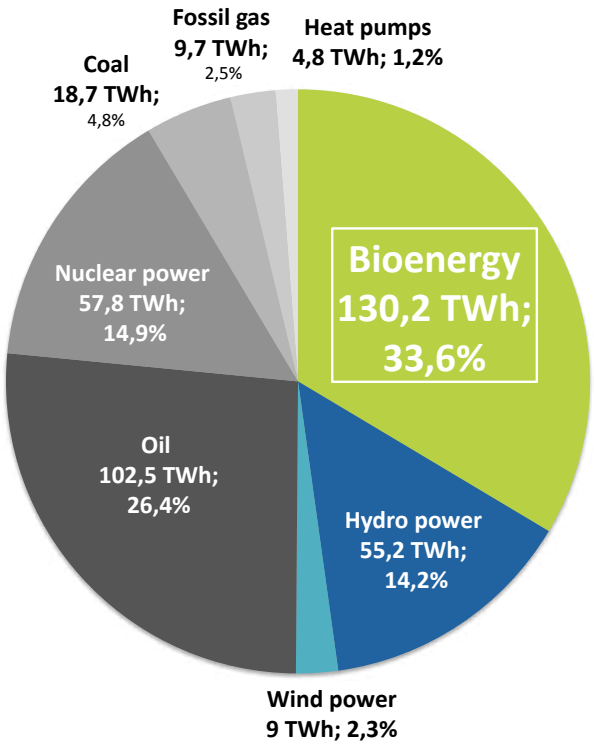
BIOENERGY IN SWEDEN IN A NUT-SHELL!

FIG. 1 BIOENERGY - LARGER THAN OIL

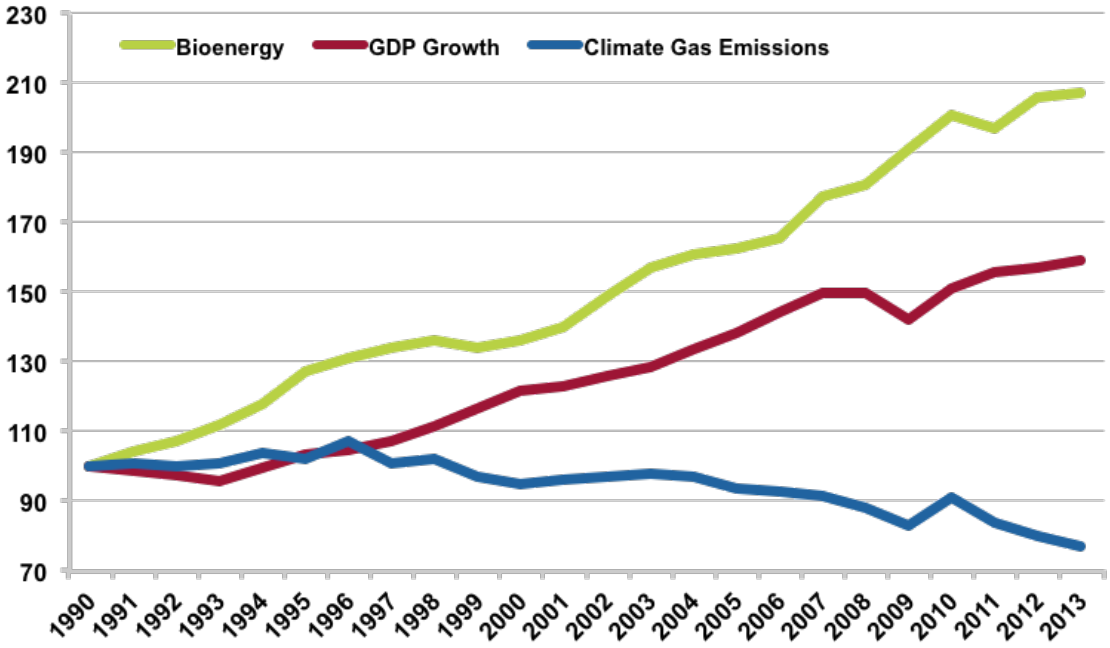


ENERGY USE 2013

Final domestic energy use in 2013 – industry, electricity production, heat, transport etc.

Source: Svebio calculation based on Swedish Energy Agency preliminary statistics.

FIG. 2 ECONOMIC GROWTH AND CARBON REDUCTION



Since 1990, the Swedish economy has grown by more than 50 percent in real terms (red line), and at the same time the greenhouse gas emissions have decreased by 23 percent (blue line). A major explanation to this decoupling between economic growth and emissions is the steady growth of bioenergy use (green line), in all sectors of the Swedish economy.

Index values 1990 = 100

Sources: Statistics Sweden, Swedish Energy Agency, and Ekonomifakta. Graph by Svebio.

1. GENERAL INTRODUCTION – SWEDEN IN BRIEF

1.1 POPULATION AND AREA

Population	9.6 million	
Land area	41.3 million hectares	
of which	forest	23.0
	bogs and swamps	4.5
	barren mountains	4.4
	agriculture land	3.4
	others	6,0

1.2 ECONOMICS

Unemplyment	7,5 %	Oct 2014
GNP	SEK 3775 (420) Billion	2013
GNP current	2,1 %	Q 3 14, cf Q 3 13
GNP per capita	SEK 393.300 (43 700)	2013
Inflation	-0,1%	Oct -14 cf Oct -13
Basic loan rate, National Bank	0,00 %	2014
Basic loan rate, Government	0,90 %	30 Nov 2014
State Budget, result	SEK – 26 (-3.2) Billion	2013
National Debt	SEK 1303 (145) Billion	2014
National Debt/GNP	34,5 %	2014
Balance of Trade	+3,8 %	2013
Taxes/GNP	44,3 %	2012

1.3 SUPPLY AND USE OF ENERGY IN SWEDEN

TOTAL ENERGY SUPPLIED 2013	**TWh**	**PJ**
Crude oil and oil products	162	583
Natural gas, gas-works gas	12	43
Coal and coke	22	79
Biomass derived fuels	121	436
Peat	2	7
Waste	16	58
Heat pumps (district heating)	4	14
Hydro power	61	220
Nuclear (incl. heat losses)	189	680
Wind power	10	36
Export of electricity	- 10	36
Total	590	2124

USE OF ENERGY 2013		
Total final use per energy sector	**TWh**	**PJ**
Industry	139	500
Transport	92	331
Dwellings, service	147	529
International transport	28	101
Total	**406**	**1461**

Source: Swedish Energy Agency

USE FOR NON-ENERGY PURPOSES AND LOSSES		
Non-energy purposes	21	76
Conversion and distribution losses (excl. nuclear power generation)	32	115
Conversion losses in nuclear power generation	130	468
Total	**183**	**659**

Source: Swedish Energy Agency

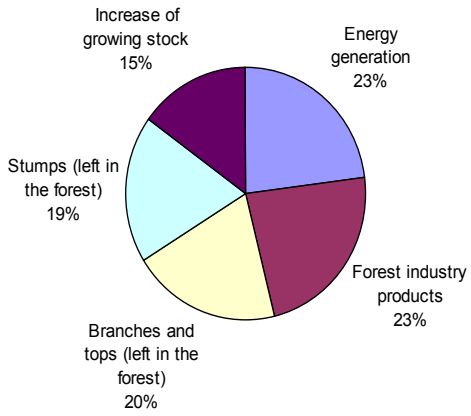
2. DOMESTIC BIOMASS RESOURCES, CURRENT USE, TRENDS AND MAIN USERS

BIOMASS FROM FORESTRY IN SWEDEN

The total annual biomass production in the Swedish forests is estimated to be about 76 Modt (Megaton oven dry substance). It corresponds to about 1.36 EJ. More than half of that quantity is left in the forest site, due to market restrictions and restrictions of technical, environmental, economic, etc. reasons.

