

Opportunities for Biomass Energy Programmes – Experiences & Lessons Learned by UNDP in Europe & the CIS

Final Report

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Last edited: 17 May 2007

Status: Final



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1 Introduction

UNDP-GEF is currently implementing 12 projects under GEF Operational Programme 6 which focus on the use of biomass from forest, agricultural or sawmill wastes through direct combustion in boilers, gasification or production of liquid biofuels. These projects share many of the same challenges in ensuring the adequacy of the fuel-supply or input flows as well as ensuring the commercial foundations of the energy outflows. The projects are located in three regions: Latin America and the Caribbean, Europe and the Commonwealth of Independent States (CIS), and the Asia and Pacific region.

Five UNDP-GEF biomass energy projects have been implemented in Europe and the CIS region. These projects are:

- ‘Integrated Approach to Wood Waste Combustion for Heat Production in Poland’
- ‘Reducing Greenhouse Gas Emissions through the Use of Biomass Energy in Northwest Slovakia’
- ‘Slovenia - Removing Barriers to the Increased Use of Biomass as an Energy Source’
- ‘Biomass Energy for Heating and Hot Water Supply in Belarus’
- ‘Economic and Cost-effective use of Wood Waste for Municipal Heating Systems in Latvia’

For more detailed descriptions of the projects, see “Annex 1: Summary of 5 UNDP-GEF biomass energy projects”.

The projects in Poland, Slovakia, Slovenia and Belarus come to an end in 2006 or 2007, and the project in Latvia ended in July 2005.

1.1 Objective of this report

This Lessons Learned Report discusses the experiences and lessons from the five UNDP-GEF biomass energy projects in Europe and the CIS. The report focuses on lessons for biomass project development and implementation for market transformation in this region based on what can be learnt from the implementation of the current portfolio on UNDP-GEF biomass energy projects, and makes recommendations for the development and implementation of new biomass projects in the region and beyond. The principle target audience is UNDP project and programme officers throughout the region.

1.2 Overview of the UNDP–GEF biomass projects

The portfolio of UNDP-GEF biomass projects in Europe and the CIS focuses on the use of wood residues from wood processing and forestry in the provision of heat and electrification. A number of key characteristics of the projects are summarized in the table below:

Table 1: Summary data on the 5 UNDP-GEF projects

	Belarus	Latvia	Poland	Slovakia	Slovenia
Start date	September 2003	March 2001	June 2002	1999	October 2002
Expected end date	September 2007	March 2004	June 2005	2003	February 2005
Actual end date	Ongoing	July 2005	December 2006	December 2006	March 2007
Total project size (million USD)	8.94	4.5 ¹	2.7	8.3	11.8 (planned) 13.5 (realized)
GEF contribution (million USD)	3.37	0.75	0.95	0.97	4.3
Government co-funding (million USD)	2.2		1.5	SR 1,14 EU 1,14 KKA 0,7	2.5 (grants) 0.4 (in-kind)
Other co-funding		2.68 (Netherlands)		3.3 (loan - DEXIA banka Slovensko)	2.3 (soft loans – Environmental fund of the Republic of Slovenia)
Leveraged co-financing (million USD)	1.78 1.59 (in-kind)	0.5 (in kind)	Municipalities in-kind 0.075 Municipal assets 0.087	BIOMASA Ass. Members 1.0 (in kind)	Municipalities 0.5 Others 3.9
Project Management Unit location / type	Independent government agency linked to Ministry of Energy	NGO linked to Ministry of Environment	Independent NGO	Association of municipalities - NGO	Government agency in Ministry of Environment and Spatial Planning
Key aims / objectives	Strengthen institutional capacity, build track record for investments, Develop revolving fund, Overcome negative perceptions & provide investors with market information	Support & promote the use of biomass energy, Promote the development and implementation of an economic & commercially run municipal heating system, Assist in removing/reducing technical, legislative, institutional, economic information and financial barriers.	Create an example of an inter-municipal, and public-private partnership company to manage biomass energy resources at the local level, Increase the use of wood waste produced locally and sustainably as a fuel for space heating	Demonstration of a new way for alternative environmental friendly fuel, Reduction of greenhouse gas emissions, Substitution of fossil fuels by environmentally friendly fuel, Increase public awareness and interest	Support the development of an initial set of Biomass District Heating Projects, Removal of barriers to increase the energy use of woody biomass, Promotion of use of biomass as an energy source
Financing mechanisms (at project design)	Bioenergy revolving fund operated by state owned company	Public-private partnership, and small fund creation	Public-private partnership	None, beyond bilateral funding for demonstration projects	Revolving equity / loan fund, grants, public-private partnership

¹ For the Latvia project the realized financing (at the end of the project) was USD 794 000 (Ludza), USD 1 700 000 (Private), USD 240 000 (Dutch), USD 36 000 (Mncpl I), USD 863 200 (Credit), and USD 117 600 (Mncpl II)

1.3 Scope of this report

This report focuses on lessons learnt from the portfolio of UNDP-GEF projects described in section 1.2. It thus focuses on:

- Woody biomass from forest residues and the wood-processing industries (wood-chips, sawdust, bark, pellets, etc.)
- Principally heat provision with CHP in some cases
- Industrial heating, heating of municipal buildings, and district heating systems
- Small- to medium-scale heating systems (between a few 10s of kilowatts to about 10 megawatts thermal)

All biomass that can be used for energy generation comes either from farming (industry, forestry and agriculture) or natural vegetation. Because of their frequent low cost (sometimes zero or even negative if there are costs associated with disposal) biomass ‘waste’ is usually the first choice for use as biomass fuel. Formal harvesting of vegetation will almost always be more expensive than farm and forest residues, and informal collection is unlikely to provide a sufficiently reliable supply of fuel for power and heat generation in the formal sector and this is the case in the Europe and CIS region. The ‘wet’ bioconversion processes, digestion and fermentation, are currently not covered by any UNDP-GEF projects in the region. The key biomass energy paths are shown diagrammatically in Figure 1 below. The highlighted blocks are the subject of this paper.

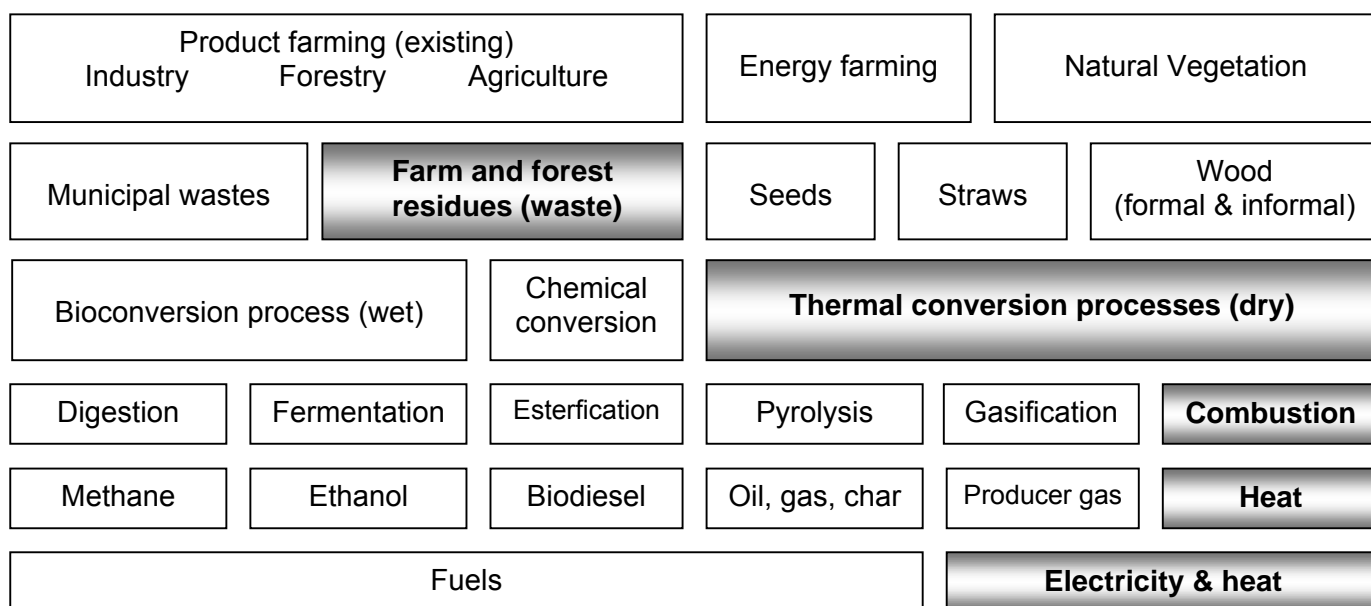


Figure 1: Key biomass energy paths highlighting the subject of this report

Biomass resources are seldom in exactly the right form, and available at precisely the right place and when needed for use in biomass energy systems and collection, processing (including processes such as drying, chipping, and pelletising / briquetting), transport, and storage are of

great importance to the success of a bioenergy system. These ‘fuel supply’ issues add to the fuel costs. Of equal importance to the questions of fuel supply are questions of the energy end-use since this represents the revenue stream, and is thus a key factor determining the overall financial feasibility of the project. Of importance is the form of energy required by the end users (mechanical (shaft power), thermal (heat, frequently in the form of hot water or steam), and/or electrical), the amount of energy required, and the demand profile (when it is required). The thermal conversion technology comes between fuel supply, and energy end-use demand, and the selection of the most appropriate thermal conversion technology for a particular location is strongly determined by the particular supply and demand characteristics.

1.4 Acknowledgements

Thanks are due to a large number of people who have helped with the collection of data, reviewing of drafts, and patient explaining and clarification. In particular thanks are due to Vladimir Voitekhovich the project manager of the Belarus project and Dmitry Goloubovsky (UNDP), Ziemowit Pochitonow the project manager of the Poland project and his team, and Ladislav Zidik (Project Manager) and Ms Dagmar Bohunická (Operation Assistant) from Slovakia, Damir Stanicic, Project Manager from Slovenia (thanks indeed for the excellent inputs!), and Silvija Kalnina from Latvia (UNDP). Anna Kaplina and Geordie Colville from the regional UNDP office both stimulated the process through provocative questioning and comments. Sara Nördstrom from Vattenfall, Sweden also reviewed a draft of the report. Thanks to Donna Skordili of Eco, UK for help finding data and preparing analyses.

2 Biomass energy in Europe and the CIS

2.1 Biomass energy use and potential

In 2004, renewables accounted for 13.1% of the 11 059 Mtoe of world total primary energy supply. Combustible renewables and waste (97% of which is biomass, both commercial and non-commercial) represented 79.4% of total renewables, meaning that in 2004 biomass accounted for about 10% of world total primary energy supply or 1100 Mtoe (OECD/IEA 2007). Its largest contribution to energy consumption—on average between a third and a fifth—is found in developing countries. Compare that with 3 percent in industrialised countries (Hall and others, 1993; WEC, 1994b; IEA REWP, 1999). In non-OECD Europe and the Former USSR renewables contribute, according to IEA statistics for 2004, 10.6% and 3% of Total Primary Energy Supply

respectively (OECD/IEA 2007). Biomass contributes only 6% and 1% respectively of Total Primary Energy Supply in this region (biomass accounting for 14 Mtoe in 2004 for both regions together)².

Estimating the biomass energy potential for countries in which biomass is not historically a significant part of the energy mix is not straightforward. With the exception of the biomass resource-rich countries of Central and Eastern Europe and the CIS, the use of wood energy is greater in countries with large forest cover like Sweden, Finland and Austria where activity sectors linked to biomass are especially significant (wood for furniture and buildings). In European countries of larger sizes and with the largest populations like France, Germany and Spain, use of wood energy is especially localised in forestry regions (Wood Energy Barometer, 2005).

Based on this relationship, countries in Europe and the CIS with significant biomass potential (over 30% forest cover) include Slovenia, Estonia, Bosnia & Herzegovina, Latvia, Russian Federation, Belarus, Cyprus, Slovak Republic, Tajikistan, Croatia, Albania, Lithuania, Serbia & Montenegro, Czech Republic, Georgia, Bulgaria and Poland (see Table 2 below). Other indicators of biomass energy potential include forest production where, based on annual roundwood production the main countries of potential are the Russian Federation, Poland, Belarus, Czech Republic, Romania, Ukraine, Latvia, Slovak Republic, Lithuania, Estonia, Hungary, Croatia, and Slovenia. Based on estimates of biomass energy technical potential from the EBRD (2003), the main potential lies in the Russian Federation, Poland, Bulgaria, Romania, Ukraine, Kazakhstan, Belarus, Hungary, Czech Republic, Albania, Croatia and Uzbekistan. This estimation of technical potential includes energy from crop residues, and farm-based biogas systems that may be roughly estimated by consideration of farm sizes, numbers of animals, and agricultural productivity. A detailed analysis of these issues lies outside the scope of this report.

Wood energy industrial development is far from being homogeneous in the EU. Many countries are just beginning to exploit their potential, while others, like Finland and Sweden, have already developed a high-tech industrial sector (in particular with combined heat and power – CHP – systems) and have already largely tapped their potential. New EU members like Poland, the Czech Republic, the Slovak Republic, Slovenia and the Baltic States possess abundant raw material, as do the accession states of Bulgaria and Romania, and countries further to the east including Belarus, Ukraine and the Russian Federation. However, this potential remains largely unused or badly used due to a lack of investment in modern, effective technologies. In these countries household fires and stoves are the main users of wood for heat. This is also the case in the most populous EU

² This figure is likely to underestimate the real contribution by a significant margin since the majority of these countries do not include the informal use of biomass for cooking and/or heating in official energy statistics (since these are often non-commercial or in the 'hidden' economy, and therefore difficult to track), and this is sometimes substantial in rural villages.

countries like France, Spain and Italy where policies focus on the upgrading or replacing existing domestic heating systems and developing new infrastructures in the industrial, municipal and farming sectors.

In some countries of the European Union, biomass fired district heating is used extensively, and is most common in Sweden, Denmark, Finland and Austria. The fuel used in district heating plants is commonly wood-chips produced as a by-product from the forestry and wood processing industries but in Denmark, significant amounts of straw are used and in Sweden willow, grown as an energy crop, is also used. District heating offers an opportunity for biomass energy since, with heating grids already available, and the potential for economies of scale, and simplified fuel supply logistics (compared to household-scale systems), biomass fuelled district heating can be cost competitive. Thus, a high degree of district heating is indicative of biomass potential.

Table 2: Indicative data on biomass potential for RBEC countries

	Forest Cover ^a	Total Annual Roundwood Production ^b	District Heating Market share in 2002 ^c	Average Farm Size ^d	Equivalent animal units ^d	Total primary crops ^d	Biomass Technical potential in 2003 ^e
	%	thousand m ³	%	Ha	number	tonne	TW _m
RBEC Countries							
Albania	39%	409	10% to 19%		792,400.00	3,930,424.00	19
Armenia	24%	33		1.99 ha [1999]	542,472.00	4,101,449.00	3
Azerbaijan	17%		0% to 9.9%	2.8 ha (household farms)	2,072,150.00	7,806,794.00	6
Belarus	38%	12500	50%	21 ha (private, 1993), 3000 ha (state, 1993)	6,258,730.00	53,361,633.00	25
Bosnia & Herzegovina	54%	40	20% to 39.9%	3.5 [2006]	628,372.00	3,456,033.00	2.5
Bulgaria	33%		18%	1% - 536 ha (co-ops) (80% of total land) 90+ % - 1 ha (14% of total area) Overall 4.7 ha [1999/2000]			95
Croatia	40%	2997	12%	2.8 ha (private, 1991)	1,053,234.00	7,443,161.00	18
Cyprus	42%		0% to 9.9%				
Czech Republic	34%	13291	44%	25% 3-10 ha (private) 32% - 690 ha (joint stock) 43% - 1450 ha (co-ops) [1997], overall: 65.5 ha [2000]	3,283,352.00	33,672,065.00	21
Estonia	56%	5118	31%	25.4 ha (private, 1991), 20.1ha (overall, 2001)	435,310.00	8,366,355.00	7
Georgia	34%		0% to 20%	0.96 ha (private), 62 ha (larger farms) [2000]	1,325,456.00	6,106,847.00	4.5
Hungary	21%	4020	19%	99% - 4 ha (private) (59.5% of total area) [2000], 1% - 311.9 ha (corporate) (40.5% of total area) [2000], 6.7 ha overall	3,310,040.00	29,279,246.00	25
Kazakhstan	7%	315		7 ha [1997]	4,528,290.00	58,576,272.00	30
Kyrgyzstan	6%	27			992,019.00	8,322,126.00	4.5
Latvia	49%	8936	70%	24 ha (private) [2000]	603,830.00	22,546,497.00	9
Lithuania	35%	5189	45%	7 ha [2001 Statistical Office in Lithuania]	1,394,920.00	20,525,473.00	9
Malta			0% to 9.9%				
Moldova	3%	397	17% ^h	2 ha (peasant) or 4-5 ha/400-800 ha (corporate) [2006]	872,880.00	8,514,487.00	4.5
Poland	30%	21772	55%	7 ha (private) [2004], 12.2 ha [2002], 600 ha (public)	14,123,941.00	83,836,385.00	118
Romania	29%	12476	34%	2.2 ha (private) [1998]	6,398,520.00	53,291,420.00	54
Russian Federation	46%	115693	70% ^f		38,550,500.00	383,046,975.00	~412
Serbia & Montenegro	34%	1320	13%	60% < 3 ha [1999]	3,571,350	21,380,329.00	
Slovak Republic	40%	5312	40%	79% - 36 ha (private) [2000], 21% - 1.322 ha (legal persons), 306 ha overall average	1,442,685.00	11,836,718.00	8
Slovenia	65%	2111	14%	0.1% - 305 ha (agri enterprises) (14.7% of total land), rest - 1.9 ha (private) (85.3% of land), 5.1 ha (overall)	763,928.00	3,155,141.00	4
Tajikistan	40%				1,047,384.00	5,346,275.00	3.5
The Fyr Yugoslavia Republic	29%	774			397,808.00	2,354,688.00	3.5
Turkey	27%						
Turkmenistan	9%				925,300.00	7,280,347.00	4
Ukraine	17%	10176	65% ^g	99% < 2ha [2004]	16,340,310.00	218,671,693.00	48
Uzbekistan	10%				5,420,460.00	26,599,400.00	18

Blank cells indicate data unavailable

^a Forest Cover Data taken from FAO <http://www.fao.org/forestry/site/country/en/>

^b Data taken from European Bank for Reconstruction and Development <http://ebrdrenewables.com/sites/renew/default.aspx>; Belarus figures (2002) from UNDP project

^c Data taken from OPET CHP/DH Project www.opet-chp.net/ and IEA 2004 <http://www.iea.org/textbase/nppdf/free/2004/cold.pdf>

^d Data taken from various websites such as: Agrocensus, FAO, National Statistical Offices, Agrifish (http://agrifish.jrc.it/marsstat/Crop_Yield_Forecasting/MOCA/00000000.HTM), USDA

^e Data taken from "Development of a strategy and national policies for biomass energy in Bulgaria" http://www.biomasa.sk/files/jrcbiomass_bulgaria.pdf

^f Euroheat & Power's 1995 District Heat in Europe

^g <http://www.chp-info.org/>, no date given

^h World Energy Council, 1999 <http://www.worldenergy.org/wec-geis/global/downloads/Berlin2003Brendow.pdf>

2.2 Trends in biomass fuel prices and competing fuels in the region

The high price of gas and oil and recent price increases is leading to a growing interest in wood energy. The share of wood energy in total EU primary energy consumption was 3.2% in 2004 and 3.0% in 2003. Use of wood and wood by-products to produce electricity is growing rapidly (an increase of 23.5% in 2004 compared to 2003, i.e. 34.6 TWh in 2004) in particular due to development of combined heat and power (CHP) plants in particular in Germany (growth of 160%), and Scandinavian countries. Biomass heat applications represent the largest single contribution to renewable energy in Europe, larger even than hydropower. Within this segment the greatest contribution comes from domestic heating with wood (over 240 TWh), followed by biomass use in industry, predominantly for process heat applications (over 85 TWh) and by district heating and electricity production (over 30 TWh), according to ALTENER renewable energy statistics³.

It goes perhaps without saying that biomass energy systems require sufficient fuel supplies, and, depending on the nature of the energy demand, supplies may need to be available throughout the year and in all seasons – even when ‘out of season’. What is less obvious is that while some bio-energy technologies are reasonably tolerant to variations in fuel supply, all technologies do impose some constraints. Bio-energy systems thus require sufficient, reliable, long-term, and affordable biomass supplies (and frequently) of a standard quality. These supplies must be gathered, and transported to the energy conversion plant. They must usually be stored and perhaps dried to avoid deterioration and to meet the needs of particular thermal conversion technologies. In many cases the biomass must be chopped, converted into briquettes or pellets or otherwise prepared for use as a biofuel. These supply-side activities set bio-energy apart from other renewables, in which the primary solar, wind, wave or hydro energy resource is freely-provided. Bio-energy requires the additional steps of fuel production, collection and delivery to the energy conversion plant. While these steps can bring substantial benefits in the form of local employment and income (benefits which have, of course, to be paid for by energy users) they may also raise serious challenges, such as those connected with labour, seasonality, and competing uses, that do not apply to other energy resources.

These underlying conditions vary from place to place and are usually complex, hidden, and dynamic, changing as political, economic and social conditions alter. They govern to a large extent how much and what kinds of bio-energy resource can be produced, the cost of production and

³ ALTENER was a European Commission energy programme, a predecessor to Intelligent Energy - Europe.

associated benefits, vulnerability to supply failure, and risks of harming existing biomass-dependent social groups. They often impose constraints that render biomass supplies for energy much more limited than a straightforward technical biomass assessment might suggest (Kartha & Leach 2001).

The cost of biomass fuels such as firewood (wood pieces and logs), wood-chips, sawdust, bark and pellets, depends on a wide range of factors including:

- The availability of the raw materials, which is strongly influenced by competing uses and fossil fuel prices,
- The cost of collecting the raw material (eg. firewood collected in the forest may be labour intensive or require costly equipment),
- The cost of processing and production (eg. making wood chips, producing pellets),
- Transport costs from the harvesting to the processing site, and from the processing site to the location of end use.

