Mobilizing Wood Resources—What's the Big Deal?

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1 Objective and Background

In Europe we have recently seen an increased demand on wood raw material due to increased demand for industrial forest products and a substantial increase in wood for fuel based on dramatically increased prices for traditional energy carriers such as oil, gas, and electricity.

Being somewhat involved in the pre-discussions of this conference, I know that the major driving force for the concerns regarding the need for mobilizing wood resources is the "conflict" between traditional forest industrial use versus energy use of existing and future wood raw material in Europe.

The organizers of the conference have charged me with the overall task of discussing whether there is a need for mobilizing wood resources in Europe and what the policy dilemmas are for the mobilization of more wood in Europe if needed. In fact, the organizers charged me with a number of questions to be answered within this framework. However, in order to elaborate on all of the questions, I am afraid that I would need something like a six-hour presentation. So there is a risk that the following discussion will be rather superficial.

2 The Heart of the Problem—Energy

Due to the fact that the perceived conflict and policy dilemma about the utilization of Europe's raw material stems from development in the energy sector, I see difficulties in discussing the policy dilemma without addressing the outlook for the energy sector.

Energy is the lifeblood of the world economic system. A number of experts argue that high energy prices reduce the possibilities for economic growth substantially (e.g., OECD/IEA, 2006). However, Nilsson (2006a) has analyzed existing studies on assessments of the empirical historical impacts of energy prices on economic growth over time. It can be concluded that:

- There seems to be a threshold value for sensitivity to energy prices and their impacts on economic growth.
- These thresholds vary with the robustness of different economies.
- The more robust economies are, the less negative impacts of economic growth.
- There seems to be a consensus that there may be short-term economic disruptions by high/increased energy prices but hardly any long-term negative impacts on economic growth.

However, it can also be concluded that the world's *different economies can perform and survive with substantial energy price rises but can not survive supply and price shocks of energy*.

The Financial Times (FT, 2006a) has later confirmed this conclusion by stating "*if stable, high energy prices need not to be a disaster. For the most part high prices provide the right incentives for consumers and producers. It is the volatility of energy prices, not their level, that is most damaging to the world economy*".

Thus, in discussing the energy issue, *energy security and price volatilities* are of major concerns. So what risks are we facing with respect to these entities?

The International Energy Agency (IEA) has recently released its new energy outlook study (OECD/IEA, 2006). They assess that the world demand on primary energy will increase from 11204 million toe in 2004 to 17095 million toe in 2030—an increase of over 50% in 25 years (see Table 1). During the same period, the dependence on fossil fuel will increase from 80 to 81%. But there are a number of constraints making it possible to meet this demand especially with respect to fossil fuels. The constraints for reaching the demanded supply, according to Table 1, causing a lack of energy security and price volatilities are many and severe (especially with respect to fossil fuels):

- Limits to economically available resources.
- Lack of financial resources for investments.
- Lack of maintenance and efficiency of existing energy systems.
- Sabotage.
- Energy used as a political pressure tool.

Table 1: World primary energy demand in the reference scenario (million toe). Source: OECD/IEA (2006).

	1980	2004	2010	2015	2030	2004–2030*
Coal	1 785	2 773	3 354	3 666	4 441	1.8%
Oil	3 107	3 940	4 366	4 750	5 575	1.3%
Gas	1 237	2 302	2 686	3 017	3 869	2.0%
Nuclear	186	714	775	810	861	0.7%
Hydro	148	242	280	317	408	2.0%
Biomass and waste	765	1 176	1 283	1 375	1 645	1.3%
Other renewables	33	57	99	136	296	6.6%
Total	**7 261**	**11 204**	**12 842**	**14 071**	**17 095**	**1.6%**

* Average annual growth rate.

2.1 Economically Accessible Resources

There are especially concerns about the economic accessibility of fossil fuels in the future. One school is arguing that the conventional oil and gas production will peak any year now (e.g., ASPO). Another school is arguing that the conventional oil and gas resources will last for a substantial period of time (e.g., OECD/IEA, 2006). Nevertheless, there is consensus among the schools that at some point in time not too far away the production of conventional oil and gas will peak but unconventional and synthetic sources of oil could last for a long time to come — but at higher prices.

For many years at IIASA we have worked on global energy assessments and produced many scenarios. We also use the terms conventional and unconventional fossil fuels. Conventional resources are defined as fossil fuels that can be extracted with today's technology at competitive prices/economic viability (Rogner, 1997). In Figures 1 and 2 we illustrate some of our scenarios on global oil and gas consumption. Scenarios B1, B2 and A2 are based on different assumptions of economic and social developments and a different future environment. Scenario B1 reflects a peak in global population in mid century with rapid changes in economic structures toward a service and information economy and the implementation of resource-efficient technologies. Scenario A2 describes a very heterogeneous world with continuously increasing global population and slower economic growth and technological change than in Scenario B1. Scenario B2 describes a world with lower population growth than in A2, intermediate economic development and less technological change than in B1. This scenario emphasizes local solutions to the overall sustainability issue.