In recent reports from SLU/Future Forests (i.a. Lundmark.T. et al. 2014. Potential roles of Swedish forestry in the context of climate change mitigation) it is predicted for 2050 that the increased yield production, growth, in the Swedish forests will lead to a "surplus" of 50 million m3 (stem-wood, incl. bark), in addition to the present conditions, corresponding to about 150 TWh (540PJ) of energy if used for energy purposes. However, there are other possible demands for that quantity, e.g. saw-mills, bio-based products, and forest conservation.

FIG. 2 THE BIOMASS BALANCE IN SWEDISH FORESTS



Source: Swedish Board of Forestry, 2006

One example of the predictions of a "realistic potential", e.g. after considering future restrictions such as ecological and additional demands from other markets, is listed below. (excluding import)

	TWh	PJ
Branches and tops	57	205
Trees from early thinning, etc	13	47
Split fuel wood	9	32
Wood from non-forest land	3	11
Cull logs and breakage	6	22
SUBTOTAL	88	317
Stumps (est.)	20	72
SUBTOTAL, Forest Fuels	108	389
Woody by-products (bark, saw dust, chips)	27	97
Recycled wood from Swedish sources	4	14
Black liquor, etc. from the pulp industry	40	144
TOTAL	**179**	**644**

Source: SLU, P. Hagström. 2006, except the value for stumps, which is estimated by SCA. 2007. Later publication, using the same basic data have confirmed the relevance and the general levels of the data presented in the study above.)

Harvesting of stumps in "controlled and responsible" manners, is provisionally in the forest legislation.

BIOMASS FROM AGRICULTURE

The total annual bio-energy production potential of Swedish agriculture is estimated by the Commission on Bioenergy from Agriculture (SOU 2007:36) to be as follows:

	TWh	PJ
Set-aside land	5 -10	18 -36
Land presently used for exported grain	4.5-7.5	16 – 27
Land used for surplus fodder production	5-7.5	18 – 27
Increased production efficiency	4 -14	14 – 50
Total	**19 – 39**	**66 – 140**

It should be noted, that the total potential estimate is based on generic policies regarding the Swedish self-sufficiency for basic food.

2.1 CURRENT USE

HEAT AND POWER

The users solid biomass fuels are primarily the district heating sector and the forest industries. Also direct heating of dwellings consume a significant amount of solid biofuels. The map on page 9 illustrates the wide distribution of users both with regard to geography and size.

PROPELLANTS

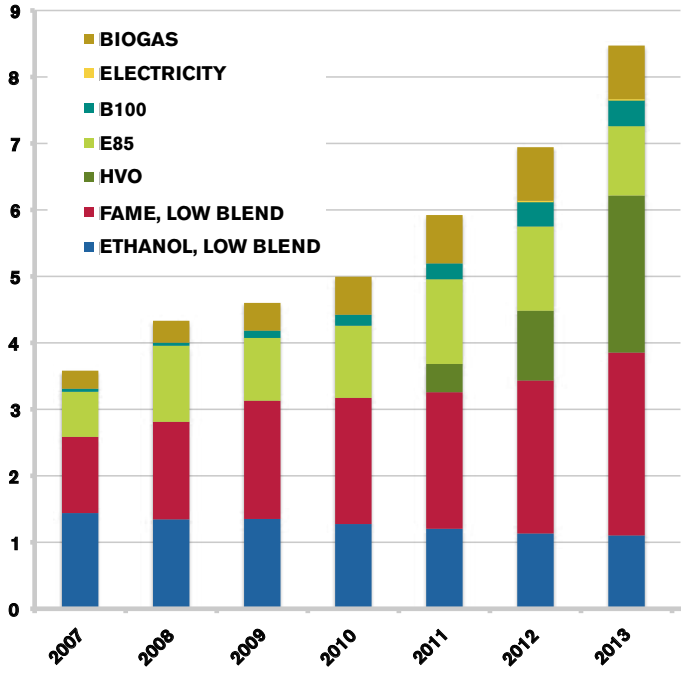
During the last 10 years there has been a significant shift from gasoline to diesel in the Swedish transport sector. The diesel consumption has increased by 42 percent whilst the total fuel use has remained stable. *(Transportsektorns energianvändning 2013 ES 2014:01)*

The percentage of renewable energy in the transport sector was 15,61 percent 2013. *(According to the accounting rules of the Directive 2009/28/EC on the promotion of the use of energy from renewable sources)* A large part of this energy came from biofuels, with a total usage of 9,7 TWh. *(Hållbara biodrivmedel och flytande biobränslen under 2013 Statens energimyndighet ET 2014:15)*

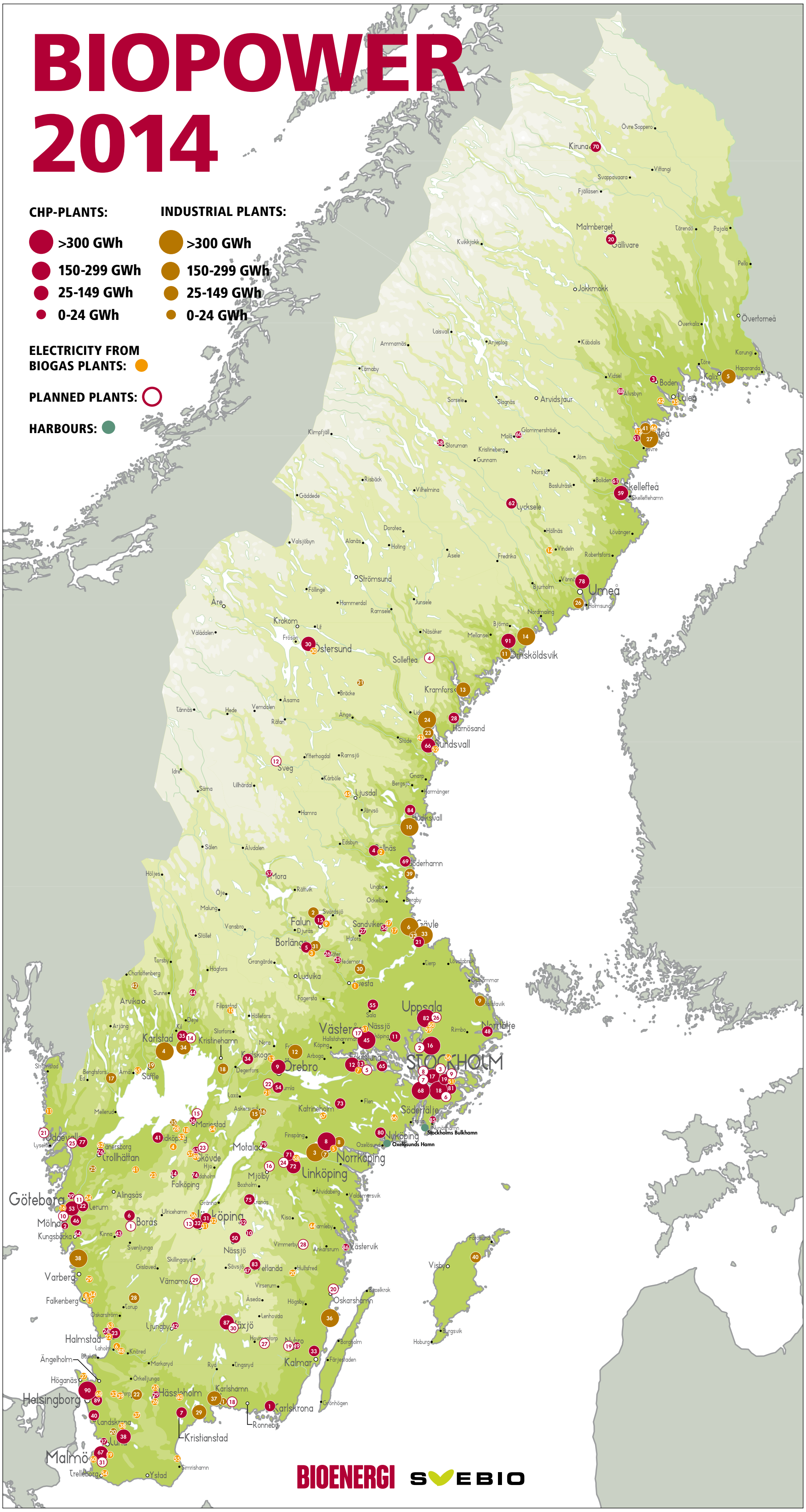
The largest market for biofuels is blending into gasoline and diesel, but there is also a market for E85, vehicle gas (with 60 percent biogas), ED95 and pure biodiesel (FAME 100 and HVO 100, although the latter is still on a pilot stage).