Some competing uses that influence the availability of the raw materials for new biomass heat or electricity generation include existing domestic fuel users (firewood), gardening (bark) and chipboard production (which uses sawdust waste, as has been experienced by the projects in Slovakia and Poland). Careful attention should be given to competing uses for biofuels for a number of crucial and interrelated reasons, including:

- **Reliability of resource estimates:** assessments of resources could predict significantly over-estimates of actual resource availability because of these hidden uses;
- **Price impact:** as greater demand is placed on biomass residues, resources can rapidly increase in price. The present and future competition for wastes should be taken into account, and arrangements to ensure long-term supply assessed. The financial feasibility of biomass energy plants is usually strongly dependent on the feedstock price; and
- **Social impact:** Some household users may be dependent on biomass residues for their livelihoods, and the development of a biomass fuel market could impact negatively on these people. Care should be taken to assess these potential social impacts (which are frequently hidden).

The change in prices of firewood, sawdust, chips and pellets during a year, and from year to year are by no means even over the whole of Europe. A comparison of fuel prices in a number of countries is shown in Figure 2 below, with data given for 2004 and 2005 for Austria, Germany and Slovakia (data adapted from figures given in WP1 report from EUBIONET2, 2005). Both Austria and Germany have reasonably developed biomass fuel market, whereas the biomass markets in Slovakia are small but growing.

The year 2005 saw a fall in overall firewood prices in Austria and Germany, and an increase in Slovakia (from a very low base). During this period, Austria and Germany had relatively stable sawdust and wood-chip prices, in marked contrast to Slovakia where the price of all three increased substantially between 2004 and 2005. While firewood in Slovakia was still cheaper in 2005 than in the other EU countries, in 2005 the prices of sawdust and wood-chips exceeded those in Austria and Germany.

While data given is average over a year, it should be noted that biomass fuel prices are strongly related to changes in seasonal demand since, where biomass is used for heating demand in summer can be virtually zero. For the same reasons as for other heating fuels, biomass fuel prices increase in the approach to and throughout winter in the Europe and CIS region⁴. Winter prices can be as much as 20% higher than summer prices.

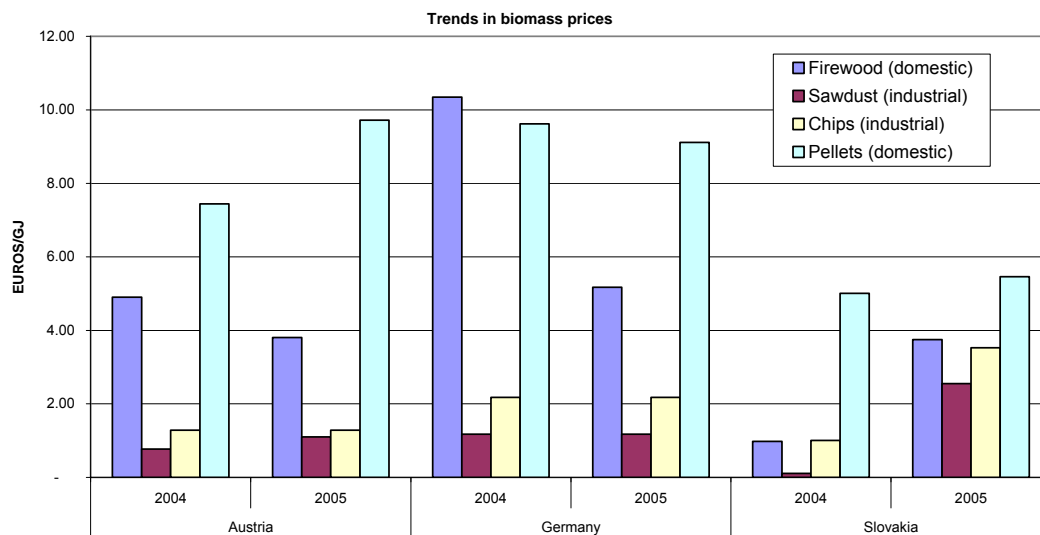


Figure 2: Comparison of biomass fuel prices in 2004 & 2005 in Austria, Germany and Slovakia

⁴ The production of wood waste in the region continues fairly steadily throughout the year with the exception of periods of extreme weather when access to forests (for example) may be impossible because of ice and snow. In contrast to this straw and agricultural residues are seasonally produced and usually available seasonally.

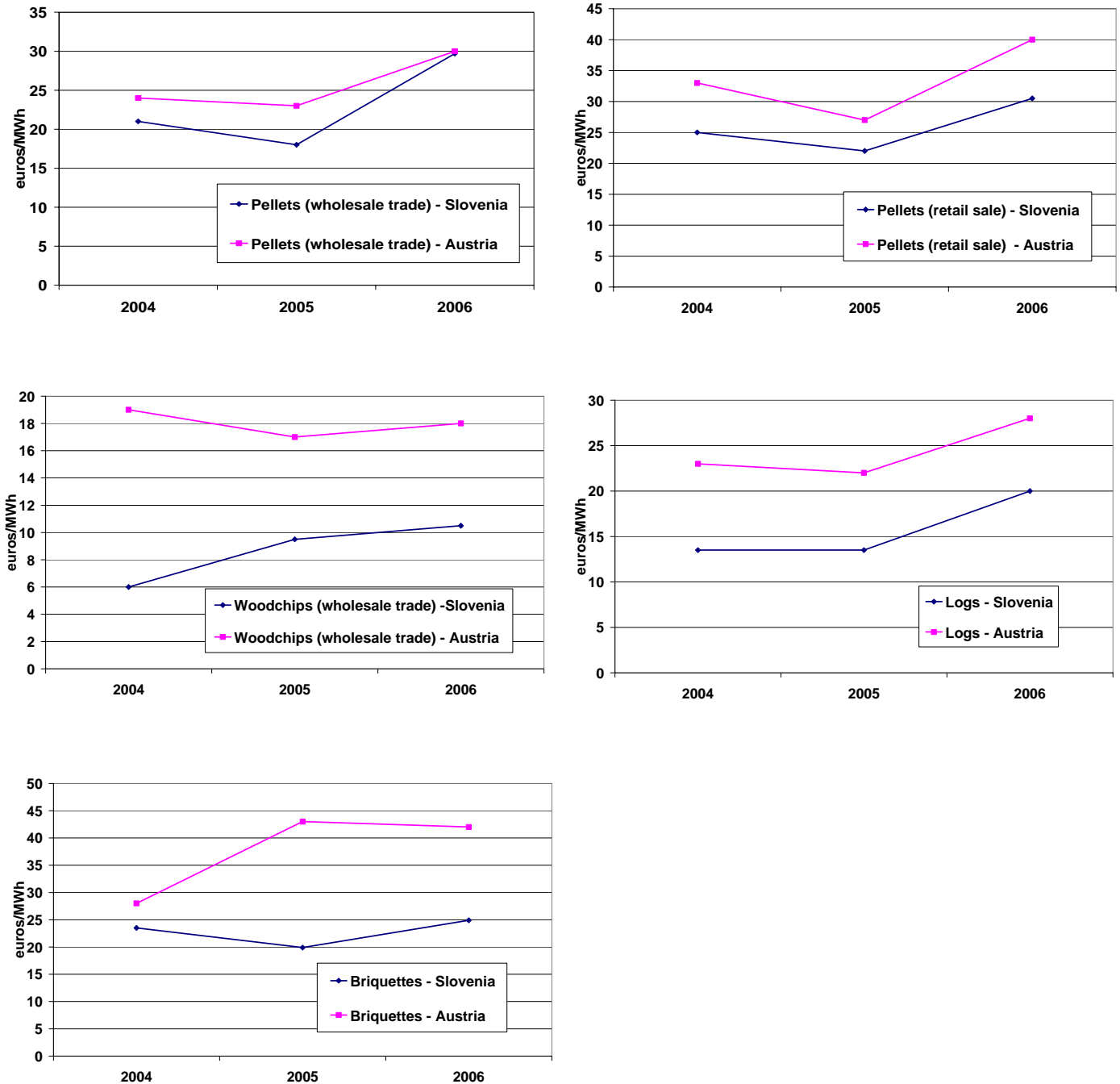


Figure 3: Comparison of biomass fuel prices without VAT in 2004 & 2005 & 2006 in Austria and Slovenia

Comparing pellet prices, those in Austria rose, and in Germany fell between 2004 and 2005 (although during the same period prices for industrial pellets in Austria fell slightly), and price of pellets rose in Slovakia. Data from the UNDP-GEF project in Slovakia show a significant jump in pellet prices between 2005 and 2006, with the expectation of ongoing increases in coming years. It is notable that the price of pellets for domestic heat follows the same trend that that of natural gas,

and signifies that pellet prices are probably dependent on willingness to pay, rather than cost factors.

In a free and competitive marketplace – as exists for pellets in the EU and most neighbouring countries – the sale price of biomass fuels, although related to the cost factors listed above, depends more on the willingness (and ability) of consumers to pay for the fuels, and this is strongly dependent on policies and penalties, least cost alternatives, transaction ease, and the customer's perception of risk. In marketing terms, while most fossil fuel heating systems are commodity items, biomass systems are true products, in which the key task of marketing involves building product awareness and acceptance. Where demand outstrips supply and the overall market is relatively small, sudden changes in production capacities (for example, one new pellet factory in a country can double supply 'overnight'), and demand results in significant market volatility.

This price volatility is particularly relevant in the pellet market although also present in others biomass fuel markets⁵: the significant interest in pellets comes from the reduced transport costs compared to undensified biomass (see the figure below), improved storage and handling characteristics (pellets can flow, much like a liquid), and more controllable and stable combustion characteristics. Because pellets are easily and relatively cheaply transported there is significant cross-boarder trade, and this can significantly influence pellet prices in neighbouring markets. In contrast, biomass fuels that are less dense and more difficult to transport (straw, for example), and which are not used as feedstock for pellets (as, for example, sawdust frequently is) are buffered to some extent from wider market pressures. Even for sawdust there is a buffering effect, since transport costs consist of two components: the cost of bringing the raw material (sawdust) to the pellet production facility, and the cost of transporting the pellets to the end-user. Thus, there is a 'capture area' surrounding the pellet factory from which it is financially feasible to bring sawdust to the factory, and a much larger area to which the pellets may feasibly be delivered. These supply- and demand-areas are by no means uniform since transport costs depend on the means of transport⁶ and existence of suitable transport networks⁷.

⁵ Slovenia, for example, experienced a 40% price increase for wood chips over the period 2004 – 2006.

⁶ Transport by sea for example can be very cost effective, explaining in part how pellets from Brazil and Southern Africa are imported into the European markets.

⁷ For example, roads of sufficient size and quality for trucks.

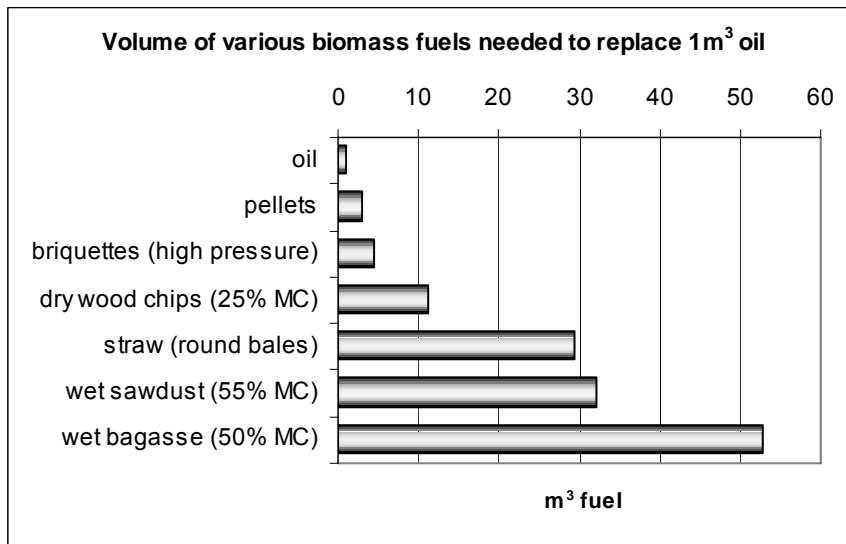


Figure 4: Volume of biomass fuels equivalent to 1 cubic metre of oil⁸

In Southern Europe, Italy has by far the most developed pellet market, and one where the supply, demand and price behaviour is dominated by a shortage of wood residues. As a result the supply of wood pellets has reached a plateau, whilst demand is still strong. The Italian pellet price was reasonable steady during the 1990s with a significant jump in prices in 1999-2000, stability in 2001 and 2002, and further jumps in subsequent years (WIP Munich, 2003). These price increases are due to the increasingly difficulties in finding the raw material for the production of pellets, the increase in the prices of fossil fuels, and the growing demand. In fact, in the last years there has been a “run” on wood waste in the region. With the development of the pellets market and growing competition from the production of panels and pallets, the demand for wood residues from both industrial and, in some cases from forestry sources (although this biomass is comparatively costly) is rising, and so these are an increasingly scarce resource. As a result pellet trade with countries with abundant biomass residues and weak demand has grown strongly. This has in turn resulted in price increases in Slovenia and Slovakia (as seen in Figure 5 below) for example.

2.4 Key market trends and support mechanisms

The discussion of key market trends and support mechanisms which follows focuses on countries of the European Union where biomass energy is well established or growing significantly. From this we can derive the key market trends, and understand the policy environment and specific support mechanisms that have led to this market growth.

⁸ MC is Moisture Content

The various strategic policy statements that have supported the development of biomass energy technology in the past decade in the European Union include⁹:

- EC ‘White Paper’ 1997 with the overall target of 12% renewable energy by 2010.
- ‘Campaign for Take Off’ (CTO), 1998 documents and the CTO itself, which ran from 2000 to 2003, setting some intermediary targets for different renewable energy sectors.
- A directive on renewable electricity generation (Directive 2001/77/EC) in 2001 requiring an increase in electricity from renewable sources from 14% in 2000 to 22.1% in the EU-15 (21% in EU-25) by 2010.
- A directive (Directive 2003/30 EC) with a target for liquid biofuels of 2% by 2005 and 5.75% by 2010.
- The ‘EU Biomass Action Plan’, 2005 has proposed that the total biomass energy contribution of 51 Mtoe in 2001 should rise to 130 Mtoe by 2010. This would come from additional contributions in: electricity 32 Mtoe, heat 24 Mtoe, and biofuels 18 Mtoe.
- More recently, in its Communication “*Renewable Energy Roadmap: Renewable Energies in the 21st century; building a sustainable future*” (COM(2006) 848), and in “*An Energy Policy for Europe*” {SEC(2007) 12} COM 2007 the Commission proposes “a binding target of increasing the level of renewable energy in the EU's overall mix from less than 7% today to 20% by 2020”. The communication emphasizes:
 - Using renewable energy today is generally more expensive than using hydrocarbons, but the gap is narrowing – particularly when the costs of climate change are factored in;
 - Economies of scale can reduce the costs for renewables, but this needs major investment today;
 - Renewable energy helps to improve the EU's security of energy supply by increasing the share of domestically produced energy, diversifying the fuel mix and the sources of energy imports and increasing the proportion of energy from politically stable regions as well as creating new jobs in Europe; and
 - Renewable energies emit few or no greenhouse gases, and most of them bring significant air quality benefits.

2.4.1 Policy drivers in the EU biomass energy market

As described above, the main drivers in EU biomass energy policy include (Biomass Action Plan 2005):

1. **Diversification of the energy mix and increase of security of energy supply:** The Biomass Action Plan estimates that, as a result of measures it outlines, and if targets are

⁹ Hollingdale A, *Recent Advances in Biomass Energy Technology in Europe and Applications for SE Asia*, NRI, UK.

reached, the share of fossil fuel use in the energy mix of the EU-25 would go down from 80% to 75% by 2010. The amount of imported crude oil would fall by 8%, with biofuels and biomass heating making the main contribution to this.

2. **Reductions in greenhouse gas emissions:** estimated to reach 209 million tons CO₂-equivalent per year, with electricity generation and heat supply contributing most to these reductions.
3. **Job creation and stabilisation of rural regions:** with an estimated 250 000 to 300 000 additional jobs which could be directly created inside the EU-25, most of them in rural areas. It is expected that biomass in electricity and biofuels in transport would be the main sources of new jobs.

The Biomass Action Plan recognizes that the above benefits will come at a cost, and without accounting for a monetary value of these benefits, “the direct additional cost would be in the range of € 2.1 billion up to € 16.6 billion per year, depending on the price level of fossil fuels” with liquid biofuels for transport followed by biomass for electricity production “accounting for the majority of the costs”. (Biomass Action Plan, Impact Assessment, 2005).

According to the 2007 “Renewable Energy Roadmap” to achieve a 20% share for renewables will result in an additional average annual cost of approximately € 18 billion – around 6% extra on the EU's total expected energy import bill in 2020. This “assumes oil prices of USD 48/barrel by 2020. If these rose to USD 78/barrel, the average annual cost would fall to € 10.6 billion. If a carbon price of more than € 20 is factored in, the 20% would cost practically no more than relying on “traditional” energy sources, but create many jobs in Europe and develop new, technology driven European companies.”

2.4.2 Policy approaches in the EU

The European Commission has identified five main barriers that impede growth of the bioenergy markets in the European Union (Biomass Action Plan 2005). These are:

1. **Reluctance among major energy and fuel suppliers, vehicle and boiler manufacturers,** placing “bioenergy at a disadvantage since it has to compete directly with fossil fuels and has costs that tend to be higher than those of fossil fuels.”
2. **Lack of appropriate policies in some countries, and political uncertainty over the duration as well as the level of financial support given to biomass energy.** In the words of the Biomass Action Plan “This factor appears to be the most important barrier to tackle since it is convincingly proven that whenever appropriate policies are implemented, the market reacts positively and develops the necessary structures and operational systems to deliver results in accordance with the policy requirements”.

3. **Technology and process costs, meaning that biomass is uncompetitive, and** “new fuel chains addressing more complex resources, new conversion routes such as gasification and pyrolysis, and new applications” are required.
4. **Lack of awareness among consumers about the benefits of bioenergy and negative attitudes with some concern regarding pollutant emissions.**
5. **The fuel chain complexity.** The Biomass Action Plan emphasizes that “bioenergy is the only renewable resource which cannot be harnessed free of charge such as wind, the solar light, running water and hot water from the earth. On the contrary, the delivery of a biomass fuel to a user entails a series of operations that are not only costly but also need to take place often over long periods of time such as planting, managing crops or forest, harvesting, transportation, size reduction, storage and pre-treatment - for solid biofuels – or chemical transformation - for liquid and gaseous biofuels.” The consequence is enormous complexity and need to involve numerous stakeholders. Efforts are needed to streamline the various operations and provide confidence for a sustainable and reliable system for both the farmers and foresters who grow the resource and the users who will use the biomass fuels in their facilities. “Guaranteeing the delivery of large quantities of solid biomass with specific quality and characteristics over long periods of time to large scale users such as utilities is still an area under development.”
6. **Slow market and trade development** requiring the development of market tools so that the fuel can become a tradable commodity. Such market tools include quality standards, a specialised trading floor, dedicated transport and storage facilities and functional market distribution systems.

The main policy tools of the European Union to address these barriers (excluding those for transport fuels) are¹⁰:

1. **Electricity/CHP through the RES-E Directive.** This directive has four main schemes which may be applied in EU member countries:
 - **Feed-in tariffs**, which guarantee a fixed electricity price paid to the energy supplier and offering long-term guarantees of support (currently used in 18 EU countries).
 - **Renewable obligations** (or quotas), in which minimum shares of renewables are imposed on consumers, suppliers or producers (currently used in 5 EU countries).
 - **Fiscal incentives** such as tax exemption for CO₂ or (fossil) energy taxes (used in 6 EU countries).

¹⁰ Based on EC directives, EU member countries develop national policies. These policies make use of the options given in the directive (when direct policy options are given), adapted to local needs and approaches. This list is adapted from the description given in the Biomass Action Plan 2005.

- **Tender scheme** (applied in only 2 EU countries).
2. **Buildings Directive**, which gives EU countries the possibility for promoting selected renewable heating technologies but does not contain targets. In order to support the development of the heat market, EU countries have put into place policies and mechanisms based essentially on the investment incentives (17 countries) and on tax incentives (8 countries).

The Biomass Action Plan proposes new policies, legislation and actions to increase bioenergy take-up, including *legislation on renewable energy in heating*, potentially including measures to ensure that fuel suppliers make biomass fuels available, the establishment of efficiency criteria for biomass and the installations in which it is to be used, equipment labelling to enable people to buy clean and efficient devices, targets, and voluntary agreements with industry. In addition the Biomass action plan proposes the *amendment of the directive on the energy performance of buildings* to increase incentives for renewable energy, and *adding the supply of district heating to the list of goods and services with reduced VAT rates*, extending to district heating any reduced VAT rate already applied to natural gas or electricity, and other tax issues affecting district heating.

2.4.3 Key factors in creating biomass markets in areas it is already taking off

The main biomass energy users in the European Union are France, Sweden, Finland, and Germany. In recent years wood energy use has seen significant growth in Finland (where wood energy contributes 20.5% of total primary energy production), where wood and fuels derived from wood play an important role in the country's decentralised and diversified energy system¹¹. In addition to the considerable wood energy resources in Finland, growth in Finland can be explained by government support mechanisms, in particular by the introduction of a tax on CO₂ applicable to fossil fuels. The government also pays back another tax levied on the production of electricity from fossil fuels to suppliers of renewable electricity¹². Finland also offers other types of incentives including a subsidy for extraction of wood energy (logs and wood chips) from forests (from the Ministry of Agriculture and Forests) and investment aid for new wood energy technology projects (from the Ministry of Trade and Industry).