The use of FAME and vehicle gas has grown whilst the E85 market has decreased, see Fig. 3 below.

FIG. 3 USE OF RENEWABLE FUELS IN ROAD TRANSPORT 2007-2013 (TWh)



The use of biofuels in transport has increased considerably in recent years. The strongest growth has been for biodiesel, e.g. HVO from tall oil and FAME based on rapeseed.



In 2014, there were around 200 units producing biopower throughout Sweden. The largest are CHP:s in district heating and in pulp factories. The total production was around 11 TWh, accounting for 8 percent of the total electricity supply.

Biodiesel has had the largest growth and ethanol has decreased both due to the lower market share of gasoline and the removed subsidies for E85 vehicles. Due to the lack of long-term incentives and stochastic regulation regarding clean vehicles the market has become more reluctant towards cars powered by biofuels, the market focus has been on fuel efficiency rather than fuel choice.

2.2 NEW PROJECTS AND PLANS FOR FUTURE INVESTMENTS.

The investment in large scale (100+ MWthermal) CHP plants has continued. This is partly due to effects of the support system for new renewable electricity. Older biomass based units are phased out of the system, whereas new units will qualify for new certificates. Examples of such plants are Örtofta (Lund), Västerås, and Jönköping. Others are under construction, e.g. Värtan (Stockholm) and Växjö. Those plants are generally designed for flexible fuels, such as chips from forest and forest industry residues, chipped round-wood, recovered demolition wood, peat, and industrial and municipal waste.

The changes in the energy taxes for certain industries and businesses (see below) mean that it is more economic to convert to bioenergy. Conversion of the energy systems for the 200 biggest users of fossil fuels in that category would result in an increase of bioenergy of about 2 TWh (7 PJ). *(Svebio 2014)*

Bioenergy has stagnated in the small scale segment. (Individual houses, etc.) The reasons are partly that the market is saturated, partly due to competition from district heating and in particular from heat pumps.

As Sweden has a strong forestry industry there has been an interest in developing fuels based on forest residues. The first biofuel plant based on forest residues, Sunpine, was inaugurated 2010 and now produces 2 percent of the total diesel consumption in Sweden. The plant produces Hydrogenated Vegetable Oil (HVO) based on the residue tall oil that is extracted from pulp plants.

During 2013 the first phase of the GoBiGas plant in Gothenburg was completed. It is a demonstration plant for gasification of forest residues to biogas to be injected in the fossil natural gas grid. Phase 1 is a 20 MW installation and a possible second phase will be of the size 80-100 MW. Late in 2014 the process was fully functional and producing gas for the grid.

Several other planned biofuel plants that has not been realized due to the lack of long term incentives. One of these is the gasification of black liquor to bio-DME. There is a large interest in Sweden to produce synthetic gasoline and diesel based on lignin from black liquor from pulp plants. But no investment decision to build a plant has been taken, mostly due to the unclear policy situation regarding biofuels both within EU and nationally within Sweden.

2.3 PROGNOSES

A SMALL MARGINAL INCREASE IN ENERGY CONSUMPTION IN THE INDUSTRY SECTOR IS PREDICTED FOR 2014-2016

Biomass derived fuels will remain the largest source with a predicted increase from 35% to 39 %. The use of oil and diesel will decrease, and the use of coal and fossil gas is predicted to increase, in particular for the mineral and metal sectors

THE RENEWABLE ENERGY WILL INCREASE IN THE TRANSPORT SECTOR

The total energy use in the transport sector will remain stable on the level about 92 TWh (330 PJ). The energy efficiency will continue to increase. However, the total transport volume will increase which will lead to a balance. The percentage of renewable in the transport sector will grow by 5 % to just below 20 % in 2016..

The new rules concerning sulfure emissions will lead to a transfer from heavy oils to low or no sulfure content in fuels in shipping. The total energy use in the shipping sector will remain stable.

LOW RATE OF FOSSIL FUELS IN THE DWELLING AND SERVICE SECTOR

The energy consumption in the sector Dwellings and Services is to a large extent dependant on weather and temperature. 2013 was a year with warm weather and an energy use of 143 TWh (515 PJ). Consequently, based on assumptions of normal weather in 2015 and 2016 the energy use will be 150 TWh (540 PJ). Biomass, heat pumps and electric heating dominate, and oil and other fossil fuels have been phased out to a great extent. The major part of heating in apartments and office buildings is supplied by district heating, where 70 percent of the energy supply comes from wood fuels, waste fuels and peat.

ELECTRICITY GENERATION WILL INCREASE.

The generation of electricity was 149 TWh in 2013.The projected increase in generating capacity from i.a. wind and CHP will lead to an estimated electricity production of 164 TWh in 2016. It seems likely that this increase will add to the present surplus of generating capacity and will open opportunities for increased export of electricity.

INDUSTRY SECTOR

A large share of energy use in industry is in the forest industry where the main energy source is internal use of biogenic residues. Despite low prices on emission rights these industries continue converting from the remaining use of fossil oil to biofuels, e g pellets for recovery boilers.

In the industry outside ETS the carbon tax will be raised in 2015 and 2016, which will lead to conversion of fossil fuel boilers to use of pellets, woodchips, bio-oils, and district heating

RENEWABLES INCREASE.

The trends of growth of renewables will continue in all sectors.

Source: Energimyndigheten, www.energimyndigheten.se. The same source has also issued prognoses for 2020.

3. POLICY SUPPORT AND EXPECTED BIOMASS USE IN 2020 (AND BEYOND)

3.1 POLICY MEASURES AND INCENTIVES

The overall objectives are:

- to ensure reliable supply of electricity and other energy
- to create favourable conditions for efficient use of energy and a cost-efficient supply of energy focussing on a low negative impact on health, the environment and climate, and
- to promote the transformation to an ecologically sustained society.

A number of rules and incentives have been introduced in order to achieve the objectives set out in the energy and climate policy.

For several of these overall objectives, it will be important to increase the proportion of renewable energy, to improve energy efficiency, to reduce the use of energy in absolute terms and to reduce emissions. One general means of achieving energy policy objectives, which is intended to contribute to achieving several of the objectives, is energy taxation, in the form of energy taxes, carbon dioxide tax and sulphur tax. Other important policy measures and incentives are the electricity certificate trading scheme, the policy measures for infrastructure and transport, technology procurement, and information activities. Emissions trading (ETS), and Research, Development and Demonstration (RD&D) constitute important elements of a long term development strategy.

3.2 POLICY MEASURES AND INCENTIVES

Apart from the targets set by the EU directives, Sweden has no specific targets for bioenergy. In Sweden, the EU targets for 2020 are already accomplished and exceeded, with a possible exception of the factor Energy Saving. However, general policy statements assert an aim of a Fossil Free Society but details and timing are still vague in that respect.

The Swedish parliament decided in 2009 that Sweden shall have a fossil independent vehicle fleet by 2030. However, the parliament did not define what this target means in quantitative terms. The former Alliance government called on an extensive investigation, Fossilfrihet på väg (Fossilfrihet på väg, SOU 2013:84), which was presented in 2013. The authors of the report defined the target to mean an 80 percent reduction of the emissions from the transport sector by 2030 and a fossil free vehicle fleet by 2040. However, this definition has not been confirmed officially. The report verifies the large potential for biofuel production in Sweden and states that the political targets can be achieved at an acceptable short term societal cost leading to long term economic growth.

The policies with regard to bioenergy have been rather stable for a long period of time. The outcome of the present political turbulence will not lead to major changes in those policies as the opinions on bioenergy do not differ substantially between parties.

Biofuels have been exempted from energy and CO2 tax, incentives that has been very successful. However, the high oil prices during the last few years in combination with reduced prices on traditional biofuels has resulted in that the tax exemption has led to an “overcompensation” of biofuels relative to fossil transport fuels, which is not allowed by EU regulations. Moreover, the revision of the EU state aid regulation for energy 2014-2020 also limits Sweden’s possibilities to exempt biofuels from energy and CO2 tax, since it contains limitation on giving tax exemptions to “food based” biofuels. The Swedish government has therefore decided that the current tax exemptions must be removed and replaced by a quota system by 1 Jan 2016. The structure of this quota system is under development and no information regarding its ambition or structure can be given. The stated political ambition is that the quota system shall not reduce the use of biofuels and that it shall promote climate efficient biofuels. The main concern is how a quota system shall assure that the current unique Swedish market for high blend biofuels such as E85, vehicle gas, ED95, FAME 100 and HVO 100 would not be jeopardized.

3.3 ENERGY TAXES

Energy taxes comprise several different taxes for fuels and electricity. A general energy tax is levied on most fuels based on their energy content. A Carbon Dioxide Tax has been in force for more than 20 years is charged on all fuels except biomass and peat. (the present charge is SEK 1080; €120 per ton CO_2). The Sulphure Tax amounts to SEK 30 (€3.3) per kg sulphure emitted. A NO_x fee of SEK 50 (€5.5) is applied annually for energy plants generating 25 GWh and more. The NO_x fees go to a revolving fund and are redistributed in relation to the energy generation.

Electricity generation is not subject to energy and CO_2 taxes. Instead, taxes are charged on the price for the end users. Also, the heavy industry inside ETS do not pay these taxes. Industry outside ETS and agriculture and forestry have had reduced rates of energy and CO_2 taxes, but these reductions are gradually taken away in 2015 and 2016. The full taxes have so far been applied in the heating and service sectors, and in transport.

Biofuels have traditionally been omitted from energy and CO_2 taxes. However, as mentioned above, due to the EU rules regarding overcompensation, where biofuels cannot receive subsidies if the subsidies makes them more price competitive compared to fossil fuels, there has been a gradual implementation of energy tax on Ethanol and Biodiesel based on rapeseed (FAME). During 2015 it is believed that these taxes will have a negative effect on the demand for Ethanol and FAME.

ENERGY AND ENVIRONMENTAL TAXES 2014

	Energy tax	CO_2-tax	Sulfure tax	Total tax	Tax/kWh SEK	Tax/MJ c
Fuels						
Light fuel oil, SEK/m3 (<0,05 % sulfure)	816	3 088	-	3 904	0,392	1,21
Heavy fuel oil, SEK/m3 (0,4 % sulfure)	816	3 088	108	4 012	0,379	1.10
Coal, SEK/ton (0,5 % sulfure)	620	2 687	150	3 457	0,457	1,41
Gasol, SEK/ton	1 048	3 249	-	4 297	0,336	1,04
Fossil gas, SEK/1000 m^3	902	2 313	-	3 215	0.292	0,90
Peat, SEK/ton, (45 % moisture, 0,3 % sulfure)	-	-	50	50	0.018	0.06
Propellants						
Gasoline, SEK/l	3,13	2,50	-	5,63	0,619	1.91
Ethanol, drop-in, SEK/l	0,34	-	-	0,34	0,058	0.17
Diesel, SEK/l	1,76	3,09	-	4,85	0.495	1.53
Low blend FAME, SEK/l	0,28	-	-	0,28	0.031	0.10
Methane, SEK/m^3	-	1,85	-	1,85	0.168	0.52
Electricity, c/kWh						
Electricity North Sweden SEK/kWh	0.194	-	-	0.194	0.194	2.16
Electricity, South Sweden, SEK/kWh	0,293	-	-	0,293	0.293	3.26
Electricity, industrial processes, SEK/kWh	0,005	-	-	0.005	0.005	0.06

€1 = 9 SEK

Ton = Metric Ton

Source: Swedish Energy Agency

4. BIOMASS PRICES

Official price data for solid fuels from biomass are collected and published by the Swedish Energy Agency (Energimyndigheten). The methodology and comments are presented in the text below:

"This fuel price statistics is shown in nominal average prices quarterly, or monthly, or for earlier years. The latest prices are preliminary. The fuel prices are shown without taxes (delivered free at plant) and are divided into densified and non densified wood fuels and peat. The fuel prices are shown for district heating plants and industry (not including internal use) for the whole country and in some cases for different regions in Sweden.

This survey covers the input amount of quarterly used fuels and the costs of these fuels. This means that the prices shown are the actual costs for the fuel used during the past quarter. In addition, this means that the figures shown are not the actual market prices for the fuel assortments. The principle for evaluation is "first in – first out". Long fuel delivery agreements may cause that the actual price level on the market differs from the prices shown in this publication. The statistical frame for the year 2014 was 133 district heating plants and industries."