¹¹ Wood energy production grew by 4.8% when compared to 2003. Finland is by far the leading country in terms of per capita wood consumption with a ratio of 1.39 toe/inhabitant (1.32 toe/inhabitant in 2003).

¹² At a rate varying from 0.42 €/kWh for biomass electricity and small hydraulic power plants to 0.69 c€/kWh for wind power and wood chips (Wood Energy Barometer 2005).

Sweden also obtains a significant part of its primary energy production from wood energy (15.5% in 2004)¹³. The significant growth in recent times (when taking the size already reached by the sector into consideration) can be explained in particular by an appreciable rise in electricity produced from biofuels with support from a green certificate coupled with a renewable obligation system (where electricity consumers are obliged to buy a certain quantity of green electricity certificates¹⁴). This system has helped make biomass electricity more advantageous and helped to stimulate investment in the field of CHP plants. Another factor is the rise in oil prices supported by a tax on carbon that has made small size wood pellet fired boilers very competitive.

France is the leading European wood energy producer due mainly to use of wood in domestic heating, with more than 5 million households using wood heating¹⁵. These generally have low efficiency, and government policy is to accelerate installation replacements with high-efficiency wood heating apparatus as well to increase the size of total national installed capacity.

Significant growth in the German bioenergy market¹⁶ is a result of a new law on renewable energies (applicable from 1 August 2004) that re-evaluated purchase conditions for electricity from biomass energy¹⁷. In order to favour development of biomass heat applications, the Ministry of the Environment subsidizes systems for 60 € per kW (for efficiency higher than 88%) and a minimum of 1 700 euros per system (for efficiency higher than 90%).

Austria also has a long tradition of support to the development of the wood energy sector¹⁸. For heat production a large number of regional and federal programmes to support development of biomass installations exist, and cover between 20 and 40% of total investment costs.

¹³ Primary energy production from wood grew by 4.2% in 2004 compared to 2003. Primary energy production per capita was 0.92 toe in 2004 (0.89 toe in 2003).

¹⁴ The obligatory percentage rate of green certificate purchase was 8.1% of electrical consumption in 2004 and this will be progressively increased to 16.9% in 2010.

¹⁵ 45% inserts and closed fireplaces, 27% open fireplaces, 13% heating stoves, 9% cooking stoves and 6% individual boilers (Wood Energy Barometer, 2005).

¹⁶ Primary energy production from wood energy in Germany in 2004 increased by 20.7%, i.e. 6.3 Mtoe (5.2 Mtoe in 2003).

¹⁷ This re-evaluation is made by the addition of production bonuses (feed-in) linked to the types of biomass used (from 25 €/MWh to 60 €/MWh depending on capacity), to the use of CHP (20 €/MWh) and to the use of innovative techniques and procedures (20 €/MWh) that comes on top of the basic purchase price that varies from 115 €/MWh for capacities up to 150 kWh to 84 €/MWh for capacities from 5 to 20 MW. Electrical production from wood energy grew from 1.5 TWh in 2003 to 3.9 TWh in 2004.

¹⁸ Austria's production of 3.5 Mtoe in 2004 puts it in fourth place position in terms of per capita production (0.43 toe/inhabitant).

Over the past five years there has been a major shift in energy policy to promote use of biomass as fuel with the realization that co-firing of biomass on existing coal-fired power stations is a technically viable option. Major co-firing initiatives are taking place in Poland, the Netherlands, and the UK (here, as a result of the UK's renewable obligation system which includes biomass co-firing).

As can be seen from the above examples where wood energy use is growing, market transformation comes about as a result of either 1) biomass energy being least cost as a result of support mechanisms, and/or 2) policy obligations (quotas), which shift the burden of financing renewables to large private sector utilities (which are ultimately passed on to consumers).

2.4.4 Viability of biomass as a competitive fuel source and its future prospects

While biomass energy prices (and consequently cost effectiveness) vary widely by location and in some cases is clearly least cost (see Figure 6 for example), in general, in the countries of the European Union described above, biomass energy is seen as a competitive fuel source as a result of policies which support biomass energy, level the playing field¹⁹, and/or tax fossil fuels. These policies represent a combination of market creation tools and internalisation of external costs (in the case of CO₂ taxes levied on fossil fuels, for example). The market creation activities are presumably temporary measures aimed at technology development and cost reductions, market barrier removal, and supply chain creation (market transformation), as described in section 2.4.5 below and in chapter 3.

There is no doubt that biomass is currently a viable alternative in many countries, with a total market growth of 11.8 % between 2003 and 2005²⁰, and “double digit growth” (16.1%) in electricity production between 2004 and 2005. However from this data is it virtually impossible to conjecture whether it would be viable without the government market support mechanisms currently in place, and at what rate the market might grow without this support. Given the large number of factors that need to be taken into account when determining viability²¹ this is by no means a simple issue.

¹⁹ For example, in many countries of the EU, reduced VAT rates are applied to heating with oil and gas, but not to biomass heating or district heating.

²⁰ Solid Biomass Barometer December 2006. In terms of total primary energy production the growth from 2004 to 2005 was 5.6% over the whole EU, with double digit growth in Germany (28%), Netherlands (57.7%), Hungary (35.5%), Slovakia (15.4%) and Ireland (16.4%).

²¹ Including, for example, energy demand characteristics, availability of competing fuels and technologies, policies on for example taxation, emissions, and environmental legislation, availability of experts for design and specification, suitable biomass fuel and associated technologies, emission standards, subsidies,

While in Slovenia, based on costs from the UNDP-GEF biomass project heating from biomass is competitive, these cost calculations do not include the risks and perceived risks of the market. A comparison of the cost per unit of energy for various fuels from 2004 to 2006 from the UNDP-GEF project in Slovenia is shown in Figure 6.

In other countries that do not have market support mechanisms, the cost effectiveness of biomass is more mixed. The following table compares annual costs of heating using various sources in Slovakia in 2006 (see Table 3 below). From the given figures, it is evident that biomass is marginally competitive.

Figure 5 shows typical expectations for trends in gas and pellet prices in the region (dating from the end of 2006), and shows how prices were predicted to continue with pellet prices being marginally lower than gas prices. Since this time consumer gas prices in many countries of the region have fallen and not risen as was the expectation in November, with a consequent impact on pellet prices.

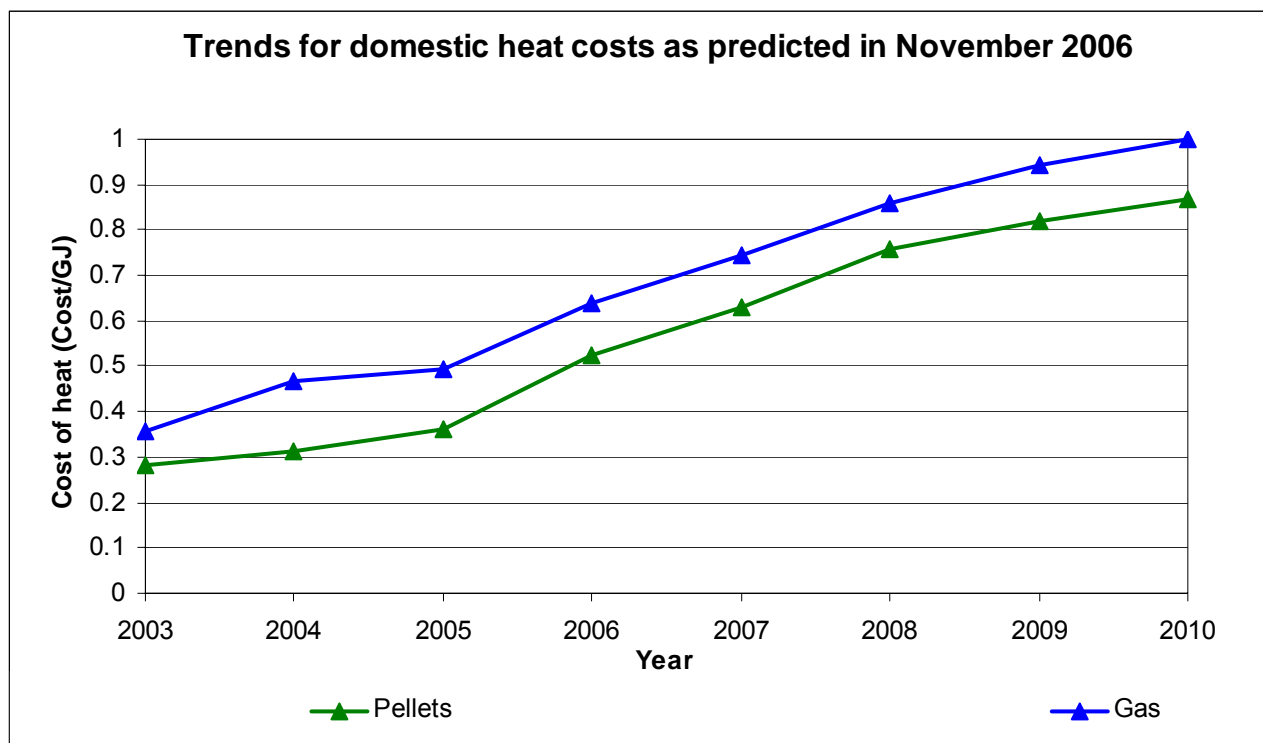


Figure 5: Comparison of energy costs from gas and pellets in with future projections

technology lock-out, feed-in tariffs and wheeling charges for small scale producers, costs of biomass fuel sourcing and supply, suitable servicing and maintenance availability, labour costs, and perceptions and reality of technology and supply risk.

Table 3: Heating price comparisons, 2006, from the UNDP-GEF project in Slovakia²²

	Unit	Price (06)	Energy content	Efficiency	Operating costs	Fuel required	Total cost per GJ	Total cost / year
		Sk/unit	MJ/unit	%	Sk/yr	kg/m ³ /kWh	Sk/GJ	Sk/yr
Log wood	kg	3	13.7	80 ⁺	7,000	9,124	344	34,372
Brown coal	kg	3.4	17.2	60 ^{**}	3,500	9,690	364	36,446
Coke	kg	8.1	27	65 ^{**}	2,500	5,698	487	48,654
Pellets	kg	6.8	17.5	90	5,000	6,349	482	48,175
Gas	m ³	14.7	33.7	90	1,500	3,297	500	49,967
Electricity heat accumulator	kWh	1.81	3.6	96	5,050	28,935	574	57,423
Electricity - direct stove	kWh	1.91	3.6	98	5,300	28,345	594	59,438
Propane-butane	m ³	29	46.5	90	4,000	2,389	733	73,295

⁺ In high-efficiency two-stage ('gasifying') boiler; ^{**} In traditional boiler

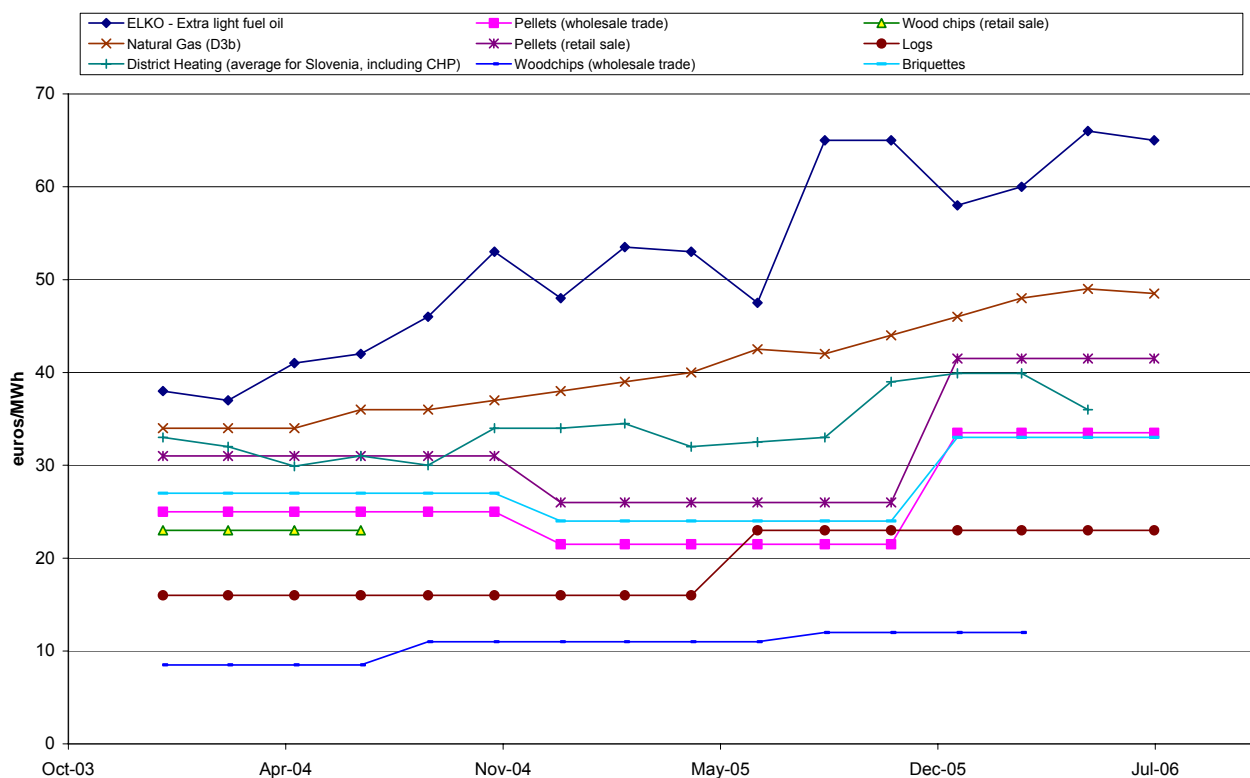


Figure 6: Heating price comparisons for the period 2004 - 2006, from the UNDP-GEF project in Slovenia

²² This comparison is for domestic heating – households (100 GJ yearly consumption) and not heat sales for BIOMASA for boiler rooms reconstructed within the project.

2.4.5 Creating Markets – key lessons from countries where biomass energy use is growing

For renewable energy to make a significant contribution to economic development, job creation, reduced oil dependence, and lower greenhouse gas emissions, it is necessary to improve the efficiency of technologies, reduce their costs, and develop mature, self-sustaining industries to manufacture, install and maintain renewable energy systems. This process is one of *Market Creation* or *Market Transformation*. As stated by the IEA (2003), “Market Transformation is about engineering substantial change in the market for a particular class of product”.

To the word ‘substantial’ could be added ‘sustainable’ since market transformation deals with the long-term impact: “When the process is completed, a successful market transformation programme will have had a lasting and significant effect”. The goal of market creation in the biomass sector is not simply to install capacity, but to provide the conditions for creation of a sustained and profitable biomass industry, which will result in increased biomass energy capacity and generation, and will drive down costs. This shifting of the market is shown graphically in Figure 7.

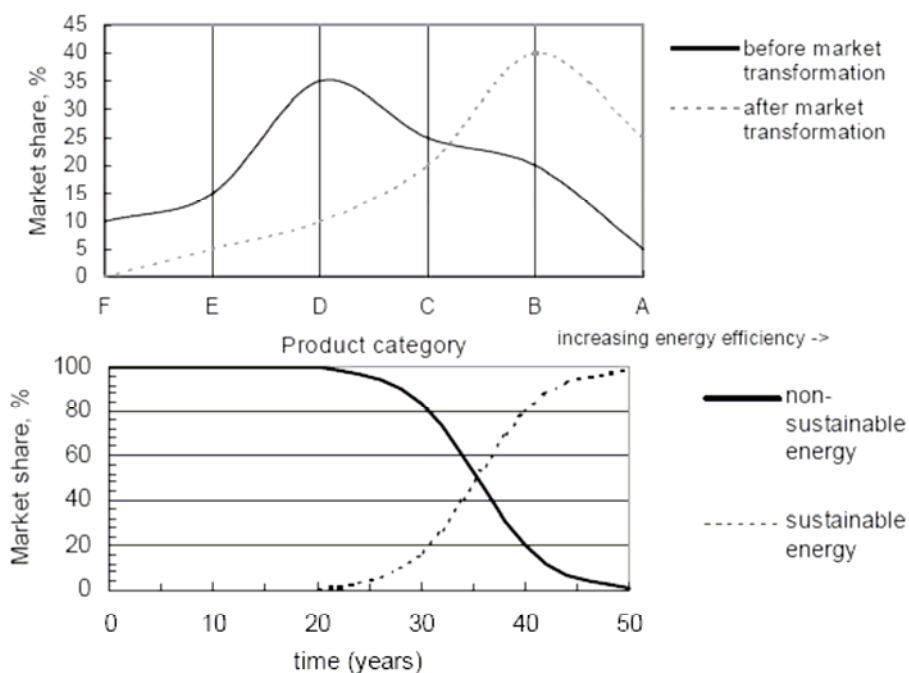


Figure 7: Market transformation outcomes²³

²³ Lund P (2001), *Market Transformation Perspective and Involvement Of Market Actors and Stakeholders in the IEA Case Studies*, report prepared for "Technologies Require Markets", IEA Workshop on Best Practices and Lessons Learned in Energy Technology Deployment Policies, Paris, 28-29 November 2001.

The IEA has identified three perspectives on market creation, namely *the research, development and demonstration (deployment) perspective*, focusing on learning by doing, *the market barriers perspective* focusing on decisions by investors and consumers, and the *market transformation perspective* which emphasizes the behaviour and roles of market actors, how their attitudes guide decisions and how these attitudes can be influenced. More detail on each of these perspectives follows here and in chapter 3.

The influence of biomass energy projects on driving down costs through market transformation, thus making them more financially viable, is principally the concern of the first of the three perspectives. The analysis of the impacts of learning by doing is frequently expressed as an ‘experience curve’ which shows the development of costs as a result of technology research and deployment. Within the biomass sector at least three separate areas in which learning and subsequent cost reduction may take place have been identified. These are: the biomass plant (the technology), the plant operation, and the fuel supply chain as depicted in Figure 8. These complex and interrelated learning systems, as well as the substantial variation in types and scales of biomass systems mean that the experience curves are not as well developed as in other sectors such as photovoltaic energy and wind energy. Nevertheless, experience curves from the biomass energy sector can usefully inform us on what we could expect from market transformation within a UNDP-GEF project context. Of the three learning systems, the fuel supply chain has been shown to be the one with the greatest need and biggest challenge in the projects.

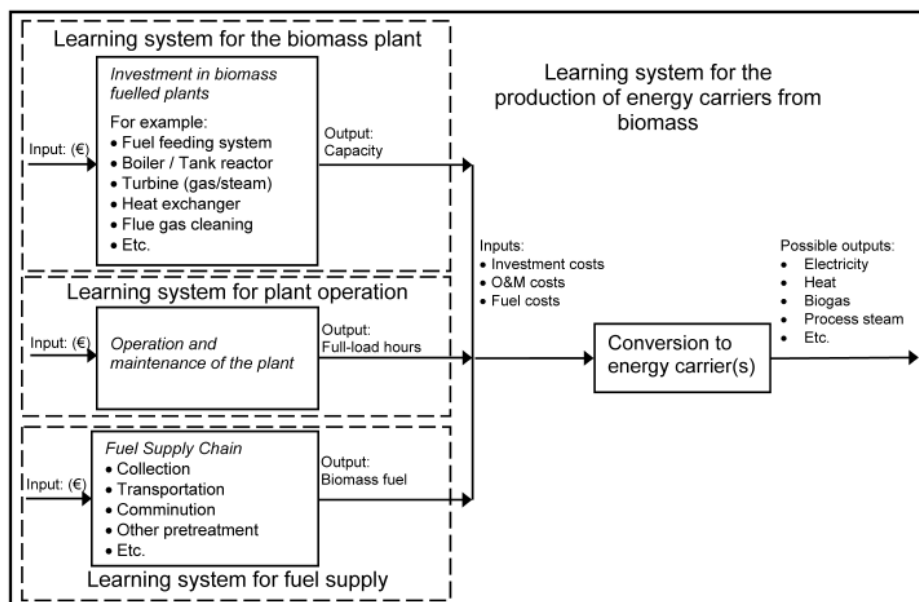


Figure 8: General structure of biomass energy learning systems (from Junginger 2005)

Technological learning and experience curves have been studied by many groups and in many areas of manufacturing including in the energy sector, and, based on an often quoted analysis of 42 learning rates of energy technologies (McDonald and Schrattenholzer (2001)) the learning rates appear to fall into two main groups as evident in Figure 9. These groups are technologies with learning rates of around 2 to 6 % per annum, and those with learning rates of between 14 and 22%.

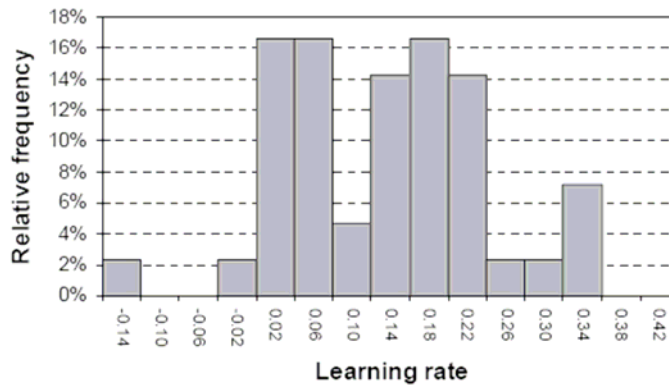


Figure 9: Learning rates from experience curves of 42 energy technologies

A key issue is the influence of *energy technology scale* on the learning rates. The survey analysis of McDonald and Schrattenholzer (2001) indicates generally higher learning rates characteristic of more modular systems amenable to mass production in factories and lower learning rates characteristic of large field-erected power plants for which standardized designs are more difficult to realize. The district heating systems which are the subject of the UNDP-GEF projects analysed here in most cases fall into the latter group since, although they are not particularly large, most learning is field-oriented. In addition, the UNDP-GEF biomass energy projects in Europe and the CIS are built on the foundations of existing technologies, and thus do not involve a technology Research and Development component focused on the production process²⁴.