WOOD FUEL, SEK/MWh AVERAGE PRICES, CURRENT PRICES EXCL. TAXES

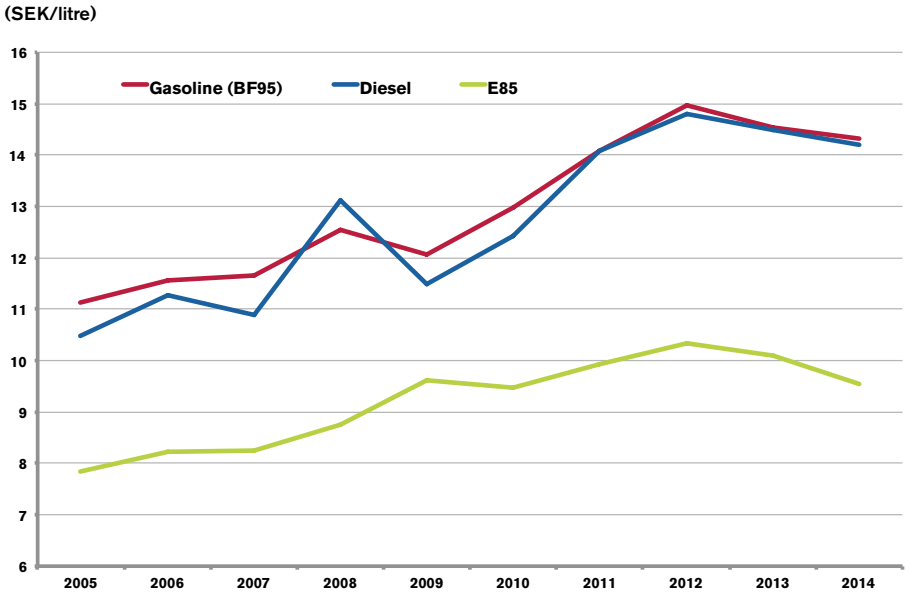
		2011	2012	2013	2013: 1Q	2013: 2Q	2013: 3Q	2013: 4Q	2014: 1Q	2014: 2Q
Densified wood fuels (pellets)	District heating	300	292	296	293	305	312	300	275	266
Wood chips	Industry	199	189	197	196	198	199	198	186	183
	District heating	214	209	199	203	203	197	192	194	193
Solid by-products	Industry	197	188	177	191	193	170	160	165	168
	District heating	184	185	179	181	172	172	182	166	174
Recovered wood	District heating	117	115	102	107	92	98	104	98	88

Source: Swedish Energy Agency

The prices above give a general picture of the price levels and trends. However, actual individual contract prices may deviate from those listed above. It would be particularly true for recovered wood, and for industrial and municipal waste fuels; the latter two not listed in the table. Waste fuels frequently are acquired for "negative prices". A recent report (Svensk Energi, 2014) estimates the price of municipal waste to minus SEK 400 (minus 44) per ton.

The long term development of prices for biomass for energy is predicted as follows:. In real value, the prices will decrease until the first years of the 2020ies, then increase for a few years, spiking at a level corresponding to the cold year 2010, and then return to a lower "long-term" level. The reason for the prediction of a "calm" price development is the increasing surplus of biomass.

FIG. 4 SALE PRICE DEVELOPMENT FOR PETROL, DIESEL FUEL AND ETHANOL (E85)



Average yearly price at pump (SEK/litre) at a manned fuel station.

Source: http://spbi.se/statistik/priser/

The pricing of low blend fuels are monitored, to make sure that no overcompensation occurs but there are no public market prices for Sweden. However, these volumes are traded on a global market and the Swedish prices follow international market prices. The pricing principle of gaseous propellant biofuels was changed in 2014 so there are no long term price trends available. However, the suppliers have strived to whenever possible to have a significantly lower price on biofuels compared to that of gasoline.

Due to the tax emption of biofuels, it has almost always been cheaper to use biofuels then fossil fuels. It has also been financially beneficial for petrol companies to blend in biofuels in their gasoline and diesel. It has therefore never been any obligations to sell *(Although the filling stations are not forced to blend in biofuels there is a law, "Pumplagen", in Sweden that states that filling stations that sell more than 1500 m^3 must provide a biofuel option.)* or blend in biofuels.

The market growth of biofuels in Sweden so far is due to economic viability, customer demand and subsidies on fossil independent vehicles.

5. INTERNATIONAL BIOMASS TRADE FOR ENERGY

5.1 BACKGROUND AND BRIEF HISTORY

International trade within the bioenergy sector started early in Sweden. Several factors coincided to develop strong drivers for that development of international trade, i.e. public policies, the structural pattern of the end users, and the traditions and contact patterns of the Swedish industry with regard to international trade.

Most cities in Sweden had district heating systems originally based primarily on combustion of imported oil. When the policy measures led to change to solid renewable fuels that structure was also suitable for import of these fuels.

Major companies in Sweden related to the bioenergy sector were and are working in international markets. That is true for enterprises e.g. in the forest industry and in combustion technology. Therefore, sourcing of raw material, shipping and international trade were already parts of their established businesses, and consequently it was relatively easy in the emerging bioenergy trade to mobilize competence to carry out economic analyses and to go on with practical handling.

In a comparably small scale the import of bioenergy took place in the period 1975-1990. It was mainly cheap fuels in form of waste from the food industries, e.g. olive kernels and other similar fuels which could compete with coal in a direct price comparison.

After 1990 the import grew due to introduction of stronger incentive measures in favour of biomass fuels and to the development of new sources: (1) the opening of direct access to cheap biomass in the Baltic states, and (2) the stricter rules for wood waste handling and combustion in Germany and Holland which led to a flow of very cheap fuel from recovered wood ("RT-chips") to those existing plants in Sweden which already had feasible combustion technology for those fuels.

5.2 BIOMASS FLOWS AT PRESENT

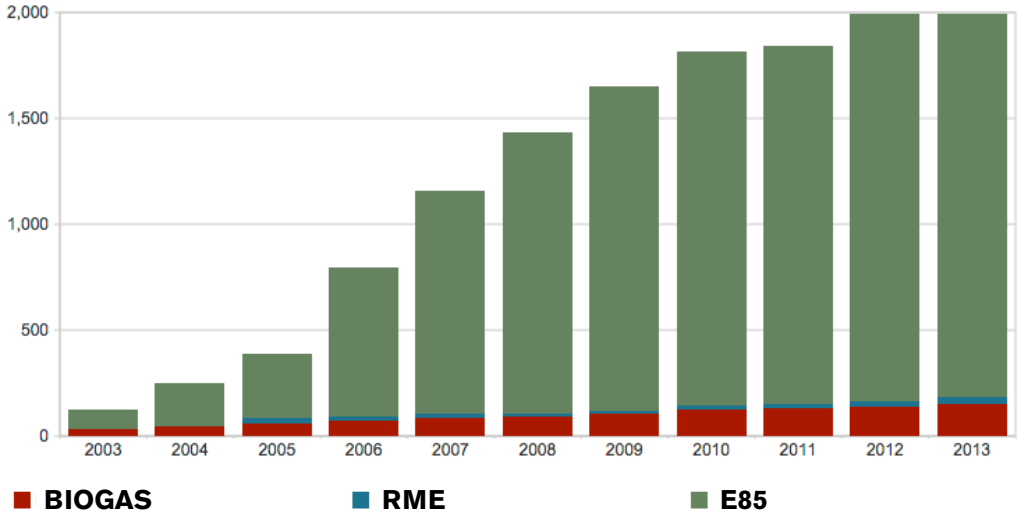
The user pattern differs with the various biomass products. Imported fuel such as chips, bark, saw dust, and fuel chips from imported round-wood are utilized primarily in large and medium sized district heating utilities. The typical importing utility plants are located at or near suitable ports. The same pattern is true for industrial users. The Biopower map on page 11 shows the general city pattern, which corresponds to locations of utility plants and industry plants. Thus most plants are located at sites with suitable logistics for import of biomass fuels.