From the earlier discussions in this chapter, and the experience of the UNDP-GEF projects the main area of learning concerns fuel supply. An experience curve for the price development of wood-chips from forest residues (Primary Forest Fuel, PFF) in Sweden between 1975 and 2003 has been developed by Junginger (2005), and is shown in Figure 10²⁵. This shows significant reductions at a learning rate of 13% between 1975 and 1995, with prices levelling out from 1995 to 2003.

²⁴ Despite this, in all the project countries, a significant amount of learning in the area of the biomass plant was needed, in the local engineering design and specification expertise, and, in some countries, on activities associated with technology transfer.

²⁵ 1 million m³ corresponds to approximately 7.2 PJ.

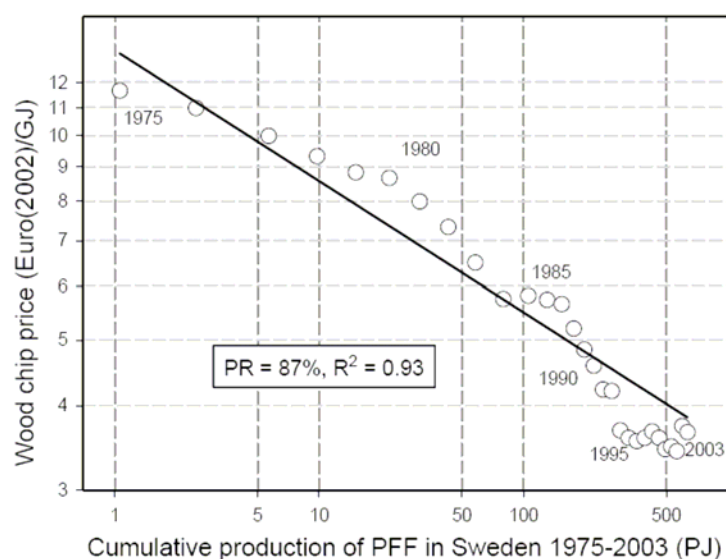


Figure 10: Experience curve for the price of wood chips from forest residues in Sweden 1975-2003, from Junginger 2005

Learning rates can be substantially quicker if they are based on the transfer of technology and experience from other countries (as is the case in GEF projects). An excellent example is from Finland in which forest residue prices were stable between 1987 and 1992, declined sharply from 1992 to 1998, with a learning rate of 89%, and levelled off (or increased slightly) from 1998. This has been attributed to the shift to the use of logging residues as opposed to residue from thinning, and that Finland was probably able to import technology and experience previously developed and gained in Sweden (from Björheden, 2004, quoted in Junginger 2005). This 5-year period matches well with the duration of many projects, and should therefore be achievable within the timescales of GEF market transformation activities.

This rapid learning corresponds to a significant growth in the market. In the case of Finland this is a growth in cumulative use of forest residues from 45 to 59 PJ, or from 6.3 to 8.2 million cubic meters for a reduction in cost by a factor of 2.5. In Sweden the number of district heating plants using primary forest fuel increased from 1 in 1981 to 130 in 2002.

It has been pointed out that although ongoing support of renewable energy can be to compensate for the fact that there are damages associated with climate change, air pollution, and energy supply insecurity that are not internalized in market prices for energy, “even with full internalization of such damage costs it would be desirable for government to subsidize commercialization of promising energy technologies because of a significant positive externality: a private firm that invests in technology cost buydown via [learning by doing] runs the risk that the fruits of its

investments will spill over to its competitors” (Williams 2003). In fact, this spill over effect is highly desirable, indeed a design characteristic, in most GEF projects since project learning is intended for ‘the country’, not just one particular commercial player.

While demonstration projects in the GEF project context are certainly intended to bring about cost reductions, and have achieved these in most cases, they are also used to raise awareness of decision-makers, not just reduce costs. The impacts of these type of projects on stakeholders, is the main concern of the third perspective of the IEA ‘Market Creation’ framework, *Market Transformation*, which emphasizes the behaviour and roles of market actors and the influence of a project on their attitudes.

How projects influence beneficiaries has been the subject of long-term analysis. The ‘Outcome Mapping’ approach developed by the International Development Research Council, IDRC, in 2002 grounds the theory of change of a project in the roles of human actors in the process (Earl 2002) and draws a clear distinction between the roles of the project implementation team and ‘boundary partners’²⁶. A project works with the boundary partners to bring about change, but it does not control them. The power to influence development rests with them. The project tries to facilitate the process by providing access to new resources, ideas, or opportunities for a certain period of time. The project is on the boundary of their world.

The importance of boundary partners, and the effect that a GEF project can have on the attitudes is particularly important because the intended ‘market transformation’ impact of a project (the project goal) lies with the boundary partners (government, industry, etc.), and their actions are outside the control of the project, and boundary partners are subject to numerous other influences apart from the project. This introduces the problem of attribution of impacts. While it can arguably be claimed that the biomass energy markets are substantially transformed in all five UNDP-GEF project countries comparing the situation at project start (in late 1990s or early 2000s) and project end, it is less easy to attribute this transformation directly to the projects. However it gives a false impression of the potential impacts of projects to see them in isolation and the scope for transforming impacts. The markets would be substantially difference now compared to the markets at the time of project start even without the projects, but it is without question that the projects have positively influenced and accelerated this transformation. Unfortunately baseline and monitoring data of sufficient quality and quantity is lacking, so a more precise understanding of these attributed impacts cannot be determined. Even with better monitoring and evaluation (M&E) systems, highly complex goals for projects intending to influence social attitudes in which desirable

²⁶ Defined as “those individuals, groups, and organisations with whom the program interacts directly and with whom the program anticipates opportunities for influence” (Earl 2002).

outcomes are themselves subject to debate, which have in the literature been called “wicked problems” because of this complexity²⁷, are difficult to attribute²⁸.

A number of issues, which may be of use to project developers, are evident from the information presented in Chapter 2, namely:

- Bioenergy appears to require special support mechanisms which go beyond those for other renewable energies because:
 - While the combustion technology presents some challenges to market development, the creation of a sustainable biomass fuel supply infrastructure is highly complex and especially challenging
 - Biomass fuel supply chains are essential to sustainable biomass energy use
 - Fuel supply touches on multiple sectors – forestry, agriculture, industry, public sector/services (district heating), environment, and energy – and this adds to the complexity of arranging fuel supply
 - There are competing uses for raw materials which are developing parallel to those of biofuels
 - Small fuel supply markets are highly volatile, and this increases initial risks for investors, until the markets have matured
 - Market tools are lacking in biomass fuel supply
 - Biomass heat is a significant opportunity, and can offer substantial benefits, but most renewable energy policies have focused exclusively on electricity (with heat as a by-product, occasionally).
- The policy approaches used in the European Union aim at creating a viable, clear and long-term government commitment to biomass energy and create markets, ensuring a fair rate of return for investors. Without predictable market conditions created by governments, bioenergy markets are constrained, and conversely, where these conditions exist the markets develop rapidly.
- Market transformation depends on numerous factors, and the ‘number of demonstration projects’ and other activities required to bring about full market transformation in the biomass section is probably outside the scope and scale of GEF projects. GEF projects can however have a very positive impact on the transformation process. Market learning

²⁷ Rittel and Webber (1973) who proposed a problem typology comprising “wicked” (ill-structured) and “tame” (well structured, but not necessarily trivial) problems.

²⁸ In four of the UNDP-GEF project countries the countries in question joined the European Union during the project period. This understandably had a much greater impact on biomass markets than the projects.

through demonstration activities is an essential part of market transformation, but projects should be designed in such a way as to combine strengths of other market influences, and persuade governments to initiate larger programmes to continue market transformation.

3 Lessons learnt in creating markets

Biomass energy projects in the GEF are implemented as part of Operational Programme 6 which aims to remove barriers to the use of commercial or near-commercial renewable energy technologies; and to reduce high implementation costs of renewable energy technologies due to low-volume or dispersed application. By definition barrier removal projects are market oriented. Under the fourth replenishment of the GEF (GEF-4), the expected market transformation impacts of projects are explicitly defined ‘as a successful activity design to develop, expand and/or transform a specified market. A project constitutes a market intervention. If that intervention is successful, it is said to succeed in “transforming” or beginning the process of transforming a market.’²⁹

The goal of market creation is not simply to install capacity, but to provide the conditions for creation of a sustained and profitable industry, which will result in increased renewable energy capacity and generation, and will drive down costs. Based on a detailed analysis of market creation projects in OECD countries the International Energy Agency has identified three perspectives on market creation that provide useful insight into approaches, and an analytical framework by which programmes such as the five UNDP-GEF projects may be analysed (IEA, 2003). These perspectives are:

1. ***The technology demonstration and market learning perspective***, which focuses “on the nature of innovation, industry strategies and the learning process associated with new technologies”. Through R&D in private industry which is stimulated by investments in a new technology, and the process of learning-by-doing technical performance is improved and costs reduced. Market transformation projects can play a role in this process by supporting government policies and implementing programmes that support initial deployment of new technologies (typically ‘demonstration projects’).
2. ***The market barriers perspective*** characterises the adoption of a new technology as a market process and focuses on the frameworks within which decisions are made by investors and consumers. This is the traditional GEF perspective emphasized under

²⁹ GEF 4 Replenishment Strategy and Priorities: Climate Change, October 17, 2006.

operational programme 6. The emphasis in this perspective is on understanding barriers and legitimate project actions to reduce them.

3. ***The market transformation perspective*** focuses on what needs to be done in practical terms to build markets for new energy technologies. It emphasizes the behaviour and roles of market actors, how their attitudes guide decisions and how these attitudes can be influenced.

As emphasized by the IEA (2003), “The strength of the research, development and deployment perspective is its vision of the future; the market transformation perspective encourages sensitivity to the practical aspects of crafting policies to get results; and the market barrier perspective leads to policies that work efficiently and generate net value.”

Lessons from the 5 UNDP-GEF biomass projects have been collected through interviews and discussions with project managers, and key project stakeholders, and UNDP staff. The lessons will be analysed using the market creation frameworks given above. Lessons may be categorized into those that address technology demonstration and market learning (section 3.1), those that come from experiences and activities addressing market barriers such as policy frameworks and financing (section 3.2), and those in which the focus is on the roles of market actors and their attitudes to market decisions (section 3.3) according to the ‘market transformation’ perspective. Lessons learnt at the level of project formulation and design, are covered in section 4.4 (creating sound project designs).

3.1 Lessons from market learning through technology demonstration

The technology deployment and market learning perspective for market creation is focused on the local technology transfer and innovation process, industry strategies and the learning that is associated with new technologies. Market prospects are the most vital stimulant of industry R&D and the deployment (demonstration) of technologies is a key source of information on them. Researchers and developers understand that market development and technology development go hand in hand and this explains why they are interested in deployment issues.

The demonstration of new technologies can lead market actors to learn how to produce and use them more cheaply and more effectively. It is the combination of the physical effect and the learning effect that creates the real impact of energy technology deployment programmes.

Investments in biomass energy systems in the form of demonstration projects took place in all five projects with the aim of supporting technology learning by market players, as well as associated institutional learning. The technology demonstration activities of the five projects are highlighted in the table below:

Table 4: Summary of technology demonstration in the UNDP-GEF biomass projects

Belarus	Latvia	Poland	Slovakia	Slovenia
<p>Five biomass boilers installed across country, ranging from approx. 2MW_{th} to 15MW_{th}, including three CHP systems, and supplying</p> <p>One 'supply side' demonstration project focusing on cost effective biomass fuel supply</p>	<p>One 7MW_{th} heat-only boiler providing municipal district heating in the town of Ludza, 3-4 follow-on projects stimulated, according to project design. 7MW_{th} boiler realized, support to 13 municipalities on switch to use of wood waste given as a result of co-operation with Environmental Investment Fund</p>	<p>Five biomass boiler houses for municipal district heating (0.5 MW_{th} to 3.7 MW_{th}) along with demand-side management and fuel supply, according to project design in three neighbouring municipalities. Realized projects are smaller and less integrated</p>	<p>Construction of a wood pellet Central Processing Unit (CPU), and conversion of 44 small boiler rooms in member municipalities ranging from 15 kW_{th} to 2,5 MW_{th}. Complex logistic solution from collection of raw material, through its processing to generous fuel and delivery of heat in reconstructed boiler rooms.</p>	<p>Target: 3-5 new biomass district heating projects financed by a Biomass Energy Fund according to project design.</p> <p>Realized: Eight biomass district heating systems realized in the framework of the Biomass Energy Fund (four large; 1 MW_{th} to 4.5 MW_{th}), and four small; 0.2 to 0,6 MW_{th}). Additional four projects prepared for realisation by the GEF project, two already realised and two being realised by private investors.</p>

The demonstration activities listed above have resulted in both technology learning and organizational / institutional learning for market and government actors in the supply chain. Lessons learnt from these activities are discussed in the following sections.

3.1.1 Technology learning

Technology learning focuses on the reduction in costs and prices, and improvement in performance of technologies. In the experience of the IEA, most programmes that aim to reduce cost and technical barriers focus on technology learning. Initial adoption of the technology in niche markets, and the prospects of larger markets in future, stimulate additional development by industry. At the same time, learning-by-doing and scale economies lead to product refinement, lower costs and larger market opportunities. Subsidies aimed at increasing market volumes can stimulate technology learning. In addition, technology procurement programmes, labelling and standards may also target technology learning.

Most of the UNDP-GEF biomass projects have resulted in technology learning as technologies were transferred and adapted by local market stakeholders to local needs and conditions, and cost reductions were realized through technology learning. This learning has been particularly evident in the Belarus project (including in technologies for fuel harvesting and processing), and in the projects in Slovakia and Slovenia where the skills of local experts to optimise designs were significantly improved.

Lessons on achieving cost reductions in demonstration projects

- ☑ **Standards for design, and quality management approaches can contribute significantly to reducing technology costs, and increasing reliability of investments [Slovenia]**
- ☑ **Where there is more than one demonstration project / phase, second generation projects can be much more cost effective than first generation projects. A phased approach to demonstration projects allows the project to learn about costs and heat demand, etc. [Slovakia, Slovenia]**

Prior to the GEF project the Slovenian biomass market was adversely effected by poorly optimised designs with oversized capacities leading to high investments, a low number of network connections leading to poor revenues, and inappropriate selection of locations leading to environmental complaints from local residents. The GEF project therefore supported capacity building focused on design optimisation, feasibility studies, cash flow analysis, and quality management activities to address these issues. Capacity building was initially facilitated through the inputs of technical international experts from Austria. Later in the project a quality management (QM) course was developed, based on a QM scheme (QM Holzheizwerke) formally used in Switzerland, Germany and Austria.

A quality management scheme for biomass heating projects was introduced in 2005-6 in Slovenia. Four guidebooks (design of heating systems, quality management plan, standard solutions, tendering), were translated from German to Slovene, and adapted by Slovene experts based on the project experiences. Two intensive training courses were held during 2006.



The main quality goals are: reliability, low maintenance, high efficiency and low distribution losses, low emissions in all operating conditions, precise regulation, and economical sustainability.

Technology learning focusing on biomass system design was shown to have a significantly positive impact on investment costs in both the Slovenia and Slovakia projects. In Slovenia, as a direct

result of technical support, initial system capacity figures determined in feasibility studies were scaled back by as much as 50%, heat storage options were incorporated in designs (allowing for better system to load matching), and costs estimates significantly reduced. Forty small-sized pellet boilers were installed in the Slovakia project in two phases. Despite a rigorous processing of checking feasibility studies during the first phase, the first boilers commissioned were significantly over-dimensioned, with realized demand only being two-thirds of that which was predicted for given weather conditions. As a result of this, based on the learning from the first phase, load calculations were reduced by approximately 30% for the second phase. According to the project team, the second phase boilers “still have a significant reserve capacity”.

Based on these experiences, it is clear that *a learning approach is preferred, with demonstration activities taking place in phases. Projects in which demonstration projects are implemented simultaneously have less chance of benefiting from technology learning. In any case, more than one demonstration activity is required during projects to ensure that risks are spread.*

Lessons on technology learning, intervention scale and selecting market niches

- Sufficient scale is required to stimulate the entire market (fuel supply, technology supply, support services) and result in significant technology learning and consequent cost reductions (“more than one investment per year, minimum 5 per year”) [Slovenia, Slovakia, Poland]**
- Niche markets can potentially provide the learning environment for technology, but picking viable niche markets requires significant local knowledge, and an element of trial and error [Slovenia, Poland]**
- GEF projects should seek to maximise impact through co-operation / partnership with other related activities, national and international programmes if they are to have sufficient scale to transform the market [Latvia, Slovenia]**

While the portfolio of five biomass energy projects co-financed by the GEF does not provide sufficient data to be able to draw firm conclusions about the scale of technology demonstrations that would be required in a market to produce a significant market transformation it is clear from the projects that sufficient scale is required. Within the portfolio of projects those in Latvia, Poland and Slovakia were medium scale projects with GEF contributions of below 1 million USD, and those in Slovenia and Belarus were full scale projects with 4.3 and 3.1 million USD contribution from GEF respectively. Despite a larger-scale project in Slovenia, the Fund Manager and Project Manager were of the opinion that the number of realized projects was insufficient to bring about a significant transformation of the market, and that in a country of the size and potential of Slovenia

at least 5 investment projects per year would be required for this. The size of the equity fund however was too small to allow more than 8 systems to be installed during the entire project period. The project manager in Slovenia made significant efforts to combine efforts with other national programmes and international programmes to try to increase the scale of project activities, but had only limited success in the demonstration components since other stakeholders were not investing in technology demonstrations in the same market niche. By the end of the project 10 demonstration projects are operational, 8 financed from the GEF equity fund, and 2 developed by the GEF but financed independently of the GEF.

Despite significant periods of project activity in the countries, it is only in later periods of project implementation that projects managed to focus activities sufficiently to address market niches successfully. Slovenia provides a good example of this, with effective targeted ‘products’ offered to niche markets such as design engineers, installers, chimney sweeps (to influence household sectors), farmers advisors, and foresters towards the end of the project. The determination of the appropriate technology options within the Slovenia project was also problematic. While good opportunities for CHP projects existed the GEF Project Document implied that CHP was not possible, and this was supported by the steering committee. In the opinion of the Project Manager this was a significant lost opportunity. In Poland, the project team commented at the end of the project, that they had finally gained a clear understanding of the project barriers that would need to be addressed.

Lessons on biomass fuel supply

- Unless barriers to both biomass fuel supply and biomass use are addressed local markets will not be created *[all projects]***
- Fuel supply is a major investment risk. In some projects these have been reduced by using biomass combustion technologies that can potentially burn more than one kind of fuel, and with ‘closed’ fuel supply arrangements *[Poland, Slovenia]***
- Fuel supply complexity depends on system size: the bigger the boiler, the bigger the fuel supply problem *[Poland, Belarus]***

Biomass energy is the most complex of renewable energy alternatives: arranging a reliable, sustainable and affordable fuel supply of sufficient quantity and quality can be challenging, biomass fuels are frequently land and labour intensive and are highly dependent on stable prices, and the project developer is faced with a huge number of alternative technologies. Unlike other renewable sources of energy, biomass energy requires that attention is given to both fuel supply

and energy demand. This rather unique characteristic means that biomass projects are uniquely complex in scope, and may involve numerous market and government stakeholders.

Experiences in all five projects underline the importance of fuel supply with all project managers rating fuel supply as being the most or one of the most significant project risks. In addition, the real and perceived complexity of fuel supply is a major disincentive to investment decisions, and these barriers are only overcome through concerted effort, and significant opportunities for technology learning. In contrast, fossil fuel supply – such as diesel, heavy fuel oil or coal – is offered to municipal and industrial clients with simple contracts and favourable terms not available in the biomass sector. It was pointed out by two of the Project Managers (Poland and Latvia) that biomass energy fuel supply is entering into highly competitive fuel supply markets (natural gas, coal, oil) that do not react passively to competition.

When biomass residues becomes a commodity then prices rapidly increase. Two of the UNDP-GEF portfolio of biomass projects have been effected by this: the Slovakia project where sawdust prices (and than also pellets prices) are affected by strong competition with fibreboard production by foreign investors as well as with other production of pellets in foreign countries, and Italian demand for domestic and industrial users, and that of Slovenia, where pellet prices follow demand in the Italian and Austrian market. These external factors proved challenging for feasibility work and financial analysis in proposed projects. The situation of 2006 in particular demonstrated to the Slovak project management team that market and prices of biomass raw material as well as pellet market is very difficult to predict (see Table 5 and Figure 11).

Table 5: Development of prices for sawdust and pellets in Slovakia during the project period

Average costs without VAT	2004	2005	2006	2007
Wet Sawdust (60 %) (Euro/bulk m ³)	1.91	3.82	5.00	7.06
Pellets (Euro/t)	91	103	162	167

Calculated with exchange rate of 2006, EUR=34 Skk, all prices without VAT and transport costs.

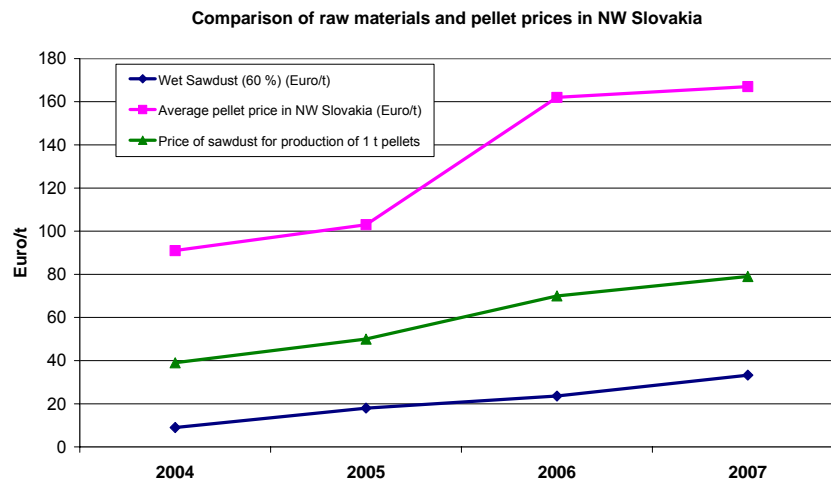


Figure 11: Raw material and pellet prices in NW Slovakia for 2004-6

In Belarus, fuel storage arrangements proved significantly more costly than expected for the large CHP systems being constructed, especially because of legislative requirements for (a) water storage for fire-prevention in case of fuel storage available, and (b) design and construction of special disposal area for ash, which increased investment costs in the large demonstration projects significantly (by 10-15%), though a new regulation on ash use in agriculture and forests is to be developed.

Lessons on heat demand / energy saving

- ☑ **The scale of heat demand in feasibility studies is usually overestimated**
[Slovakia, Slovenia, Poland]
- ☑ **Energy efficiency measures should be implemented before (or together with) the specification and installation of heating systems** *[Slovakia, Poland]*

As described before, despite a rigorous processing of checking feasibility studies in Slovakia, realized demand was two-thirds of that which was predicted. As a result of this, based on the learning from the first phase, load calculations were reduced by approximately 30% for the second phase. In Slovakia a number of mayors decided to implement energy efficiency activities after the design and commissioning of the biomass boilers. In addition, not all buildings were connected to network as had been originally planned, and this contributed to decrease in heat demand (partly as a result of a shortage of financing for connections and partly by other reasons). This has had a negative impact on efficiency of heating systems and cash flow in the Association, and has resulted in activities aimed at extending micro-grids so as to increase connections to the biomass system and heat delivery.

In Poland, the heat demand determined when the feasibility studies were repeated during the implementation of the project gave heat loads of approximately 60% of previously estimated figures from prefeasibility studies carried out under the PDF-A (see Table 6). This difference had a significant impact on the overall financial feasibility of the project and ultimately resulted in the withdrawal from the project of the private sector investor.

Table 6: Historical development of heat demand during the project in Poland

When	Activities	Estimated heat load
Spring 2002	prefeasibility study prepared by private partner based on data supplied by project proposer	53 k GJ
Spring 2003	demand based on energy audits as well as measurement, without any thermal improvement	41 k GJ
August 2003	feasibility study prepared by private partner based on energy audits and expected DSM improvements and consumption pattern	33 k GJ
September 2003	data for design work, based on previous analysis, standardisation according to historical weather condition, practical experience of designer and expected consumer behaviour	27 k GJ
At this stage private partner changed his attitude to this project: he recommended production of pellets as additional source of income. His conclusion was simple: heat sales of these levels will not be profitable.		

3.1.3 Institutional learning

For technologies that are technically mature and cost efficient, other barriers may exist including information flows, standards, transaction costs, financing and the organisation of markets (OECD/IEA, 1997a and 1997b). These barriers are strongly present in countries where new technologies, or new local applications of technology (since in many of the project countries domestic use of biomass is very common³⁰) are being introduced from neighbouring countries as is the case in all five of the UNDP-GEF projects. Institutional learning is thus a highly important component of all these projects. Institutional or organisational learning refers to an increase in an organisation's capability for effective action. Applying that idea in this context, market deployment leads to organisational learning for the company developing and promoting a technology, as it learns how to overcome those barriers that are not directly related to the cost or performance of the technology itself. At the same time, the other market players (consumers, intermediaries, governments) also have the opportunity for organisational learning, but in this case the organisation being referred to is the market itself.

³⁰ In Slovenia for example, 200 000 households are heated solely with biomass fuel, and local producers of large boilers supply both the Swedish and German markets.

Lessons on the importance of institutional learning

- ☑ **Building institutional capacity is crucially important in new markets [Latvia, Slovakia]**

It was evident from the Latvia project that institutional capacity can be particularly challenging. As a result of misunderstandings and vested interests between the municipality and the private sector investor in the demonstration project (which were exacerbated by a change in political composition of the city council and election of a new mayor two weeks after the start of the project) the two parties sued each other, and the UNDP and the project management had to attempt to mediate. By the end of the project capacity development was still underway and “beginning to demonstrate a satisfactory result”.

While many factors that influence institutional capacity are virtually impossible to predict while designing a proposal, additional analysis of relevant factors may mitigate or even avoid at least some of the risks. In general, a flexible design, which for example may incorporate a competitive phase or the selection of alternative project sites (as characterized by a revised project document prepared during the project), can minimize these risks significantly.

Lessons on the time and effort required to address administrative barriers

- ☑ **Administrative barriers (approvals from government and municipalities, tender processes, obtaining bank guarantees) take significantly longer to address in new markets than expected *[Slovakia, Slovenia]***
- ☑ **Government bodies responsible for providing construction licenses (or related permissions), also need to learn about biomass energy. Getting licenses is frequently very time consuming with unknown technologies and processes *[Slovenia, Slovakia, Belarus]***

In the Slovenia the application for the building licence for one demonstration investment took 9 month to process. On average contract preparation for technical and legal support in the same project took 66 working days to approve within the government. The length of such activities is not usually predicted at the time of project development, but is important to identify and address as real project barriers, not external project risks over which the project has no control.

Government bodies giving construction and other licences and permits that are not familiar with the technology and approaches used with biomass energy, can significantly delay investments and project activities related to relatively short building season. Including activities to overcome these barriers, and incorporating institutional learning at the level of building regulation and control in the project design, can help to mitigate this risks. Time delays have also been experienced in the Belarus project where arrangements for the management of the biomass energy revolving fund took significantly longer than expected.

Lesson on government access to specialist skills

- ☑ **Governments frequently do not have sufficient specialist in-house legal expertise to support the development of innovative mechanisms. External expertise, while frequently costly, is essential *[Slovenia]***

The initial concept of using GEF funds in Slovenia to create a revolving equity fund that could take risk (“soft” equity) did not develop smoothly because it did not anticipate the legal complexities for implementing the concept in Slovenia. One of these legal complexities was due to the fact that, in accordance with the Project Document, the initial capital of the Fund was transferred from the GEF to the Government of Slovenia and was thus considered a state asset. Transfer of the GEF grant directly to the Fund Manager, EcoFund, would not have avoided the state assets designation, as the

EcoFund (while operating outside the state budget) is still owned by the state. These complexities required the use of external legal expertise to resolve, and the decision to make use of external expertise was resisted by the various government departments as an unnecessary cost. Legal expertise outside the project group was also required to move project issues forward in Belarus. A change in VAT procedures between Russia and Belarus, for example, presented challenges which required detailed and time-consuming attention from the project team so as to avoid double taxation. New procedures also led to delays in supply of equipment for demonstration sites.

3.2 Lessons from addressing market barriers

Market barrier perspectives focus on market processes, and decisions made by investors and consumers, including policy, technology, skills, and finance, and on the desirability of facilitating the adoption of biomass technologies, through policies consistent with the underlying objectives and constraints of a market system (i.e. that they are economically efficient).

There are a wide range of market barriers depending on the specifics of the market size and type. Some typical barriers in the biomass energy sector as experienced in the UNDP-GEF biomass projects in Europe and the Commonwealth of Independent States (CIS) are shown in Table 7 below:

Table 7: Overview of typical biomass market barriers

Barrier	Key Characteristics <i>Adapted from IEA (2003)</i>	Typical Measures & UNDP-GEF biomass projects which use them
Uncompetitive market prices	Economies of scale and technology learning have not yet been realised, supply chains for products and services are not yet developed	<ul style="list-style-type: none"> • Learning investments (all 5 projects) • Additional technical development (fuel supply side technology transfer in Belarus)
Price distortion	Costs associated with existing technologies may not be included in their prices (e.g. oil or coal-fired boilers offered below cost, and costs recuperated in fuel prices, no accounting for environmental impacts in fuel prices) or they may be subsidized (e.g. electricity, oil, gas and coal subsidies)	<ul style="list-style-type: none"> • Regulation to internalise 'externalities' (none) • Special offsetting taxes or levies (none) • Removal of subsidies (none directly, although in Latvia, Poland, Slovenia & Slovakia via EU accession)
Information	Availability and nature of a product must be understood at the time of investment	<ul style="list-style-type: none"> • Standardisation (Slovenia) • Biomass exchange (Slovenia) • Labelling • Reliable independent information sources (all projects) • Convenient & transparent calculation methods for decision making (Slovenia, Belarus)
Transaction costs	Cost of administering a decision to purchase and use equipment	
Buyer's risk	<p>Perception of risk may differ from actual risk (e.g. 'pay-back gap')</p> <p>Difficulty in forecasting over an appropriate time period, particularly relevant for fuel</p>	<ul style="list-style-type: none"> • Demonstration (all projects) • Routines to make life-cycle cost calculations easy (Slovenia)

Barrier	Key Characteristics <i>Adapted from IEA (2003)</i>	Typical Measures & UNDP-GEF biomass projects which use them
	supply	
Finance	Initial cost may be high Imperfections in market access to funds	<ul style="list-style-type: none"> • Third party financing options (Slovenia) • Special funding (Belarus) • Adjust financial structure (Equity fund, Slovenia)
Inefficient market organisation in relation to new technologies	Incentives inappropriately split - owner/designer/used not the same Traditional business boundaries may not be appropriate Established companies may have market power to guard their positions	<ul style="list-style-type: none"> • Restructure markets (Belarus) • Market liberalisation could force market participants to find new solutions (none, in Latvia, Poland, Slovenia & Slovakia via EU accession)
Excessive/inefficient regulation	Regulation based on industry tradition laid down in standards and codes not in pace with development	<ul style="list-style-type: none"> • Regulatory reform (Slovenia, Belarus) • Performance based regulation (Belarus)
Technology-specific barriers	Often related to existing infrastructures in regard to hardware and the institutional skill to handle it	<ul style="list-style-type: none"> • Focus on system aspects in use of technology (Belarus, Poland) • Connect measure to other important business issues (productivity, environment, job creation) (Slovenia)

Lessons from the UNDP-GEF biomass projects on Policy and Financing barriers are discussed in more detail below.

3.2.1 Addressing policy barriers

Addressing market barriers in an economically efficient way entails creating and enforcing policies consistent with market principles and address market failures where they exist. All five GEF projects including policy development components and attempted to influence policies to support biomass energy. A number of lessons may be derived from these project experiences.

Lessons on the prerequisites for influencing policies

- ☑ **Policy development work requires prior government willingness to address policy issues: where government are keen to develop policies on a particular subject, the project can effectively assist [Slovenia, Belarus]**
- ☑ **Where governments are not already intending to develop policies and legislation, projects cannot guarantee to produce results [Slovakia, Latvia]**
- ☑ **Project Management based within the Government have unique opportunities to provide policy support and leadership [Slovenia, Belarus]**

Policies are political, management, financial, and administrative mechanisms with the aim of reaching explicit goals. Most government policies are made at a national level, although regional

and municipal governments also develop and implement policies to achieve their administrative and political goals. Local or municipal policies, which in many cases take the form of unstated management, financial and administrative mechanisms, can have significant impacts on the progress and impact of projects. In Poland, at a municipal level, positive policies enhanced the activities of the project, since local authorities were required to develop land use plans, energy (supply) plans and environmental programmes. This had a positive impact on the project outcomes and has facilitated progress towards achievement of these outcomes. In addition to the establishment of Renewable Obligations on distribution companies, to assist consumers to cope with significant price increases for heating, the Polish Parliament established a Thermal Modernization Fund to promote energy savings in 1998.

Common to almost all projects (with the exception being Belarus) is the impact of municipal elections on projects since these take place every 3-4 years, and in many economies in Europe and the CIS change every election cycle. The project experience was that during the first year of a new government no decisions were made by the political leaders and administrative systems since they were 'settling in'. Equally during the election year (the fourth year of office in many countries) project managers found that municipal decisions in the biomass energy sector became slow and in most cases non-existent (presumably since biomass is risky from a political standpoint). In Belarus the investment cycle follows the calendar year, with municipalities and government departments having little or no money for investments during the first three months of the year, contracts being signed with contractors in the middle of the year, and difficulty in arranging work in the second half of the year because of 100% allocation of contractors. Thus in the experience of all the projects local policies and administrative procedures have had a real impact on projects, and have resulted in time delays and unexpected costs.

Latvia held municipal elections in March 2001 (two weeks after the GEF project document was signed) that changed the political composition of the Ludza city council and resulted in the election of a new mayor. The contract signed between Ludza municipality and Ludza Bio-Enerģija sparked a political debate in Ludza, based on difficulties for low income groups to pay, technical difficulties (inadequate heat supply in parts of the system) and a disadvantageous purchase agreement which appeared inflexible and gave no incentive for energy efficiency.

Despite efforts by the UNDP and the project management to mediate between the two parties the City of Ludza and Ludza Bio - Enerģija sued each other in the middle of 2002. UNDP and the project management "Vides Projekti" strongly encouraged both parties to drop the charges and proceed to the negotiating table. The parties eventually dropped the charges and summer of 2002 was spent in finding a compromise between Ludza City Council and Ludza Bio-Enerģija in which the UNDP-GEF project played an important part. As a result of the considerable difficulties to establish credible co-operation it was decided that the project would no-longer take Ludza as the main focal activity, and by 2003, 7 additional municipalities were involved in the project.

In Poland budget laws made it difficult for municipalities to make fuel supply contracts, or buy fuel in advance. Since biomass fuel prices change during the year according to availability, it would be most cost effective to buy fuel when the price is low, but at this time the municipal budgets do not have the money required. This was not an issue in Slovenia, where all companies involved in demonstration activities were acting under concessions, and budgeting is consequently

independent of the municipalities. In Slovakia municipal finance rules allows municipalities to buy fuel when it is cheaper (if they have money available). However in the GEF project in Slovakia municipalities pay for heat in planned monthly payments (equal throughout the year) and schedule is adjusted according their conditions (there might be some problems at the beginning of year with payments from municipalities for heat, as they receive regular money from state taxes “with delays”).

The project impact on policy at a local level has been more limited than the local policy impact on the projects. In the project in Slovakia, which focused on small-scale municipal heating, the project has had a positive impact on the attitudes to biomass energy at a municipal level. A similar impact, but at a lower scale was achieved in initial years of the project in Poland. In this project the Project Management Unit played a strongly supportive role throughout the period of project implementation, by establishing and maintaining relationships, generating and maintaining community support, and assisting the municipalities to negotiate with the private sector. However, following policy changes at the national level, which exacerbated mistakes made in the original feasibility studies, the interest from the participating municipalities and the financial feasibility of the proposed biomass systems were compromised, and the planned Public Private Partnership could not be established.

In the biomass energy sector, policies frequently do not exist – at both local and national levels – and where they do they are frequently uncoordinated. In Poland, for example, the policy environment is characterized by:

- A lack of co-ordinated strategies
- Little clarity on who is responsible for what
- Three levels of government, each with sometimes competing agendas
- Three ministries responsible for biomass legislation: agriculture, environment and energy/economy
- Frequently changing national and local governments (during the 4-year project period there were six different Ministers of Environment)³¹

Two of the projects made significant positive impacts on national policies: Slovenia and Belarus. Both these projects were proposed and implemented by the national governments. In Belarus a national policy has been passed stipulating that the domestic fuel consumed in Belarus, mostly biomass, must increase from 15% (2004) to 25% of total primary energy supply by 2012. A study tour aiming at supporting and enhancing the Policy and Regulatory Framework was conducted in

³¹ For historical interest and reference these were Zelichowski, Slezak, Swaton, Belka, Podgajniak, and Szyszko.

April 2006 in Sweden with a high-level and committed participation, and the findings from this tour have been the subject of discussions with the vice Prime Minister in parliament. In Slovenia, the National Energy Plan (NEP) developed and approved in 2004 has important goals for biomass energy systems, and the Project Management Unit worked closely with officials from the Ministry of Economy to draft the biomass component of the plan. When theorizing on the reasons for the success of the Slovenia and Belarus projects to influence policies it possible to conjecture that the two projects initiated and managed from within government ministries had better access to policy makers, and were more demand-driven from the government perspective. However these are not the only similarities between the projects – both were larger projects with GEF budgets over 3 million USD, and therefore more significant from the government’s point of view. Certainly the smaller projects in Poland, Latvia and Slovakia were sometimes viewed as ‘too small to notice’ from the government perspective, especially in the context of EU accession which these countries were undergoing during project implementation. Despite this, in Latvia, the project served “to improve inter-ministerial cooperation and highlighted the importance of horizontal inter-ministerial coordination in energy sector planning as a means of addressing the gaps in the energy sector, especially in rural Latvia. However, the National Energy programme has not been updated since 1997, and representatives of the Ministry of Economics indicated that their involvement in this Project has highlighted the need to update this document and to foster inter-Ministerial coordination in the energy sector” (Terminal Evaluation, 2005).

The Belarus project has also had a positive impact on local policy through the demonstration sites (implementation of the demonstration projects is supported by local municipalities through so called “institutional support”), in country training courses for technical specialists and decision makers from the regions.

The overall impacts of the projects on policies and policies on the projects have been summarized in Table 8.

Table 8: Impacts of policies on projects and projects on policies³²

	Local policy/project impact		National policy/project impact		Proposer
	on project	on policy	on project	on policy	
Belarus	-	+	+++	+++	National govt.
Latvia	-	--	--	++	Private sector
Poland	-	+	---	0	University
Slovakia	++	++	0	0	Local govt.
Slovenia	-	+	-	+++	National govt.

³² + indicates a positive influence on policy / project, and – a negative impact. 0 is used with the impact was minor.

Lessons on ensuring policies are implemented

- ☑ Ensuring sound implementation of policies also requires significant support (it is one thing to have the right policy, another to have mechanisms to realize that policy)
- ☑ The right legislation can help to raise awareness and reduce risks for investors and end-users [*Slovenia*]

In Slovenia, in order to mitigate the fears of municipalities and the public regarding the possibility of long-term price increases for district heating systems financed by private investors (e.g. large oil companies), a set of control and preventive mechanisms were developed, including a tariff order, concession act, and technical and economic criteria for delivery of heat, for inclusion in the by-laws of biomass district heating companies. This legislation has raised awareness in municipalities and significantly reduced risks for investors and consumers.

3.2.2 Financing sustainably

Four of the five projects (with the exception being Slovakia) included barrier removal activities that focused on finance and access to finance. The main mechanisms according to the original project designs are summarized in the table below:

Table 9: Summary of financial mechanisms in the UNDP-GEF biomass projects

Belarus	Latvia	Poland	Slovakia	Slovenia
Bioenergy revolving fund operated by state owned company	Public-private partnership, and small fund creation	Public-private partnership	No funding mechanism ³³	Revolving equity / loan fund, government operated grant scheme, public-private partnership

³³ Although within the project a support mechanism for pilot private houses installed with biomass heating within the project was created – a decision made during project execution and approved by BIOMASA members and Project Steering Committee

Lessons on finding private sector investors

- ☑ It is challenging to find private partners that truly want to reduce investment or operating costs (building contractors, equipment suppliers and suppliers of raw materials have a conflict of interest, and may want to maximize investment costs) *[Slovenia, Latvia, Poland]*
- ☑ When developers have vested interests in the project (raw material suppliers, equipment suppliers, etc.) the design may not be cost effective *[Slovenia]*
- ☑ The price of equipment in feasibility studies is usually overestimated when developed by equipment suppliers *[Slovenia]*
- ☑ It is challenging to find private partners that are willing to invest in projects offering lower IRR (in transition economies there are frequently lots of other places to invest money offering substantial returns on investment) *[Slovenia, Poland]*
- ☑ A significant risk for (bank) investors is the low level of management and business skills (companies do not perform well, and maximize profits, decision-making is poor, this is particularly the case in small companies/projects where a technical expert ends up assuming business responsibilities) *[Slovenia]*

This first set of lessons relate to challenges in finding suitable private sector investors. Firstly, private sector companies that are building contractors, equipment suppliers and suppliers of raw materials may have a conflict of interest in that they want to maximize income from the services of equipment they supply. If an investor benefits from increased investment (eg. equipment) or operating costs (eg. fuel), this is it highly possible that costs are uncompetitive. On the other hand, it is very challenging to find other types of private partners who are willing to invest purely for the sound operation of the investment and profits what will be made through the biomass energy business itself. Biomass energy projects in Slovenia, for example, had a typically internal rate of return of 5 % (mostly caused by the intended construction of district heating networks) and maximum of 11.6 % when grants and soft loans are applied. Most investors in the same market however are looking for a minimum internal rate of return of 15%³⁴. Since there is no major shortage of available investments that are likely to offer these high returns, pure investors are

³⁴ According to the project manager biomass CHP units, without the network, have more “normal” internal rates of return.

difficult to find. These figures from the investor’s perspective assume no financial benefit for the consumer (ie. heat prices for final consumers do not change depending on the fuel).

In Slovenia because of the equity fund which was created, the Fund Manager and Project Manager had the opportunity to get involved in the management of biomass energy businesses. It was very evident that most of the investors in the projects come from a technical background and there is a severe lack of sound business skills. This is a real threat to the sustainability of the investments, and is a cause for concern. Based on this experience, training in quality business practices would be an important element of future demonstration projects. The project translated and promoted quality management approaches to address this gap to some degree.

Lessons on managing financing risks

- ☑ Significant effort and time is required to secure financing for initial biomass projects, and resource and time are required to address these *[Slovakia, Slovenia]*
- ☑ Construction risks can effectively be transferred to technology suppliers based in neighbouring more developed markets *[Slovakia]*
- ☑ The banking sector is best placed to address financial barriers *[Slovenia]* (the government as implementing and executing agency is not sufficiently flexible and responsive to provide financial mechanisms effectively).