With the introduction of electricity certificates and tradable emission rights, the process industries, in particular the forest industries increased their use of biomass fuels and several industries also increased their use of imported wood fuels, and particularly in recent years demolition wood and waste.

In free and open competition with domestic biomass fuels, imported wood, pellets and briquettes are also used in district heating utilities. In an increasing rate these types of imported fuels, in particular wood pellets, are also used in small and medium scale burners in individual households, small energy heating units, schools etc. In these cases fuels are imported by middle men or distributors.

There are three main markets for liquid biofuels in Sweden, energy production, low blend biofuels and high blend biofuels. For heating and electricity production the biofuels are mostly used in small industries or as a complementary fuel in oil burners used for back-up or as additional energy for peaks in energy demands. During 2013 4,6 TWh biofuels where used for energy and electricity production. The use of biofuels for energy production is assumed to increase for small scale industries as the current reduction in carbon tax will be removed at the latest 2019. The total use of biofuels in Sweden during 2013 was 9,7 TWh, of which the majority was used as low blend propellant fuels. The Swedish law allows for 10 percent ethanol in gasoline, but the tax system limits it to 5 percent. For diesel the tax system and fuel specification limits the blending of FAME to 5 percent and there is no limit other than the fuel specification regarding HVO. HVO low blend was up until 2014 limited by tax laws to 15 percent but this limit is now removed. The high blend fuels that are commercially available on the market are E85 (E75 during the winter season), ED95, FAME 100 or vehicle gas (in average it is a mixture of 60 percent biogas and 40 percent fossil natural gas). E85 network covers most of Sweden, approximately 1800 filling stations. In total 150 public vehicle gas stations can be found in the south of Sweden an along the east coast up to Sundsvall and Boden. FAME 100 filling stations, approximately 34 public ones, can be found mostly in the south of Sweden. ED95 filling stations are often non-public as the fuel is used within internal buss fleets.

FIG. 5 NUMBER OF FUEL STATIONS OFFERING RENEWABLE FUEL



The graph shows the total number of stations each year with a pump for renewable fuels

Source: http://spbi.se/statistik/forsaljningsstallen/forsaljningsstallen-med-fornybara-drivmedel/

Propellant fuels, e.g. ethanol are used by the main oil companies either as low mix (5%) in petrol or as 85% ethanol fuel (E 85).

5.3 QUANTITIES AND TYPES OF BIOMASS

The official statistics does not provide a single source of information for biomass import. Biomass is imported under different headings and definitions and it is often mixed with other categories of products. This is especially true for wood in unrefined forms.

Round wood in form of pulp wood and saw logs is normally imported in un-debarked form, and as the bark is used for energy purposes it could be classified as "imported biomass". The same could be the case for saw dust and other residues from imported logs.

Moreover, a portion of the round wood import consists of energy wood for direct use (after comminution) for energy generation. However, the import statistics does not separate round wood directly used for fuel.

A rough estimate of the bioenergy portion of that import can be carried out based on the total import of wood.

TOTAL IMPORT OF WOOD (BOARD OF FORESTRY)		
	2012	**2013**
Round wood, million m3 solid under bark	7.4	6.3
of which coniferous	49 %	51 %
broad leaved	51 %	49 %
and saw logs	15 %	16 %
pulp wood	85 %	84 %
Chips, million m3 solid,	1.6	1.6
of which coniferous	83 %	84 %
broad leaved	17 %	16 %
Wood residues million m3 solid	1,0	0.8

TOTAL EXPORT OF WOOD (BOARD OF FORESTRY)		
	2012	**2013**
Round wood million m3 solid under bark	0.70	0,75
of which coniferous	99 %	99 %
broad leaved	1 %	1 %
and		
saw logs	43 %	42 %
pulp wood	47 %	49 %
other	10 %	9%
Chips, million m³ solid,	0.6	0.3
of which coniferous	100 %	91 %
broad leaved	0 %	9 %
Wood residues, million m³ solid	0,1	0,07

IMPORT AND EXPORT OF UNREFINED SOLID BIOMASS FUELS

The bioenergy portion of the wood trade can roughly be assumed as follows: “Direct” refers to the portion that directly is used for fuel, “indirect” to secondary fuels like bark, saw dust, black liquor, etc. from the portion that is used in industrial processes. (2013)

IMPORT		
	Direct	**Indirect**
Round wood	5 PJ	28 PJ
Chips	1 PJ (est.)	2 PJ
Wood residues	1 PJ	-
Total	**7 PJ**	**30 PJ**

Export		
	Direct	**Indirect**
Round wood	-	4 PJ
Chips	-	1 PJ
Wood residues	est. 0.3 PJ	-
Total	**0.3**	**5**

IMPORT AND EXPORT OF PELLETS

The production and trade of pellets are recorded by the Swedish Pellet Association. Published values, not adjusted for estimated activities for non-members (about 10 % of production), are for 2012 and 2013:

	2012		**2013**	
	K ton	**PJ**	**K ton**	**PJ**
Import	491	8,7	713	12.7
Export	129	2,3	162	2,9

The total use of recovered wood is 4.6 TWH (16.6 PJ) (Energimyndigheten 2014, unpublished data). Data for import is lacking. An informed guess would result in an estimate of 50% import. UK is the main source.

For Sweden, Municipal Solid Waste (MSW) is recorded to 2.2 million ton (Avfall Sverige) of which 50.1% was utilized for energy. There are no official data for import, but shipments are recorded from i.a. Norway and Italy.

5.4 GEOGRAPHIC TRADE PATTERNS

The main part of the imported round wood and the chips in 2013 had its origin in the Baltic states and in Norway. To a large extent biomass for energy was integrated in the harvesting and in the flow of wood to the Swedish forest industries.

Some years ago, wood residues, especially recovered wood fuels (RT) came from Germany and Holland. In later years, the major part of the flow of residues to Sweden emanates from UK.

In 2013, pellets were imported mainly from neighbouring countries in the east, Russia, Finland, Estonia and Latvia. Canada has lost her position as the main single supplying country. Detailed data on quantities imported, broken down for supplying countries, are not available from the official statistical sources since 2008.

For 2008, pellet import is reported to come from the following countries, listed after import quantities: Latvia, Russia, Finland, Estonia, Canada, Poland, and Portugal. The Latvian top position can be explained by the fact that a substantial share of the Latvian pellet industry is owned and managed by Swedish companies.

5.5 QUANTITIES AND TYPES OF LIQUID BIOFUELS

According to Swedish law liquid biofuels must be able to comply with the EU sustainability requirement within Directive 2009/28/ on the promotion of the use of energy from renewable sources, including reporting of country origin. The feedstock for biogas originated to 97 percent from Sweden. 98 percent of the biogas was produced from waste or residues. For ethanol only a fourth of the feed stocks originated from Sweden and 49 percent form non-EU countries. For FAME only 5 percent of the feed-stock originated from Sweden and 75 percent from non-EU countries of which Australia accounted for 22 percent of the feed stock. For HVO again a fourth of the feed stocks originated from Sweden in the form of tall oil.