The GEF biomass energy project in Slovakia required significant efforts in the securing of co-funding for the investments. The final financing mix in this project was as shown in the table below:

Table 10: Realized financing for the GEF biomass energy project in Slovakia

Source	€
Global Environmental fund (GEF) – grant	854 780
DEXIA banka Slovensko a. s. – loan	2 926 830
Ministry of Environment of SR – subsidy	990 780
European Commission –LIFE III Program – grant	1 011 900
Austrian Environmental fund (through KKA)	604 650
BIOMASA Ass. members – own sources	880 480
Total	7 269 420

Exch. rate, mid 2003: 1 USD = 36 SKK, 1 EUR = 41 SKK

The loan from Dexia was particularly challenging for the project management as well as for Dexia. Dexia is a world leader in public sector financing, and has a good track record in supporting renewable projects and providing financing for municipalities. The bank supported the GEF project because of the demand-side measures included, and not primarily because of the use of renewable energy. Dexia provided 46% of the financing for the demonstration project. Project complexities included:

- Many members in the association (25), each requiring due diligence and guarantees
- Complex financing mix (many donors)
- Low contribution of the association itself (2%)
- 3 year period of planning and realization (in 40 locations)
- Rapid changes in exchange rates from the US dollar in which the GEF contribution was denominated and also that denominated in Euro, resulting in a need to increase the size of the loan
- Donors giving money only after the investment has taken place, requiring bridge financing (temporary loan)
- Separate procedures to be followed for each donor
- Co-existence and intersection of commercial and non-commercial aspects in the project
- An atypical project – considerable number of different public procurements
- Implementation in the time of structural changes in the society and market – public administration reform and decentralisation, EU accession, opening of markets, etc.

Lessons on financing effectiveness

- ☑ **Equity financing mechanisms can effectively address finance barriers (such as municipal limits on debt allocated to other priorities) *[Slovenia]***
- ☑ **Effective provision of equity financing relies on flexibility for the fund manager and the investor. Where fund conditions such as the period for the sale of equity is defined in project documents, the fund manager cannot maximise returns *[Slovenia]***
- ☑ **Perverse incentives can result from poorly structured equity instruments *[Slovenia]***
- ☑ **Promotion / awareness is highly important for the success of an innovative financial instrument *[Slovenia]***

The Slovenian project included an innovative biomass energy fund, which conceptually aimed to provide flexibility to financing projects through equity, debt, and/or guarantee instruments. Since government grants and EcoFund loans were potentially available to project investors, the favoured

instrument was for the equity instrument at a 25% share of the investment cost. For municipalities this was particularly attractive since it would allow funds to be raised without increasing the debt exposure of the municipality. A project financing approach of 25% equity using USD 2.5 million GEF funds, 25% owner equity, 25% grant (USD 2.5 million from the government of Slovenia) and 25% EcoFund loan (representing an additional US\$ 2.5 million) was proposed. Eight new biomass district heating projects were financed by a Biomass Energy Fund during the period June 2003 (public call for investments) and December 2006 (all funds contracted). The Fund to be operated by the EcoFund would aim to recover its funds at a rotation speed of 3 to 5 years and reinvest the revolved and additional funds in new wood biomass energy projects. Public sale of the equity share of the Fund would take place 3 to 5 years after the project investment, with a minimum repayment level of 50% of the original value of the Fund equity share.

A number of challenges were posed by the fund structure:

- Under these conditions, the fund equity share could potentially be the majority owner in the project, so potential project owners took steps to increase the capitalization of the district heating company to avoid this situation. This had added costs as the implementation of the initial projects was delayed.
- The obligatory public sale of the fund equity within a 3 to 5 year timeframe was found to be too constrained from the perspectives of both the Fund Manager and the project investors, since it was insufficiently flexible for the Fund Manager to be able to maximize the returns from the investment, and provided insufficient time for the project investors to be sure that capital gains on the project will allow them to effectively bid for the equity at a public offering. This was especially troubling to the private investors, who were taking the risk to make a project successful, but could see others gain significant benefits by acquiring the Fund equity when the investors were short of liquid assets to purchase the share.
- The fund conditions for the sale of the equity share between year 3 and 5 with a minimum 50% recovery of the fund equity was found to be prone to moral hazard for the project sponsors since there was a clear risk that projects would be deliberately mismanaged during years 3 to 5 to ensure that the shares could be bought back at minimum cost, and without competition.
- Two guarantees were required (to both the EcoFund and the government for purchase of the Fund equity under the Option agreement). This is an added cost to project owners even though they have no guaranteed right to purchase the Fund equity due to national legislation for state property.

Early on in the operation of the fund it became clear that it could not operate sustainably at its intended level of capitalization, with a gap of 3 to 5 years in its ability to promote and invest in biomass district heating projects (this gap was overcome by the Government with additional funds

allocated in the budget for the year 2007). In addition, when the project owner was a municipal utility with other assets, the Fund was found to buy into ownership and possible liability issues related to these other operations. Even when this was not a risk, the participation of the Fund Managers in the operation of the business units in which the Fund owns a share was found to be extremely challenging.

The efforts needed to resolve the issues related to the Fund structure required inputs from many different government ministries, and a significant amount of time and effort from the staff of the Project Management Unit.

3.3 Lessons from market transformation

Market transformation refers to a significant shift in the distribution of products in a market, in which a new product substantially displaces an old one. In effect, the long-term objective of the UNDP-GEF projects was to make biomass energy a substantial and sustainable norm in a market place, thus to facilitate the market transformation process.

The IEA describes the process of developing effective market transformation policies as follows: “first to develop an understanding of the buyer-relevant characteristics (both positive and negative) of the technologies being promoted and the workings of the markets that will potentially be transformed; and then to identify strategies that would help to boost the positive attributes (including high energy efficiency) and overcome the negative ones (e.g., high purchase costs, a lack of a proven track record, etc.).”

In earlier sections (2.4.2 to 2.4.5) we discussed the questions of whether biomass energy is viable, under what conditions, and what scale of activity is required for market transformation. This discussion, while not being able to provide definitive answers either from the literature review or the 5 UNDP-GEF projects analysed, suggests that market transformation is a long-term goal, and that learning rates in the fuel supply and field deployment areas are in many cases slower than technology learning. In many European Union countries this transformation process has continued for decades, and direct support to industry and other stakeholders continues. In this section we discuss lessons from the market transformation activities, all within the above context – ie. sustained support may be required, and an important contribution of any GEF biomass project is in creating the policy frameworks and willingness for governments to initiate other support mechanisms over a term longer than that of the GEF project itself.

A market is a social arrangement that allows buyers and sellers to discover information and carry out a voluntary exchange of goods or services. A simple ‘market model’ is shown in the figure below

with the main market stakeholders shown in bold, together with common barriers to renewable energy markets shown in octagons, and typical project activities to overcome the barriers around the borders.

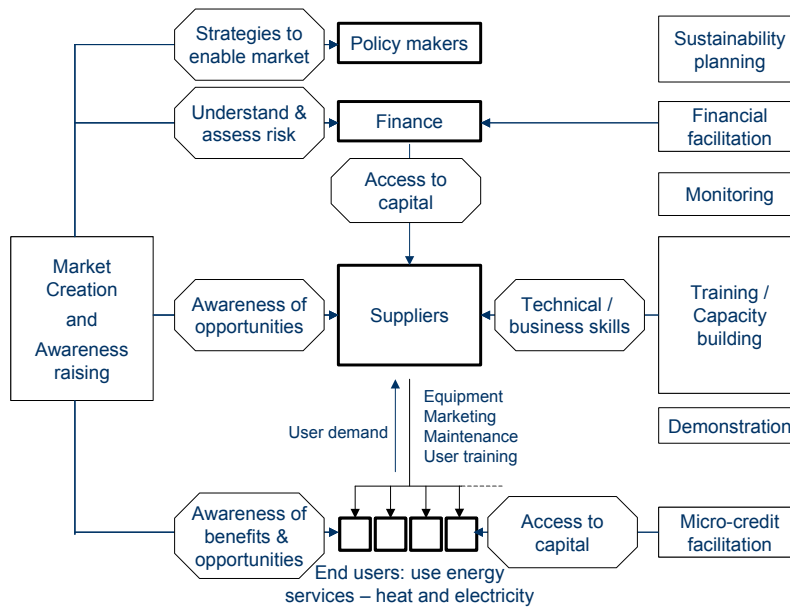


Figure 12: Simplified market model with typical project activities

Table 11: The roles and key market actors in a typical market

Typical Role	Market Actor
Buyers & sellers	Distributors, wholesalers, retailers, purchasers, contractors service companies, utilities, energy distributors
Development	Planners, architects
Development – manufacturing	Manufacturing companies, parts suppliers
Financing	Funding brokers & other financial institutions
Information dissemination	Energy agencies, mass media companies & agencies, individual investors
Policy & funding	Government agencies, other public institutions
Policy – formulation & decisions	Politicians, regulatory agencies & other public authorities
Research & development	Universities, research institutes, corporate research labs
Seller	Equipment installers, energy distributors
Special tasks (e.g. policy analysis)	Consultants
Technology user	Homeowners, consumers, customers, end-users

Lessons on community awareness and acceptance

- ☑ It is essential to get large demonstration projects right first time since markets can easily be constrained by perceived failures *[Latvia]*
- ☑ Scepticism about biomass energy as a clean and modern energy source must be persistently addressed in early markets *[Slovakia]*
- ☑ Local awareness raising in the locations where demonstration projects will take place are essential to maintaining community buy-in, and technology acceptance *[Slovakia, Latvia, Slovenia]*
- ☑ Targeted awareness raising should start from the outset, before demonstration projects are commissioned *[Latvia]*

The Latvia project was hampered by a risky project design characterized by the dependence of all outputs and activities upon a single condition external to the Project – the demonstration project. It should be noted however, that while it is easy to theorize about the ideal Project design after the fact, there are inherent difficulties associated with designing a Project that requires significant levels of confirmed co-financing, operates independently of external forcing mechanisms, and is sufficiently flexible outside of a controlled laboratory setting. In the Latvia project case, available co-financing from the Netherlands depended on the construction of the heating system in the municipality of Ludza. GEF has become increasingly open to commercial partnerships, although co-funding secured from the private sector on a competitive basis during Project execution is no longer counted as ‘real co-financing’ by the GEF (now called leveraged financing). This type of issue is likely to become more prevalent over time, and may require a fundamental solution from within the GEF framework rather than being addressed on an *ad-hoc* basis.

In Slovenia, the project management encountered a problem with the public perception of biomass district heating projects, mainly caused by two earlier EU-funded projects. The companies that were involved in these projects provided poorly optimized designs with oversized capacity leading to high investments, a low number of connections leading to poor revenues, and bad location selection leading to environmental complaints. Therefore, the project has supported a lot of design optimisation, and a proper and targeted approach to public relations activities. Also, the project has developed a strong cooperation with NGOs as a necessary means to reach a national consensus that biomass district heating is a clean and feasible technology.

In Latvia, tensions between the private investors and public-private partnership (PPP) operator of the demonstration project and the local Municipality were a major challenge for the project team.

The project team actively encouraged a soft assistance element early in the implementation phase and this was instrumental in allowing the project (eventually) to have positive impacts and ‘move on’ to other targeted activities. Soft assistance included the involvement of UNDP, the Steering Committee, and the Ministry of Environment representatives in dialogues with the local municipality to address technical, institutional, and political issues. Soft assistance also included multidisciplinary discussions sponsored by UNDP and the Ministry, lobbying for sustainable energy use during seminars, and other awareness oriented activities. This influenced project development positively and provided the basis for improving the project strategy. Soft assistance helped facilitate Project sustainability in all elements of the revised Project strategy and has provided a solid communication base for further activities.

In the Latvia project, a public relations specialist hired early in the project schedule may have been able to mediate some if not most problems encountered during the project by launching a public awareness campaign prior to the formalizing of relations between the municipality of Ludza and the private investor ‘Ludza Bio-Energija’. Each Project activity could have been strategically supported by PR activities. The Project did, however manage to support a limited amount of environmental awareness through its activities prior to the retention of a public relations specialist.

Lesson on building technical skills

- ☑ **The more focused & targeted training and skills–building activities, the more relevant** *[Slovenia, Latvia, Belarus]*

The lack of local capacity (available experts with sufficient experience) constrained successful project execution in a number of projects including Latvia and Slovenia. In the Latvia project, in retrospect, more project elements and activities that directly addressed capacity constraints over the long-term may eventually have reaped greater beneficial impacts for subsequent projects. In Slovenia, the project team successfully partnered with other (EU) programmes addressing capacity building, and appears to have addressed this issue successfully. In Latvia these adjustments came too late (mostly because the demonstration project was almost fully commissioned before the GEF component started, a result of GEF decision-making delays). This was also a manifestation of a somewhat unclear long-term project vision and intervention strategy.

In Belarus a number of highly successful study tours have been held during the project, including:

- April 2006 - delegation of Belarusian specialists took part in a study tour to Sweden on the topic "The Use of Biomass for Energy in Sweden – Critical Factors and Lessons Learned"

- October 2005 - the delegation of Belarusian specialists in power engineering, energy efficiency, and forest industrial production took part in a study tour to Finland
- April 2005 - delegation of Belarusian high-level decision makers and technical specialists took part in a study tour to Austria and the Czech Republic on “modern equipment and technologies of wood fuel combustion”
- October 2004 - delegation of Belarusian technical specialists and directors composed of 11 persons took part in a training trip to Austria to study its experience in use of biomass (waste wood) in the provision of heat and electricity production.

These events have been highly influential in the development of awareness of best practice in biomass energy and development of policy frameworks.

3.4 Creating sound project designs

The essential starting point for a successful project is a sound project design. A sound project design fits together logically (identifying the links to UNDP overall outcomes, as well as relationships/links between objectives, outputs and activities), identifies risks including the limitations of relevant institutional capacities, applies sound implementation strategies, and includes objectively measurable performance indicators. The contribution of these parameters towards successful project execution cannot be underestimated.

In this section lessons for project design and development based on the implementation experiences from the five biomass projects are discussed.

Lessons on monitoring and evaluation

- ☑ **Sufficient resources should be allocated to monitoring and analysing project impacts (baseline, impact, GHG emission reductions) *[All projects]***
- ☑ **Baseline monitoring is essential for the determination of impacts *[All projects]***

The monitoring and measurement of project impacts, technical and financial data, greenhouse gas emissions, and other relevant baseline and impact data should be systematically collected by a good monitoring system. In most of the projects however, the determination of impacts is derived from secondary data or calculated using proxies after the end of the project. One of the significant gaps in all the project designs is the lack of allocation of project funds for the determination of baselines and project impacts and execution of reliable monitoring and evaluation systems.

Lesson on timing of project activities

- ☑ **Lesson: The start-up phase of a project takes longer than anticipated [All projects]**

Without exception, the start-up phases of all projects took significantly longer than estimated at the time of project development. These typical start-up activities include:

- Finding and hiring the project manager and staff
- Arrangements for the project management unit – institution and project office (Poland)
- Establishment of sufficient financial sources and contract with all donors (Slovakia)
- Harmonisation of timing, rules, procedures and conditions with all cofinancers (Slovakia)
- Re-establishing confirmed partnerships, re-discuss, re-define, reaffirm goals and strategies to reach them, etc (Latvia)
- Establishing financial management rules and procedures
- Tendering procedures for project experts (Belarus – valid since 2006, Slovenia, Slovakia)
- Tendering procedures (international competitive bidding) for selection of contractors and equipment suppliers for demonstration sites (Belarus, Slovakia)
- Establishing revolving fund management and financing mechanisms (Belarus) (although not highly significant since the fund establishment was planned for the third project year in the original project design)
- Commencement of operation of a funding mechanism (in Slovenia the financing instrument only commenced 1 year after the project start³⁵)
- Feasibility studies and final technical analyses for all sites (Slovakia)

³⁵ The project officially started in March 2002 (when the project document was signed), the Project Implementation Team was hired in October 2002, and the public call for investments (equity funding) was announced in June 2003. The first project was signed in June 2004.

Lesson on project management, implementation frameworks and management flexibility

- ☑ **Project teams should be creative and flexible, and the UNDP should make efforts to ensure that conceptual ideas given in the project brief / document are truly relevant at the time of implementation *[Slovenia, Latvia]***
- ☑ **Complex ownership and multiple financing sources significantly increase transaction costs and are difficult to replicate *[Slovakia]***
- ☑ **Good financial managers and legal advisers are costly for project teams *[Slovakia, Slovenia]***
- ☑ **Careful attention should be given to institutional roles (governments=policy, finance=banks, market & supply chains=private) *[Slovenia]***
- ☑ **Project teams based in governments struggle to be flexible and as responsible as needed to work effectively with the private sector *[Slovenia]***

Market conditions change rapidly, and projects should thus be implemented so as to ensure that the project is able to adapt to these changing conditions. In Latvia the original project design did not anticipate rapid sector development and the impact of these market changes on sustainability. Project flexibility to adapt to these changes was paramount in providing successful results. The challenge for project managers, the UNDP and Steering Committees is to ensure that the overall, market creation / transformation objectives of the project are delivered while remaining flexible enough to changing conditions. In Slovenia the Steering Committee proposed not to include CHP in project portfolio, and in the opinion of the Project Manager this resulted in a lost opportunity because, when it was agreed to fund CHP projects it was too late to change anything (given the complexity of having two state aid schemes – equity from GEF and favourable feed-in tariffs). The project financing approach (the equity-oriented Biomass Energy Fund) favours large-scale biomass district heating projects. Unfortunately, the wood industry in Slovenia is not able to invest in biomass district heating due to problems related to its core business and for strategic investors the profitability of projects was too low. Thus, the Project Implementation Unit had to develop additional activities to develop small scale biomass district heating projects and support the involvement of small entrepreneurs and biomass resource owners (farmers) as key project development players. In the design of the equity fund, the project team appeared to be constrained by the fund conditions as described in the project document.

Lessons on working with stakeholders

- ☑ **Elections can significantly change interest and project ‘ownership’ in government *[Slovakia, Latvia]***
- ☑ **When officials change, significant efforts are required to re–build understanding and awareness *[Latvia]***
- ☑ **Non–formal, non–institutional co–operation provides the basis for effective work. Project teams should thus work hard to establish these relationships, and/or well–connected team members should be hired *[All projects]***

It can be difficult to isolate project activities from political influences and manipulations, as is evidenced in the Latvia project. The project team developed a Memorandum of Understanding within the Project structure which helped to buffer external forces, facilitated regular follow-up with relevant agencies and stakeholders, and structured clear and concise statement regarding Project activities and outcomes.

To improve the situation with the participating municipality in Latvia a two-step approach was used:

- 1) Convincing the parties to negotiate. This was accomplished through the use of a) regular meetings and discussions organized for the municipality and the private investor with the participation of the Steering Committee, UNDP and Ministry of Environment representatives, b) drafting agreements on co-operation that were agreeable to the 3 parties, and c) the application of international expertise to resolve potential problems.
- 2) Changing the Project strategy to avoid political risks. The Project was expanded to include an additional five municipalities and a competitive mechanism was put in place to facilitate further expansion, which eventually attracted a total of 15 partnering municipalities.

In Latvia, project replication activities facilitated the development of an effective capacity building network among stakeholders to learn and share experiences regarding district heating. Networking is an important mechanism that can facilitate sustainable activities that aim to change social behaviour patterns, and in the Latvia case proved to be essential for project impact. A key to project success was the wide variety of stakeholders involved in the project. The project steering committee included a diverse membership that facilitated an effective multi-disciplinary dialogue. Unlike many projects, the steering committee in Latvia had a profound influence on the project’s implementation and ultimate success (although it should be noted that significant project delays occurred when the committee repeatedly gave the conflicting parties ‘one more chance’ to resolve the situation). While UNDP should encourage steering committees to make difficult decisions in a timely manner, delays (except in exceptional circumstances) should not be used as an excuse to cut

back on participatory approaches. In the long run, UNDP perseverance appears to have paid dividends. The use of a local consultant to develop/redesign project strategies in a participatory manner that included frequent group and individual interaction with steering committee members appears to be an approach that could be replicated in other projects/countries.

In Poland, it was evident that the open approach of the project management was critical to project progress. Keeping dialogue open, listening to those involved, and being prepared to adjust and adapt approaches as necessary, as was demonstrated by the Project Management served to overcome difficulties and build teamwork and commitment. Misunderstandings and distrust can easily develop in projects involving many stakeholders. Ongoing and persistent communication is the only way to overcome these obstacles.

In most of the projects the Project Managers emphasized the importance of personal contacts and informal, non-institutional co-operation to 'get things done'. In one country it took the Project Manger 6 months to find out the name of the responsible person within the Ministry of Education to participate in a market assessment activity. It was emphasised repeatedly that "non-institutional co-operation provides the basis for work". Project teams should thus work hard to establish these relationships, and/or already well-connected team members should be hired.

Lessons on the design of demonstration projects

- Having many smaller demonstration projects reduces the risk of some projects not being successful [Latvia, Slovakia, Slovenia]**
- Real demonstration projects which are pre-selected during PDF-A or B activities struggle to 'get the timing right', with private sector investors unable to accept GEF decision delays [Slovakia, Latvia]**

A project design in which almost all outputs and activities depend on one condition being met which itself lies outside the control of the project, is inherently weak – as was the case in the original project design for Latvia. While it is fairly easy to theorise about the ideal design of a project, it is difficult to design a project that requires significant levels of confirmed co-financing, which does not depend on external assumptions and is sufficiently flexible. This was certainly the case for Ludza demonstration project in Latvia where the co-financing from the Netherlands depended on the construction of the plant in Ludza. However in Latvia, as a result of significant difficulties with the demonstration project, a financial scheme was designed to support the switch to wood biomass heating and initiated by the end of 2003. Eight municipalities in cooperation with Latvian Environment Investment Fund implemented wood biomass heating projects, with total

planned investments in 2004 of more than 1.12 million USD. The UNDP GEF contributed 15% of the total. This success (which was not part of the original design), shows the benefits of cost effective use of GEF funds when competitive mechanisms are put in place during project implementation.

A similar change was made to the project in Poland, where the originally proposed public-private partnership collapsed after more than 3 years of work. Following this, a wider number of locations for demonstration projects were identified, and the project could effectively move forward.

Having a larger number of (smaller) demonstration projects without doubt reduces project risk.

Both the Latvian and Slovakian projects struggled with co-financing difficulties resulting from mismatches of timing. In the Latvian project the private sector partner, with Dutch co-funding proceeded to make the investment, and the plant was commissioned even before the final signing of the GEF project document. In Slovakia, as a result of significant delays with the GEF approval processes political changes in Denmark meant that the expected co-funding could not be realized by the time the project started.

Lessons on securing co-funding

- The timing of co-funding in demonstration projects is a critical project risk**
[Slovakia, Latvia]
- Private co-financing in GEF projects offered as a means to secure GEF funds is usually identified without competition, and thus can create a conflict of interest**
[All projects]
- When demonstration projects and/or investors are not selected competitively they are unlikely to be cost effective**
[Latvia, Slovenia, Poland]

The timing of the GEF Intervention was a critical component of the difficulties of the demonstration project in Latvia. Initially, there was a significant time delay between the co-financing investment and approval for funding from GEF. As a result, key negotiations over service and institutional structures between the Ludza municipality and Ludza Bio-Enerģija (co-financed by the Dutch Government) were conducted in isolation from the UNDP-GEF project team. The municipality lacked experience in the energy sector and the resulting pilot investment has faced criticism due to local perceptions of poor quality of service and high tariffs. The Project team resolved the crisis by serving as a “neutral broker”, developing an agreement between Ludza

municipality, Ludza Bio-Enerģija, and UNDP to stabilize relations between parties and secure a base for sound Project implementation

Returning to lessons addressing the avoidance of moral hazard as described in section “3.2.2 Financing sustainably”, in general a project design that is flexible and incorporates a competitive phase or similar selection of alternatives (as was included in the revised project document in the Latvia project following on from the difficulties experienced in the original demonstration project) can reduce project risks significantly. In both Poland and Slovenia it was found that the pipeline of projects developed during the PDF project, did not reflect realities on the ground.

Lessons from (pre-)feasibility studies during project design

- ☑ **Feasibility studies made with PDF funding, are generally superficial and ‘pre-feasibility’ in nature. On GEF project approval, most investments are significantly redesigned. While they are useful to inform stakeholders to take the next steps, they are not investment-grade studies. Any serious investor will redo feasibility studies themselves in any case [Poland]**
- ☑ **When investors are not seriously considering investing, feasibility studies are unreliable (realistic feasibility studies rely on the intention to invest, or there are many consultants making feasibility studies that are feasible ‘on paper’) [Slovenia]**
- ☑ **The financial health of the organisations with the heat loads is an important consideration in the design of the investment [Slovenia]**
- ☑ **External factors can significantly alter feasibility in small markets [Slovakia]**
- ☑ **The price of inputs in feasibility studies is usually underestimated. The medium-term prices of inputs will tend to those in the EU, but in some cases may exceed them [Slovakia, Slovenia]**
- ☑ **Raw material and heat prices are not the only factors likely to change with time. Other factors to consider include fossil fuel prices, demand, labour costs [Slovakia]**

In the case of Poland, the feasibility study carried out under the PDF-A funding (this funding was little more than 25 000 USD and clearly inadequate for an investment study) was little more than a concept. A competitive phase during project execution – with the project focused on support to the creation of market-based financing instruments would help to alleviate this pressure. This however is somewhat contrary to GEF expectations since (the private sector) co-financing under such circumstances (where feasibility studies are yet to be undertaken) will be nothing more than an

intention. While this approach does perhaps shift a little more risk in the direction of the GEF (since co-financing may not be forthcoming), it would be more compatible with market stimulation approaches, and more realistic in terms of what can be done within the scope of limited PDF support.

Even when good numbers are used as inputs in feasibility studies there are significant unknowns in new markets, and benchmarks do not exist for costs, uptake, fuel supply and heat demand. Most of the projects found that feasibility studies did not bear very high degrees of correlation with reality. In small markets such as the biomass fuel markets present in all the project countries availability and prices of inputs are highly volatile. In Poland the prices of biomass residues increased substantially as a result of Polish legislation to co-fire biomass in coal-fired power stations. Sawdust prices were also affected in Slovakia by strong competition with fibreboard production and demand by foreign producers of pellets. In Slovakia labour prices in the project region increased substantially during the project as a result of the establishment of a KIA factory in the neighbourhood.

Lessons on exchange rate risks

- Changes in exchange rate can have significant impacts on project resources and potential *[Slovakia, Slovenia]***
- Project funds should be denominated in the currency where costs will be incurred *[Slovakia, Slovenia]***

All five projects suffered as a result of exchange rate losses (up to 30% over the project period). This was most acutely felt in the Slovakia project in which one large integrated investment formed the foundations of the project with little flexibility to change the overall investment scale as a result of reduced availability of GEF funds.

Lessons on ensuring project sustainability

- The right institutional arrangements are a key to ensuring that project activities will continue after the end of the project *[All projects]***
- Institutional arrangements where stakeholders benefit from project activities they are responsible for delivering are critical to successful implementation models *[Poland]***

The executing agency needs to see a clear benefit to themselves for taking on the responsibility of the position. Project designs in which they have direct (paid) activities to implement (as subcontractor), and which clearly help them fulfill their mission would overcome this barrier. Furthermore it is essential that supportive and interested support comes from the Ministry playing the role of executing agency.

4 Conclusions and Recommendations

Lessons from the 5 UNDP-GEF biomass projects have been collected through interviews and discussions with project managers, and key project stakeholders, and UNDP staff. Using a market creation framework consisting of technology demonstration and market learning, market barriers emphasizing policy and financial barrier removal, and market transformation emphasizing how their attitudes guide decisions and how these attitudes can be influenced, lessons learnt from the five projects have been presented. In addition lessons learnt from the projects at the level of formulation and design have also been presented.

4.1 Project level lessons

The overriding messages coming from the lessons learnt analysis include:

- *Need for flexibility:* it is clear that a project design in which learning and adaptive management is rooted in the foundations of the intervention logic and can take place throughout the project is more effective than one in which conditions are fixed and the project cannot easily adapt. Thus the projects in which single demonstration activities were planned struggled to adapt to changing market conditions and practical requirements compared to those in which flexibility was easier. This was the case in both the Latvian and Polish projects, where the project management had the challenge to deliver complex single demonstration projects, and only managed to adjust their approaches after the mid-term of the projects. A learning approach is to be preferred, with demonstration activities taking place in phases. Projects in which demonstration projects are implemented simultaneously have less chance of benefiting from technology learning.
- *Competition:* In new emerging markets where benchmarks do not exist, and project risks are high, value for money cannot be easily judged. Where competition does not form the foundations of the project intervention logic, the accuracy and reliability of inputs is questionable. Feasibility studies in which investors hope to receive grant funds do not reflect project realities. When a serious investor considers whether to risk his or her own money in a venture, and where prices are open to market forces, the figures in feasibility studies are more reliable.

- *Understanding of incentives:* When developing project proposals the finding of co-funding presents a significant challenge. It is a significant challenge to find private partners that truly want to reduce investment or operating costs in a project, and maximise operation efficiency and cost effectiveness. In co-funding, building contractors, equipment suppliers and suppliers of raw materials frequently are exposed to moral hazard since they may want to maximize investment and operating costs, not investment profitability. Project developers should be particularly vigilant to identify and analyse interests and incentives of all project stakeholders to assess whether their goal coincide.

4.2 Lessons in market transformation

Looking at the bigger picture, the analysis of market transformation and lessons emerging in the biomass sector have highlighted the need to address biomass supply as an absolute prerequisite to most biomass energy projects. This fuel supply is potentially an area for significant learning and cost reduction in which UNDP-GEF could make a significant impact³⁶. Despite this the fuel supply issue remains volatile and certainly represents a project risk³⁷.

While boilers are fairly ubiquitous (many of the countries had local production of boilers before the GEF projects, many being joint ventures with EU partners), and there consequently isn't significant scope for cost reductions as a result of market learning, the other significant area of learning in the UNDP GEF projects has been in the area of technical experience. Most of the systems in the projects were initially over-dimensioned and designs underwent numerous iterations to get dimensioning right – as has been described in section 3.1.1 *Technology learning* – and there appears to be further scope for learning in this area.

In addition to the cost issues and the potential role of GEF projects to influence learning in fuel supply and technical expertise, the policy, information, awareness and financing aspects of the projects have effectively helped to support the market transformation process.

³⁶ For example the high rate of learning on supply of wood fuel from forests in Finland where over a 5 years the price of this fuel dropped by 60%, in part attributed to technology transfer from Sweden. This has been discussed in section 2.4.5 *Creating Markets - key lessons from countries where biomass energy use is growing*. A similar opportunity (although not necessarily in the 'wood from forests' sector exists throughout the region.

³⁷ Since – at the scale at which the GEF projects are working – the supply markets can potentially be upset 'overnight' when neighbouring country policies change or alternative demands for biomass develop.

Annex 1: Summary of 5 UNDP–GEF biomass energy projects

“Biomass Energy for Heating and Hot Water Supply in Belarus”

Project objectives:

Objective 1: Strengthen institutional capacity to support biomass energy projects

Objective 2: Establish a track record for investments in sustainable biomass energy projects, including both fuel supply and demand.

Objective 3: Develop straightforward financial “starter” mechanisms in a challenging investment climate that will allow continued financing for biomass energy projects.

Objective 4: Overcome negative perceptions of biomass energy and provide public and private investors with much-needed market information.

Project description

Project duration is 4 years (September 2003 – September 2007)

The following components (activities) will be implemented:

- demonstration component, which includes 6 separate demonstration projects: 5 small and medium size boiler houses and CHP located in different regions of Belarus, and one wood waste supplier. The boiler houses and CHP will demonstrate modern clean technologies of wood waste combustion. Wood waste supplier will be also a sample of efficient collection, processing and transportation of wood fuel.
- a revolving fund for biomass energy related projects. GEF contribution to the project amounted USD 1,54 will be paid back by all demonstration sites and accumulated in the revolving fund which is considered as a start financial mechanism for future biomass energy projects. Same contribution to the fund is expected on behalf of the Committee on Energy Efficiency.
- Geographic Information System (GIS) as a decision making tool will be developed. GIS includes geographical data on existing boilers, heating needs, wood-waste resources, wood enterprises, existing government wood supply organisation, and transport systems (rail, road, water). This will allow for the development of integrated and co-ordinated approaches for the planning of replication, and providing tools for financial decision-making.

Many other additional activities directed to improvement of awareness will be conducted too (study tours, best practice guidebooks, training and awareness campaigns, National biomass energy plan etc.).

Project financing

Source	USD
Global Environmental facility (GEF) – grant	3 374 000 incl. 1 540 000 for Revolving Fund
Committee for Energy Efficiency - grant	2 192 000
Demonstration sites own resources (cash and in kind)	3 370 000
Total	8 936 000

Project

results

Direct fossil fuel savings as a result of this program represent approximately 1.08 million tons of CO₂ reduction over a 15-year period. Estimates of the potential impact on wood-fuel use resulting from this project total an additional annual amount of 895,000 tons of CO₂ by 2015.

Summary of what was actually achieved

Demonstration component.

- One demonstration site (biomass consumer) was implemented in 2004 (Volat-1 private company) – about 5 thousand tons of CO₂ were reduced.
- One demonstration site (biomass supplier) was implemented in 2006 (Vileika Forestry Institution).
- Two big size demonstration sites (2 CHP 15 MW_{th} and 2,5 MW_{el} each) are almost finished and will be put in operation by the end of March 2007.

Revolving fund component

The RF was established within Republic Unitary Enterprise “Belinvestenergosberezhenie”. Its capitalisation by the end of 2006 is US \$ 2,38 million, US \$ 1,54 million of which is GEF contribution, and \$ 0,84 million is Government contribution. 5 loan agreements were signed.

Geographic Information system component

The GIS is 90% completed. The GIS is based on standard Mapinfo software and include various information layers – data bases, including boiler houses; forest resources with 10years plan of forest harvesting activities and additional software to count forest residues; roads, railways, rivers; wood processing enterprises (wood processed, wood waste used, wood waste available), geographic data, other useful information.

Institutional component

Wide international training program abroad was finished during which 4 study tours to Austria, Finland, Czech republic and Sweden were conducted. 10-11 decision makers and technical specialists took part in each event. Each study tour was widely discussed and advertised. Study tours reports were submitted to the Government, discussed in mass media and placed at project web site. The findings of the last study tour were discussed in the Government jointly with Vice-Prime Minister.

Funds used by the end of 2006

Source	USD
Global Environmental facility (GEF) – grant	2 845 000 incl. 1 540 000 for Revolving Fund
Committee for Energy Efficiency - grant	4 165 000
Demonstration sites own resources (cash and in kind)	5 239 000
Total	12 249 000

“Economic and cost-effective use of wood waste for municipal heating systems in Latvia”

Project Objectives

- Promote the use of wood waste by removing/reducing barriers that currently hamper the substitution of imported heavy fuel oil (mazut) with locally sustainably produced wood waste for municipality heating systems.
- Promote the development and implementation of an economic and commercially run municipal heating system that includes generation, transmission and distribution in the municipality of Ludza.
- Assist in removing/reducing technical, legislative, institutional/organizational, economic, information and financial barriers related to the replication of a pilot project in the municipality of Ludza.

Project Description

Project duration was 3 years (March 2001 – March 2004)

The following activities will be implemented:

- Installation of heat meters as well as design of metering and billing system. Moreover, a municipal energy department will be created, that of Ludza.
- Campaign for the promotion and awareness of how end-users can deal with the improved heat and hot water supply system.
- Alteration of the legislation and policy framework for the promotion of wood waste use for municipal heating systems as well as enhancing local project development and implementation capacity.
- Monitoring and evaluation of the pilot project and of the UNDP/GEF intervention will be carried out during and after the project.
- GEF will also contribute to the project by providing a supportive fund amounted USD 750,000. The project was also subsidised by various other institutions and organizations with approximately 2.6 million USD in cash as well as with 500,000.
- The project will be a pipeline for 4-6 investment similar projects as well as a financial infrastructure for financing future projects will be created.

Project Financing (as structured)

Source	USD
Global Environmental facility (GEF) – grant	750,000
PDF A	0
Co-financing: (cash)	2,680,000

Co-financing: (in-kind)	50,000
TOTAL:	3,480,000

Project results

The installation of 675 heat meters as well as the operation and design of the metering and billing system were created as a result of this project. Furthermore, the Ludza Energy Department has been set up and is operated. The consumers are finally aware of and can deal with the improved heat and hot water supply system and a number of local project developers became interested in these new supply systems. Additionally, 4-6 investment plans have been created and the CO₂ emissions are reduced as well as lessons learned and feedback for the UNDP/GEF have been occurred. Finally improved availability and accessibility of investment capital demonstrated in the form of financing deals closed for projects.

“Integrated Approach to Wood Waste Combustion for Heat Production in Poland”

POL/01/G35/A/1G/99

Objectives:

- to create an inter-municipal and public-private partnership company to manage biomass energy resources at the local level in an integrated way, which can be replicated in other areas.
- to increase the use of wood waste produced locally for fuel for space heating in order to reduce coal use and greenhouse gas emissions.
- These objectives will be achieved by local and nationwide investment, promotional and educational activities.
- Pilot Project - Local activities

Project description

The project duration, as designed, was 3 years (June 2002 to June 2005).

In the first phase the project activities focus on Pilot Project in southern Poland, city of Jordanów and municipality of Bystra - Sidzina.

The aim of the Project is to develop the market for wood waste, by creation of proper organizational structure combined with investments. The wood waste will be purchased by the Inter-Municipal Public Private Partnership Company from the local wood-processing plants and workshops and used for district heating³⁸. The shareholders of the company will be the city of Jordanów, the municipality of Bystra-Sidzina and the private partner Bio-Energia ESP (which had been involved in project preparation). The private partner will support the investment with considerable funding and knowledge related to technical and organizational aspects of the project.

Investment activities

The environmental and economic impact will be enhanced by integrating fuel conversion with energy efficiency improvements on the demand side.

SSM – Supply Side Management

The overall objective, which is reduction of greenhouse gas emissions, will be achieved mainly by fuel conversion. Wood waste instead of fossil fuels will be used for heat energy production. The project assumptions forecast to build five biomass boiler houses: one in Jordanów (3,7 MW), three in Bystra (0,5 MW all together) and one in Sidzina (0,7 MW). New heat grids will be built in the

³⁸ During the project an idea for surplus wood waste to be used for pellet production was explored.

area. Development of the local wood waste market and fuel conversion will have a significant environmental and social impact.

DSM – Demand Side Management

To increase energy management efficiency and to lower the cost of energy consumption the thermal improvements will be done. The energy audits of 42 buildings and the recommended DSM measures are completed. Thermal conditions in all buildings to be connected to the biomass heat grid will be improved. Proposed improvements range includes insulation, carpentry improvements and installation of control equipment.

Expected results

- reduction of greenhouse gas emissions 5507 tonnes of CO₂ per year
- reduction of energy consumption
- increase of the use of wood waste for energy production
- an example of public-private partnership company created
- an experience in cooperation work for regional sustainable development gained
- employment opportunity for 20 persons

Promotional and educational activities

To build public confidence and understanding of public-private environmental investments and to improve ecological awareness as well as to enhance social impact of the Project several activities will be carried on through local NGOs and schools. The educational project “Man – Energy – Environment” is an example of such activities.

Nationwide activities

In the second phase the project will focus on dissemination of Projects results, replication of the similar projects in other parts of Poland, promotion of the wood waste biomass use for heat energy production and Public Private Partnership.

Information and promotion campaign

Nationwide campaign promoting wood waste biomass as a renewable energy source and will be targeting to reach following groups: decision makers and local communities, schools as well as general audience.

The cooperation with other similar initiatives such as Association “Polish Biomass” will be continued. The important part of the campaign will be promotion of Public – Private Partnership as this concept is relatively new in Poland.

New projects

Several new projects related to wood waste combustion for heat production will be identified, developed and prepared for financing.

Those projects should fulfill following criteria, approved by the Ministry of Environment:

- local government initiative
- integrated approach to fuel conversion
- use of wood waste as a main fuel

Public-Private Partnership cooperation model will be financially and organizationally supported cooperation with local community in project implementation.

The increase of the use of biomass will impact significantly local community and air quality. Global environment will benefit through a reduction of greenhouse gas emissions.

Summary of what was actually achieved

Investment activities

1. JORDANÓW – modernization of 2 heating plants

The project prepared a complete project and technical documentation for modernization of 2 heating plants in Jordanów (in a primary school, kindergarten and grammar-school).

The modernization processes of the heating plants was completed in Autumn 2005 and two automatic Moderator boilers each (with 120 kW burners), adapted for biomass combustion in the form of briquette, wood pellets and wood chips have been installed in the place of obsolete, considerably over-dimensioned coal-fired boilers. Thermomodernization works including the installation of thermostatic valves and the regulation of internal installations have been conducted during Spring 2006.

Project beneficiaries are very satisfied with the new boilers installed and stressed that thermal comfort in the schools increased and the costs of heating decreased.

2. LANCKORONA – domestic hot water and space heating system in the Ecology, Heritage and Renewable Energy Centre in Lanckorona

In Lanckorona the project designed a domestic hot water and space heating system in the future Ecology, Heritage and Renewable Energy Centre. The goal of the project is to make use of renewable energy (biomass and solar power) as a part of the revitalization process of a building designed for a centre of local social initiative support run by the Association “On the Amber Trail”. The planned heating system assumes the installation of a 30 kW wood gasification boiler (with a

possibility to use natural gas as emergency fuel), three solar collectors and making an internal central heating installation.

3. NIEPOŁOMICE – demonstrational project in Niepołomice directed at individual consumers

In Niepołomice, together with municipal authorities, the project team prepared a programme directed at individual consumers – beneficiaries of social welfare which obtain assistance from the municipality in a form of firewood for winter. Replacing obsolete, ineffective in wood combustion coal-fired boilers at households of the beneficiaries with modern wood gasification boilers will allow a better use of the local authority's means attributed to social help.

However, despite conducting a number of meetings with the inhabitants, carrying out simplified energy audits and local inspections it turned out that potential beneficiaries have resigned from participation in the programme. Concerns for fuel accessibility and lack of agreement of inhabitants for installation of buffer tanks – essential for proper functioning of biomass boilers – where the cause of such a situation. In order to overcome the concerns of the inhabitants regarding wood gasification boilers installation the existing old coal-fired boiler at Fire Station in Podgrabie (the last one in public buildings in Niepołomice) was replaced with a modern wood gasification boiler and the modernized boiler plant is available to visitors, in order to thus become a relevant element of biomass promotion in the Niepołomice area. A wood gasification 60 kW boiler was purchased after carrying out the tender procedure in June 2006.

4. ŁYSZKOWICE - Retrofitting of boiler house in the Nursing Home for the Disabled.

Analysis of the state of the heating system and demand for heat consumption and power for the heating and hot water system for 8 buildings belonging to the Nursing Home have been carried out at the turn of May and June 2005. The heating system of the institution is in very bad technical condition and a majority of the buildings are under-heated during the winter period.

There is vast water consumption in the hot water installation resulting from:

- specificity of the structure (frequent baths of the boarders),
- non-operating circulation,
- uneconomical overflow from taps,
- high pressure in the water-pipe network (about 6 bar in the boiler plant !).

Such factors cause over-normative hot water outflows and the existing hot water preparation system does not assume sudden large water consumption.

Based on the findings of this analysis the project prepared a study of modernization of the central heating and hot water preparation system for the Nursing Home. Following variants:

- variant I – biomass boilers (wood pellets and briquettes, oats),
- variant II – biomass boilers with peak gas boiler,
- variant III – oil and gas boilers,
- variant IV – oil boilers with a compression heat pump with heat consumption from a ground heat exchanger were analysed:

Entry	Unit	Present state – coke boiler plant	Biomass boiler plant	Biomass boiler plant	Biomass and natural gas boiler plant	Gas and oil boiler plant	Heat pump +peak oil boiler plants
		Variant 0	Variant Ia	Variant Ib	Variant II	Variant III	Variant IV
Expenditures (gross)	thousand PLN		435 858	435 858	437 979	321 212	1 809 379
Operating costs	thousand PLN	400 488	225 526	261 267	268 815	204 311	206 967
Fuel	thousand PLN	321 972	194 777	230 518	238 367	196 155	194 983
Personal	thousand PLN	72 000	18 000	18 000	18 000	0	0
Conservation & maintenance	thousand PLN	3 016	6 033	6 033	6 068	3 690	3 690
Electricity energy consumption	thousand PLN	3 500	6 716	6 716	6 380	4 466	8 295
Savings	thousand PLN		174 962	139 221	131 673	196 177	193 521

PLN is Polish Zloty, 1 PLN = 0.36 USD = 0.26 EUR

Finally the variant based on biomass fuelled boilers has been chosen as the most profitable from the economical and technical side.