5.6 TRADE STRUCTURE

The trade is organized and carried out in a variety of forms and patterns. There are several examples of long term contracts. Seasonal contracts are also common and so are spot contracts.

As mentioned above, some of the trade in round wood, chips and wood residues is captive, meaning that the entire chain is controlled by the end user or the national distributor. But other portions of the trade are performed in form of fob or CIF contracts, etc. either directly between producer and end user or involving one or several agents or other middle men.

Two different trends of emerging patterns could be noticed, namely (1) that the major users of imported biomass fuels tend to prefer buying biomass fuels in the same manner as they buy other types of fuel i.e. from established trade channels and based on well defined quality norms and classifications and (2) major producers and large end users sign contracts for biomass fuels that are suitable for the specific requirements of that particular end user. When the resource base for raw material widens due to increased general demand of biomass fuels, this trend would be further explored.

Trade of recovered demolition wood and for municipal etc. waste tend to develop own trade pattern, as they are not integrated in traditional trade flows of forest products and traditional fuels.

ORIGIN OF FEED-STOCK, ETHANOL

	Sustainable volume [m³]			[%]
Country of origin	**2011**	**2012**	**2013**	**2013**
Sweden	134 900	120 900	89 510	25%
Lithuania	5 754	28 180	50 030	14%
France	70 050	70 970	49 890	14%
Brazil	42 270	10 320	35 650	10%
Ukraine	5 760	2 694	20 720	6%
Poland		6 350	18 170	5%
Romania	6 911	3236	12 770	4%
United Kingdom	32 200	25 580	12 240	3%
USA	15 900	17 370	10270	3%
Guatemala	6 478	2 774	10 250	3%
Other countries	70 110[1]	97 100[2]	42 170[3]	12%
Total	**390 400**	**385 500**	**351 700**	**100%**

[1] Belgium, Costa Rica, Denmark, Estonia, Lithuania, Russia, Serbia, Spain, Germany, Hungary

[2] Belgium, Denmark, Estonia, Lithuania, Peru, Serbia, Slovakia, Spain, Germany, Hungary

[3] Belgium, British Virgin Islands, Costa Rica, Denmark, Nicaragua, Peru, Spain, Germany, Hungary

ORIGIN OF FEED-STOCK, FAME

	Sustainable volume [m³]			[%]
Country of origin	**2011**	**2012**	**2013**	**2013**
Australia		20 610	72 530	22%
Denmark	58 490	70 310	64 740	20%
Lithuania	51 750	70 950	60 070	18%
Poland		4 098	24 820	8%
Ukraine	50 840	3 512	22 470	7%
Germany	32 190	46 830	16 650	5%
Sweden	5 910	10 830	16 200	5%
Other countries	40 510[1]	74 660[2]	48 680[3]	15%
Total	**239 700**	**301 800**	**326 200**	**100%**

[1] Afghanistan, Bulgaria, France, Kazakstan, Lithuania, Ryssia

[2] Belgium, Bulgaria, Estonia, France, Kazakstan, Lithuania, Russia, United Kingdom, Belarus

[3] Belgium, Bulgaria, France, Lithuania, Russia, United Kingdom, Czech Republic, Belarus, Austria

ORIGIN OF FEED-STOCK, HVO

	Sustainable volume [m³]			[%]
Country of origin	**2011**	**2012**	**2013**	**2013**
Sweden	32 450	59 020	101 840	26%
Netherlands	2 489	45 850	69 080	18%
Germany			49 420	13%
Indonesia		8 502	49 240	13%
Malaysia		6 734	24 890	6%
France			19 900	5%
Finland		10 100	19 460	5%
Other countries		9 399[1]	57 370[2]	15%
Total	**34 940**	**139 600**	**391 200**	**100%**

[1] Spain, Uruguay, USA

[2] Australia, Belgium, British Virgin Islands, Denmark, United Kingdom, Ireland, Italiy, Lithuania, New Zeeland, Poland, Slovakia, Spain, Uruguay, Austria

Source: Sustainable biofuels 2013, Swedish Energy Agency

6. DRIVERS, BARRIERS & OPPORTUNITIES

6.1 DRIVERS AND BARRIERS FOR AND AGAINST TRADE

A number of drivers have created favourable conditions for trade of biomass for energy i.e.

- Differences in policy incentives between countries
- Cost structures
- Drivers from a procurement perspective

Policy incentives have until recently been more favourable and stable in Sweden then in most exporting countries (in the Swedish case, trade has up until now been dominated by import) making it attractive to move biomass from none or low bioenergy incentive countries to Sweden with high incentives. These positive policy incentives have been paired with a favourable (low) cost level for biomass in the Baltic countries as well as in Russia.

However, in the last year several of these conditions have changed. Supply of biomass raw material has tightened in the Baltic states, Finland and Poland, and the prices have increased to levels over and above the prices in the Swedish domestic market. The uncertainty with regard to Russian export was for some time related to imposed and indicated plans for export levies, but now it is affected by the political unrest. However, there are still no published statistical data available to illustrate the quantity and structure of the effects of that change.

From a procurement perspective there are several factors that are positive with regard to import:

- Competitive fuel costs
- Risk distribution
- Negotiation power

The third point has been an important (but not transparent) factor for biomass import. Many forest industry companies and the major utilities are interested in keeping the prices of biomass as low as possible in the Swedish market. The forest industries want to safeguard their supply of cheap pulp-wood; the utilities want cheap biomass for fuel. Thus, import from other independent markets has been a rational choice, even in cases when prices are higher for imported biomass. However, the turbulence regarding supply, prices, politics, and currencies, that has been experienced recently, has made most of the strategy logics above redundant.

6.2 BARRIERS AND OBSTACLES

In the Swedish perspective three main types of barriers related to bioenergy trade are identified

- Technical barriers
- Transport, mainly shipping barriers
- Prices and competition
- Policies

Technical barriers have their roots in difficulties to describe and measure quality and energy content in adequate and efficient ways. As uses and applications for biomass fuels has widened and become more diversified more technical issues have been included, e.g. regarding contamination, durability, storability, and health risks. One specific issue is the measures applied in the biomass trade. In forestry and agriculture

it is part of the professional skill to be able to handle a range of various measures, developed for different purposes. However, these measures have proven to be confusing, when applied in the energy sector. A need to simplify and to increase the transparency of the measure systems is apparent. “Energy content” and/or “dry substance base” (Am. odt) seem to be the solution for the future. The ongoing work to remedy these problems is not yet finalized.

There are a number of cost driving aspects of shipping biomass for energy. The harbour facilities are often not equipped in fashions that enable cost efficient handling and storage of the products. In addition to that, there are only few units of the shipping fleet, which are specially designed for efficient shipping of biomass for energy. These problems are less severe for liquid biofuels as existing technology for oil, etc. can be used.

The low prices for electricity and for recovered wood and municipal waste constitute barriers for the expansion of the utilization of traditional biomass fuels. Successful saving programmes, expansion of wind power, and efficiency increases of nuclear power have resulted in an “oversupply” and very low basic price of electricity. Low, even negative, prices on waste biomass mean that traditional fuels like forest residues, etc. are unable to compete for supply to (large) energy plants equipped with efficient flue gas cleaning technology. The situation has been further aggravated by sub-normal winter temperatures and a slower pace in the expansion of the district heating networks..

Since the implementation of the EU sustainability criteria of biofuels, the trade of liquid biofuels have been tightened. The legislation has made it harder for developing countries or smaller biofuel actors to trade freely due to the high costs required to fulfil the administrative demands.

Companies in Sweden has applied for and used TVBUT duty exemption for non-EU ethanol, mostly Brazilian ethanol, for E85 or ED95. These exemptions have been regarded controversial. Therefore, in the last few years the use of these exemptions has decreased. There has also been a large debate regarding duties on ethanol and the former government wanted the duties to be removed, which was heavily criticized by the Swedish Ethanol producers and the suggested change was retracted.

However, the Swedish long term policy is to establish free trade within the entire energy sector, including propellant fuels. At several occasions representatives of the former Alliance Government have taken initiatives e.g. within the EU to get support for that policy.

6.3 TRENDS AND DEVELOPMENT

Some major trade trends are identified, namely:

- From local to regional and now more international
- From demand in Sweden to demand in other parts of Europe
- Growing surplus of biomass
- Increasing quality concern
- “Free” competition for biomass
- Strong growth in the utilization of recovered wood and MSW

- FROM LOCAL TO REGIONAL AND NOW MORE INTERNATIONAL

The bioenergy sector in Sweden started as local demand/supply in the late 1970-ies and 1980-ies. In the 1990-ies energy utilities started regional markets for biomass e.g. by shipping biomass from surplus areas in northern Sweden to plants in the major cities. That trade developed soon to import of cheap recycled demolished wood from Holland and Germany and thereafter to import of wood chips from the Baltic states. Now steps are taken to an international market in which prices of biomass for energy are set in competition with products from sources far away, e.g. from south of Europe as well as from North and South America. Parallel to the widening of the international influences, improvement measure have also been carried out in the regional and national logistics for biomass, e.g. in rail terminals and storage facilities.

- FROM DEMAND IN SWEDEN TO DEMAND IN OTHER PARTS OF EUROPE

Some years ago Sweden was pretty much alone in Northern Europe when it came to demand for imported biomass for energy. This created a favourable situation with low prices and reliable sourcing. Now, as the demand in other parts of Europe are emerging and the cost structure in the east Baltic region is rising, the low cost arguments for imports are diminishing. The imported biomass in form of traditional fuels like forest and forest industry residuals is often more expensive than domestic biomass. On the other hand, biomass fuels in form of recovered wood and waste is cheap. However, for these fuels there are specific market problems, as it is generally assumed that the utilization would take place close to the source, thereby taking advantage of the opportunities for cheap energy generation.

- GROWING SURPLUS OF BIOMASS

The growth in the Swedish forests has exceeded harvesting and losses for more than a century. Now recent data clearly indicate that this difference will increase for the future. It is partly explained by the expected levelling of the demand from the pulp and paper industry, but the main reason is the increase of the growth of the forests. It is predicted that the annual surplus will amount to 50+ million m3 in addition to the present situation (SLU 2014) The surplus will first appear in the south of Sweden, where the ownership is dominated by private individuals. Therefore, one can expect that there will be a stronger pressure on the owners´ organizations and on governments to expand markets and demand. The energy sector would then be an obvious choice, including exploring export opportunities.

- INCREASING QUALITY CONCERN

The process of increased use of bioenergy in various applications and a simultaneous process of widening the resource base to other types of biomass have led to focussing on quality issues. This is generally appearing in all applications of biomass fuels but varying with different combustion technologies, size, requirements for accessibility, etc.. For example, the number of user of wood pellets for small scale domestic heat generation is increasing rather fast. In the early stages of that application most users were enthusiasts and hence prepared to handle minor disturbances themselves, and to identify an adequate pellet quality to suit their equipment. However, now new users are expecting to get similar technical performance from their pellet burning equipment than from oil or electricity heaters. They also want cheap fuels, which sometimes mean that their chosen pellets are unsuitable for their application. Similar examples are abundant for chips and demolition wood.

No transport fuels that do not fill its legal quality specifications are allowed to be sold on the Swedish market. There is scepticism towards biofuels from vehicle owners there is therefore a large focus on quality in order to increase customer's willingness to use high blend biofuels and to accept higher blending volumes in gasoline and diesel.

For ethanol, however, the quality norms have been very strict already from the start of the import for fuel applications. In the introduction of new fuel and in the further development of existing bioenergy systems, quality aspects nowadays form an integral part of the work.

- "FREE" COMPETITION FOR BIOMASS

For many years the forest industry companies have applied a strategy aiming at protecting their pulp wood supply from competition from the energy sector. This was done in various ways: by lobbying, by using their harvesting and acquisition organizations, by development of supply technology and organization for harvesting of non-industrial biomass ("grot", branches and tops, but not round-wood, etc.) and by PR-activities towards forest owners and the public.

In spite of the fact that thinning methods in certain applications have proven to produce cheaper wood-fuels with higher quality compared to fuel from logging residues, the methods have not been generally applied, partly due to the slump in demand for forest fuels. Most pulp&paper companies now seem to accept that the "fibre surplus" in the Swedish forests would be utilized by the energy sector rather than being a potential base for expansion of the pulp&paper production. An obvious line of development is integrated production of various bio-based products in "bio-refineries"; the products would be pulp, paper, wood products, various types of propellants, bio-chemicals, heat, electricity, etc. Contributing factors for the change in thinking is of course the new predictions of lower future demand for virgin long fibre wood pulp, and the fact that pulp&paper companies make good profit from their internal "green energy" generation. Thus, even

if the forest resource market also in future will be oligopolistic it will become more competitive and liberal. It will increase opportunities for biomass trade, especially from south Sweden to Western Europe.

- INCREASE OF RECOVERED WOOD AND MSW FOR ENERGY

The position of Swedish energy sector as an early utilizer of efficient flue gas cleaning technology has led to a wave of investment in capacity for energy generation based on recovered wood and MSW. It certainly solves important waste problems and it has proven to be competitive enough to reduce the demand for forest biomass fuels, especially for energy plants located at ports, where these imported fuels are cheap.

6.4 GENERAL POLICY TOWARDS BIOMASS TRADE

Solid biofuels are subject to a trade liberal policy and for these fuels, the general energy policy is very much supprtive. This has enhanced the competitiveness of biomass for energy compared to competing fossil energy. Especially the CO_2 taxation has had a decisive impact.

However, liquid biofuels have to comply with the EU rules and regulations regarding duties, blending rates, and supprt schemes. As mentioned in chapter 6.2, these rules and regulations have had a restricting effect on the trade of liquid biodfuels.

Pro-trade and pro-bioenergy policies have created the needed framework for trade of solid biomass derived fuels. So far the flows have predominantly been inwards but with increasing demand in the rest of Europe and higher costs emerging in the eastern Baltic region and the tensions in the trade relations with Russia, drivers might be on the edge to shift the direction of the trade.

6.5 KEY ISSUES FOR FURTHER DEVELOPMENT

Four key elements are identified that need to be in place in order to facilitate an increasing international trade of biomass for energy, namely:

- Increased demand for bioenergy
- Liberal trade policy
- Efficient production and logistic systems
- Prevent powerful established actors, potential losers, to block or disturb a viable development.

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