We have:

- developed an appropriate construction designs with cost calculations for retrofitting and construction,
- prepared all tender documents for public procurement
- supervised the construction works.

Installation of boiler (capacity of 233 kW) fuelled with pellets, wood chips and oats for hot water production was completed by the middle of August 2006. Two pellet boilers for heat production with capacity 160 kW each were installed November 2006.

5. BAŁTÓW - Installation of biomass boiler in the Jurassic Park

Association for Development of the Bałtów Municipality is promoting tourist values of the region and to support all initiatives strengthening the local development. A Jurassic Park run by the Association is one of the main tourist attractions in the area. The Park attracts about 300 000 visitors every year. Gasification boiler for wood logs (50 kW) was installed in the mid of November 2006 at the Jurassic Park area and will serve as a demonstration investment and for biomass promotion. The information board promoting use of biomass was prepared and located close to the boiler house, which is open for visitors.

Informational and promotional activities

BIOMASS INTERNET SERVICE: www.biomasa.org

Biomass internet service have been continuously developed. Number of hits reached nearly 960.000 in the period from of December 2004 to February 2007.

PROMOTION OF BIOMASS ENERGY

Demo sites

In Niepołomice and Bałtów the boiler houses, facilitated with the information boards, are open for public.

Project presentation during POLEKO 2006 trade fair

The investments projects implemented under the Project scheme and biomass internet service were presented at POLEKO trade fair in Poznań since 21st to 24th November 2006. POLEKO is the biggest ecological trade fair in Poland gathered over 25.000 visitors from 25 countries.

The project stand attracted several hundreds visitors such as local government's representatives, biomass producers, farmers interested in setting up plantations as well as house owners interested in switching into biomass heating. An article about investments implemented under the project scheme was published at "Czysta Energia" ("Clean Energy") magazine, special edition for POLEKO 2006 fair trade.

The leaflets produced

1. Practical information on use of wooden biomass as a fuel
2. Basic information about different types of biomass
3. Key issues for preparation of biomass projects
4. Case study - Retrofitting of boiler house in the Nursing Home for the Disabled in Łyszkowice

“Reducing Greenhouse Gas Emission through the Use of Biomass Energy in Northwest Slovakia - Integrated Logistic for Use of Biomass Energy in Slovakia”

Aims of the project:

- To demonstrate a new way for introduction of alternative environmental friendly fuel, competitive to fossil fuels and to create the market with wood pellets in Slovakia.
- To contribute to the reduction of greenhouse gas emissions in Slovakia by utilization of biomass - specially wood pellets for heating.
- To substitute fossil fuels by environmentally friendly fuel - wood pellets in public building in member municipalities and to regulate the heating systems.
- To increase public awareness and interest for establishing biomass heating in Slovakia through using local wood waste residuals.

Project description

The project duration was 5 years (1999 – 2003)

The project was originally located in Northwest Slovakia, but it was already extended also to the East Slovakia. The project is built on the strong partnership, which has been created inside BIOMASA Association.

The project presents complex solution for the implementation of biomass heating and establishment of the market with biomass (wood pellets) in Slovakia. It is focused on creation and management of innovative integrated logistics system of wood waste (sawdust) collection, transport, processing to wood pellets, the distribution of wood pellets and delivery of heat to the end users. Within the project logistics production plant for wood pellets (Central Processing Unit – CPU) will be constructed and 42 boiler rooms in BIOMASA Association member municipalities combusting coal/coke will be replaced by the pellet-firing ones.

1) Construction and Operation of Central Processing Unit (CPU)

The Central Processing Unit will be situated in Northwest Slovakia, municipality Kysucky Lieskovec. CPU aimed to carry out the following activities:

- Collection and transport of wood waste in the form of dry and wet sawdust
- Processing of sawdust to the form of pellets in the technology process
- Distribution of pellets to the Slovak boiler-rooms localised in the municipalities participating in the project
- Export of pellets
- Central co-operation, direction, monitoring and service for boiler-rooms

2) Reconstruction of 44 boiler rooms

The reconstruction is divided in following parts:

- Dismantling the existing systems
- Construction works: groundwork for connection of building with central heating system, setting of new heating conveyors, and the preparation of the district heating system
- Reconstruction of boiler rooms
- Upgrade of the heating systems: upgrading the old heating system in order to be compatible with new one
- Supply and installation of new boiler plants
- Energy efficiency measures

Results

- Reduction of CO₂, SO₂, NO_x, CO emissions and particulates
- Increase in re-utilization of local wood waste
- Modernization of old heating systems
- Decreased operating costs for heating
- Strengthening of local economies and the economy of the Slovak Republic
- Creation of new job opportunities
- Decrease in Slovak dependence on fuel import
- Increase in general awareness concerning the use of alternative energy source

Financing of the project

Source	EUR
Global Environmental fund (GEF) – grant	854 780
DEXIA banka Slovensko a. s. – loan	2 926 830
Ministry of Environment of SR – subsidy	990 780
European Commission –LIFE III Program – grant	1 011 900
Austrian Environmental fund (through KKA)	604 650
BIOMASA Ass. members – own sources	880 480
Total	7 269 420

Exch. rate, mid 2003: 1 USD = 36 SKK, 1EUR = 41 SKK

Project holder

The project was prepared by BIOMASA Association in co-operation with the main project partners: Ballast-ECI, Denmark and the Agency for Regional Development in Zilina, Slovakia.

Established in 1999, BIOMASA Association is an independent, non-profit association of legal entities. In 2000, BIOMASA Association improved its legal status in additional business activities

(sale of heat from biomass boiler rooms). Nowadays, the BIOMASA Association has 27 members (19 of them are municipalities).

BIOMASA Association is the implementing agency for the project, provides services, carry out activities and promotes the project as it is described in the project document. The project is nationally devolve upon the Ministry of Environment of the Slovak Republic, which is the Executing Agency. A Project Steering Committee oversees the project.

The Association is the owner of newly constructed production unit for wood pellets and the technology in reconstructed boiler rooms in the member municipalities and it will sell the heat to the end users.

Summary of what was actually achieved

The Project *created a real market* with wood pellets in Slovakia, promoted biomass and considerably contributed to development of biomass heating in Slovakia.

Pellet production in 2006 reached 10 200 tons, plan for 2007 is 12 000 tons = final capacity. Through the project, local biomass sources were re-utilised directly in the region – 18 000 tons of sawdust from the local wood processing industries were re-utilised in 2006; it will increase in the future to 23 thousands tons of sawdust.

The project replaced more then 28 MW of coal and coke boilers by installation of 13 MW of modern biomass boilers capacity. The reconstructed boiler rooms were the pilot ones in public buildings in Slovakia.

Upgrading old heating system and improvement of energy efficiency in public buildings

- 44 new biomass boiler rooms replaced in total 100 obsolete inefficient boilers in 54 old coal/coke boiler rooms. As the new buildings were connected to the heating system, heating about 80 buildings in total. But even though not all buildings planned at he beginning of the projects were connected
- Energy efficiency measures, modernization and regulations of heating systems were realized in majority (80 %) of boiler rooms and in connected buildings (windows, doors and radiators replacement, regulating valves, additional thermal outside insulation)
- New heating operational regulations
- Better heating quality in buildings (very welcomed especially in schools and kindergartens)
- Decreased heating costs of many members, e.g. in basic school Hrustin by about 2 700 EUR annually and in NEDU Lubochna by 45 000 EUR annually

Following table presents installed output of all boiler rooms reconstructed by BIOMASA :

Installed output	Number of boilers
over 1 MW	3
425 kW – 900 kW	10
50 - 300 kW	19
up to 35 kW	13
Total	45

Direct *annual reduction of CO₂* by replacing of fuel source in reconstructed boiler rooms and realization of energy efficiency measures is 12 100 tons. Other reduction: from consumption of sold pellets in converted boilers in Slovakia: 1800 tons plus 3 150 of CO₂ equivalent, plus other indirect CO₂ reduction by promotional activities. *Cumulative annual CO₂ reduction is more than 20 000 tons.*

The project has created 33 jobs and it considerably contributes to the regional development. Biomass generally can create or save a lot of jobs and this fact was not very considered in Slovakia in national strategies yet. The project *was awarded* by National Energy Globe 2006, the European award for local climate protection activities Climate Star 2004 and international Environmental Prize ÖGUT in 2001.

Project *strengthened the local economics* as it has created a lot of contracts with local companies (raw material, construction, technology, services), new biomass fuels producers as well as new pellets consumers. It is helping also on *expansion of business and supporting services for renewable energy* and energy efficiency, strengthening companies assembling and projecting Renewable Energy Source (biomass) systems through experiences gained in the project implementation. It also developed basis for accession of boilers/ stoves producers and sellers to the Slovak market due to increased demand.

Experiences gained from the project were and will be used in the process of preparation of different regulations and legislation, e.g in the field of fire protection in such similar plants (as no relevant regulations exist in Slovakia), biomass utilization development strategies or supporting regulations in the field of the use of renewables (consultation in Ministry of Environment, Ministry of Economy, etc., newspaper articles).

Different *activities for biomass promotion and dissemination of result* were done: organisation of 3 annual international conference (340 participants together), 40 seminars for decision makers

(mayors, director of schools, energy managers, NGOs) and other target groups (students, pupils, public, energy experts, environmental officers) with about 300 attendants, project presentations at energy related conferences and seminars (up to 40), printed presentation materials – leaflets, panels, book “Heating with wood pellets”, web site, media campaign - 84 articles/news in national and regional media, information panel has been placed in each reconstructed boiler room, excursion to CPU and biomass boiler rooms, meetings and daily consultancy for potential biomass users.

Project was implemented in the time of structural changes (state administration reform, decentralization, EU entering – new rules and regulations, free market opening, etc.), what sometimes created problems, but on the other side also the challenges to solve them. Project gives example of *strong partnership building and cooperation* of a wide range of participants (municipalities, NGOs, health institutions, state administration, etc.).

“Slovenia - Removing Barriers to the Increased Use of Biomass as an Energy Source”

Project objectives:

Objective 1:

- Support the development of an initial set of Biomass District Heating Projects (BDH) by:
- Covering the learning costs
- Reducing investor risks
- Demonstrating the technical and financial of the projects to the local communities and residents

Objective 2:

Removal of barriers to increase the use of biomass

Project description

Project duration is 3 years (March 2002 – February 2005)

This project was carried out to remove barriers to the increased use of biomass as an energy source, thereby reducing the fossil fuel consumption and associated greenhouse gas emissions. The project seeks to support the development of an initial set of BDH projects by covering the learning costs, reducing investor risks and demonstrating the technical and financial feasibility of the projects to the local communities and residents.

Moreover the project was partially financed by GEF with the amount of 4.3 million USD as well as Ecofund, Municipalities and other organizations/institutions will provide a supportive fund amounted 2.5, 1.5 and 1 millions USD, respectively. The project was also subsidized by the Government of Slovenia with the amount of 2.5 million USD.

Project Financing (as implemented)

Source	USD
Global Environmental Facility - grand	4,300,000
Government of Slovenia	2,500,000
Government of Slovenia (in-kind)	400,000
Ecofund	2,300,000
Municipalities	518,000
Others	3,882,000
Total	13,500,000

Summary of what was actually achieved

The following activities contributed to the success of the project:

- The construction of eight investments that received high public recognition – the biomass district heating (BDH) demonstration projects in Vransko, Kočevje, Mozirje, Luče, Loče (Slovenske Konjice), Črnomelj and Solčava, all of which received financial, legal and technical support within the framework of the GEF project. Additional four BDH projects were prepared for implementation by the GEF project. Two projects out of four are already in operation (2006) and two being built, all by private investors. After the successfully completed public tender, GEF project allocated capital equities and grants of an equal amount of US\$ 2,500,000 to the following BDH projects:

BDH Project	Biomass boiler [MW]	DH network [km]	Investment VAT 0% [000 US\$]	Start of operation
Vransko	2+1.2	4.7	2,873	December 2004
Kočevje*	4.5	3.6	2,821	March 2005
Mozirje & Luče (package)				
Mozirje/School	0.5	0.175	293	February 2007
Mozirje/Podrožnik	0.5+0.11	0.59	590	December 2006
Luče	0.5+0.11	0.79	1,227	December 2006
Loče	1	1.34	1,023	January 2007
Črnomelj	2.2	1.84	2,626	January 2007
Solčava	0.22	0.43	247	February 2007

* Includes wood biomass boiler and extension of DH network

The majority of the projects also received favourable soft loans from the Environmental Fund of the Republic of Slovenia. The amount of the loans is US\$ 2,300,000.

Environmental Fund of the Republic of Slovenia will in 2007 support new BDH projects, by running the Biomass Energy Revolving Fund, partially financed by returned GEF equities.

The executed GEF projects contribute to the CO₂ reduction up to 10,740 ton/year.

- The implementation of measures which removed the institutional barriers concerning public awareness and information provision, as well as increased professional competence.

Removal of institutional barriers

The proposal of the national Woody Biomass Action Plan, which was prepared at the beginning of 2007 and submitted to the Ministry of Environment and Spatial Planning for interministerial reconciliation, public hearing and approval by the Government, offers a systematic framework for further activities in the area of woody biomass energy use for the period 2007 – 2013, in line with EU and Slovene targets in terms of greenhouse gas emissions, renewable energy sources, energy efficiency and security of supply.

Public awareness

Together with the construction of the BDH investment projects and events connected with them, the dissemination of information via media, established web sites and consultation meetings with the representatives of local communities and industry have helped to raise the awareness of woody biomass and of the possibilities for woody biomass energy use in Slovenia. Thematic natural science days at different class level were also organised for the primary and secondary school population. Two GEF BDH projects are information points in the framework of the Biomass Road in Slovenia.

Web Sites organised by the GEF project:

1. *Woody biomass* (<http://www.gov.si/zgs-biomasa/index.php>)
2. *Biomass Exchange Slovenia* (<http://ove.borzen.si/DesktopDefault.aspx>)
3. *GEF Project* (<http://gov.si/aure/>)

Training and education

Trainings of Slovene experts in the field of planning, installation, maintenance and management of woody biomass energy plants, as well as organised trips and demonstration events helped to raise the level of knowledge and competence of Slovene experts. Some of the important events were:

- International seminar Woody Biomass District Heating (2x)
- Seminar Quality Management at Planning and Construction of Biomass Energy Systems (2x)
- International seminar Biomass Energy Supply Contracting in European Practice
- Training of Designers – Small Scale Biomass Boilers
- Training of Installers – Small Scale Biomass Boilers (2x)
- Training of Chimney Sweepers – Small Scale Biomass Boilers
- Study tour to Notranjska and Dolenjska Region (3x)
- Study tour to South Tyrol and Karinthia Region (Austria)

- Regional presentations of equipment related to woody biomass energy use – “LesEnDemo” (8x)
 - Operation of Biomass Energy Consultants Network – “LesEnSvet” (foresters, farming and energy advisors), training of consultants (5x)
 - 4th International Round Table: Operation of BDH Systems
 - Biomass District Heating Investments Brokerage Event
-
- The design of a set of potential new BDH projects in Slovenia, which was made possible by:
 - The co-funding of 40 feasibility studies and in individual cases the preparation of and project documentation for the execution of biomass district heating systems (9 projects)
 - Two public sector market studies: the analysis of the possibilities of using woody biomass for heating secondary schools in Slovenia and the analysis of using wood biomass for heating residences for the elderly and for care and work centres, were carried out to serve as a foundation for preparing energy supply contracting projects.
 - Executed seminar Biomass Energy Supply Contracting in European Practice served as a preparation of potential parties in contracting
 - Preparation of a basis for the energy contracting model or for capital alliances of forest owners and farmers for the supply of heat from biomass
 - Completion of a project assignment “Energy from Biomass in Public Buildings” to bid for the funds of the Swiss funding mechanism
 - Development of the methodology and software of impact assessment of the renewable energy sources projects on the greenhouse gas emissions
 - Assessment and evaluation of woody biomass potential at the municipal level (public data base)
 - Organisation and start-up operation of the Biomass Exchange
 - Numerous information brochures, leaflets and study materials were published, all available on the government web site (<http://gov.si/aure/>)

Annex 2: Overview of key terms and issues in biomass energy

Biomass is a renewable energy source with major advantages compared to fossil fuels and other renewable energy sources to provide energy services, improve rural livelihoods, increase welfare and reduce poverty. Biomass energy systems have potential to lift people in rural areas out of the poverty trap while contributing to sustainable development and environmental protection and are receiving increasing worldwide attention. The key reasons for this attention include (Karthi & Leach 2001):

- Wide availability, even in remote areas: biomass fuels are available wherever trees grow and crops are grown, and food and fibre are processed, and are more widely available than fossil fuels;
- Resource which can be used when needed: Biomass fuels are forms of stored energy which can be drawn upon at any time to provide energy services unlike other renewables that are intermittent and/or seasonal;
- Versatility: Biomass can provide all the major energy carriers - liquids, gases, heat and electricity;
- Climate neutral: When sustainably harvested, biofuel is climate friendly and CO₂ neutral; and,
- Retained added value for rural communities: The added value of biomass energy systems is retained locally and can contribute strongly to rural development through local income generation activities. The essential advantage of biomass energy as a tool for poverty reduction is that income generation, in the supply chain and the use of heat and electricity for e.g. agro-processing, welding, workshops in general in rural areas is facilitated. Biomass energy may provide a mechanism for financing restoration of degraded land.

These inherent advantages, however, do not come without difficulties - biomass energy is the most complex of renewable energy alternatives: arranging a reliable, sustainable and affordable fuel supply of sufficient quantity and quality can be challenging, biomass fuels are frequently land and labour intensive and are highly dependent on stable prices, and the project developer is faced with a huge number of alternative technologies.

Constraints to greater use of biomass energy include: subsidies to competitors, scepticism over reliability and economic feasibility, and lack of awareness. However, such constraints and/or

barriers for an increased use of sustainably produced and consumed biomass resources for energy/electricity generation are very site specific and hence site-(country) specific barriers and barrier removal programmes need to be developed and implemented.

Biomass is a rather simple term for all organic material that come from plants (including algae), trees, and crops. Biomass sources are therefore diverse, including organic waste streams, agricultural and forestry residues, as well as crops grown to produce heat, fuels, and electricity (energy plantations).

Bioenergy resources can be broadly classified into three categories:

- (1) residues and wastes,
- (2) purpose-grown energy crops, and
- (3) natural vegetation.

Global production of biomass residues, including by-products of food, fiber, and forest production, exceeds 110 EJ/year, perhaps 10 percent of which is used for energy (Hall et al., 1993). Residues concentrated at industrial sites (e.g., sugarcane bagasse, and sawdust) are currently the largest commercially used biomass source.

Some residues cannot be used for energy: in some cases collection and transport costs are prohibitive; in other cases, agronomic considerations dictate that residues be recycled to the land. In still other cases, there are competing non-energy uses for residues (as fodder, construction material, industrial feedstock, etc.).

The amount of residues available in a given area can be crudely estimated based on "residue ratios," the weight ratio of residue to primary crop. Roughly speaking wood waste from wood processing in the sawmill has a residue ratio of 0.5 meaning that for each tonne of product there are roughly 500 kg of residues. Sawmill residues are already fairly commonly used as fuel in the wood processing industry, and for the production of chipboard. These residues make an excellent fuel source and are frequently in the form of sawdust that may be burned directly. Large pieces may need to be reduced to uniform sizes by chipping.

To determine actual availability on a project-by-project basis, two things are needed: measurements of actual residue production, and evaluations of other uses of residues. The cost of producing and transporting residues to a utilisation site must also be considered in any project. Transportation costs are particularly important for projects that require relatively large quantities of residues at a single site. Ideally, local cost supply curves would be developed for any project

where residue utilisation is being considered. Growing costs (for crop residues or energy crops) should include agricultural and labour inputs as well as land rent.

Animal manure is another agricultural by-product that can be used in anaerobic digesters to produce biogas. The availability of this resource depends both on the condition of the livestock producing it and on how much of the animal's manure is actually collected. In some cases, estimates of manure availability used for project planning purposes have been far in excess of actual availability, which has led to project failures.

Growing crops specifically for energy has significant potential. Biomass intensive future energy supply scenarios (developed by the Intergovernmental Panel on Climate Change, IPCC) includes 385 million hectares of biomass energy plantations globally in 2060 (equivalent to about one quarter of current planted agricultural area), with three quarters of this area established in developing countries. Such levels of land use for bioenergy could intensify competition with other important land uses, especially food production. Competition between land use for agriculture and for energy production can be minimised if degraded lands are targeted for energy. In developing countries in aggregate, hundreds of millions of hectares have been classified as degraded. A wide variety of technical, socioeconomic, political, and other challenges are involved in successfully growing energy crops on degraded lands, but the many successful plantations already established on such land in developing countries demonstrate that these challenges can be overcome.

One question often asked is whether the energy inputs required to establish and maintain energy plantations are larger than the net biomass energy they produce. Based on extensive trials on short-rotation intensively cultivated crops in the United States (such as switchgrass and hybrid poplar), the biomass energy output is 10 to 15 times greater than all required fossil fuel inputs (including energy embodied in fertilisers, herbicides, and pesticides and fuel for machinery) (Hall et al., 1993).

Constraints to greater use of biomass energy include: subsidies to competitors, scepticism over reliability and economic feasibility, and lack of awareness. However, such constraints and/or barriers for an increased use of sustainably produced and consumed biomass resources for energy/electricity generation are very site specific and hence site-(country) specific barriers and removal of barriers programmes are to be developed and implemented.

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