In all scenarios, the peak of conventional oil consumption is around 2020 and the conventional natural gas peaks around 2030–2040. If the oil consumption level at the peak in these scenarios is compared with the IEA demand scenario (Table 1) for 2030, it can be concluded that the assessed demand can not be supplied with conventional oil. The deficit is 15 to 25%. This means a very difficult supply situation and increased oil prices and high risks for *supply and price volatilities* with respect to oil. The gap or deficit of conventional natural gas at 2030 is not as difficult as for oil but there is a deficit in the magnitude of nearly 10%, which again indicates risks for *supply and price volatilities* of natural gas.

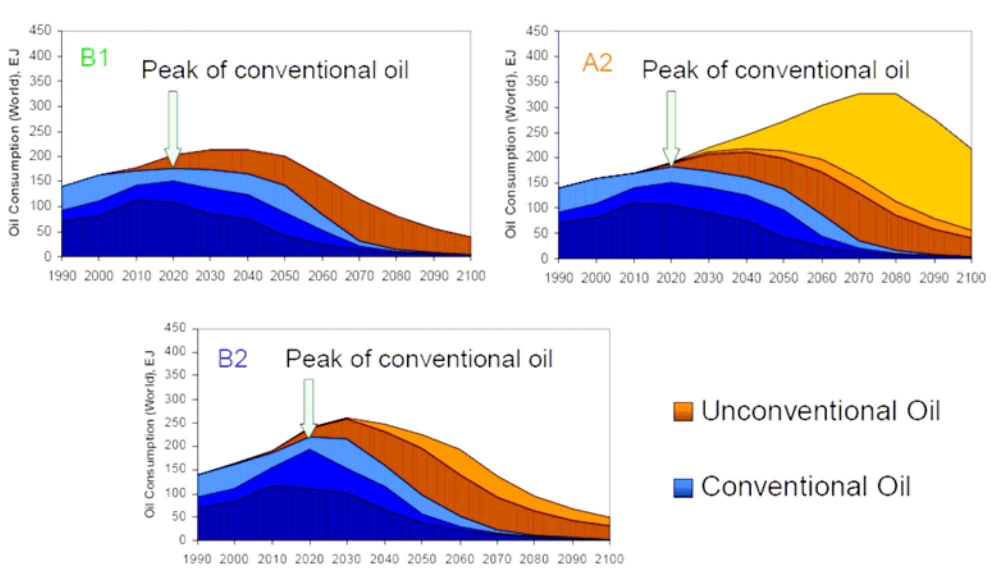


Figure 1: Global oil consumption (conventional and unconventional reserves and resources). Source: Riahi and Keppo (2006).

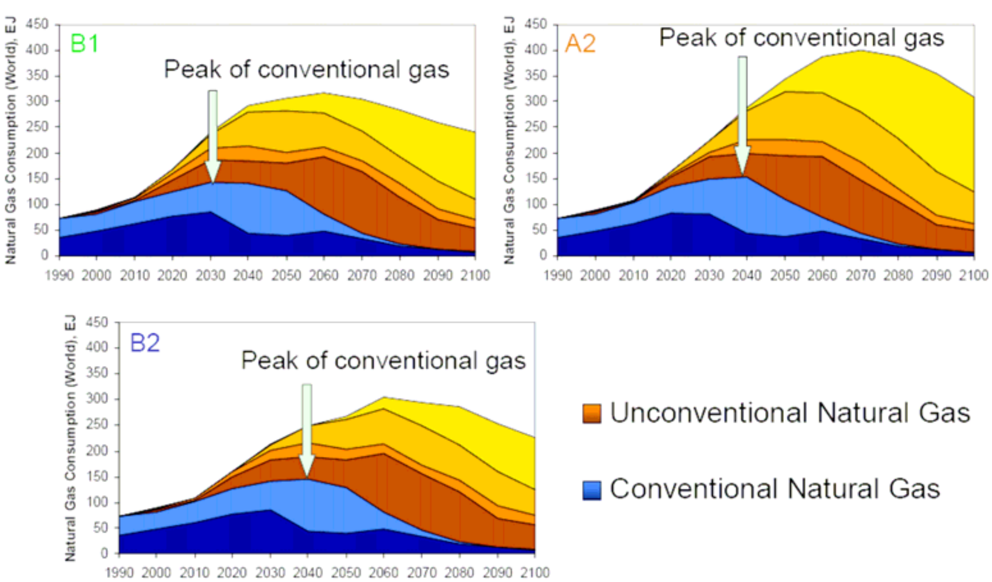


Figure 2: Global natural gas consumption (conventional and unconventional reserves and resources). Source: Riahi and Keppo (2006).

Currently, global oil supply stands at 84 million barrels per day, with a spare capacity of only 1 to 1.5 million barrels per day—the lowest level during the last 30 years (Newell, 2006).

2.2 Lack of Investment Funds

The IEA states that to reach the primary energy supply, which will meet the demand of 17095 million toe in 2030 (see Table 1), enormous investments in the energy infrastructure must be made (OECD/IEA, 2006). The accumulated amount needed to 2030 is over $20 trillion (2005 $). About half of the investments are needed in the electricity industry in the form of transmission and distribution networks and in power generation. The rest of the investments are roughly needed for the fossil fuel industry. Some $2.5 trillion of investments are needed in the European energy sector.

More than half of the investments will be allocated to just maintain the current level of supply. Much of the world's current production for oil, gas, coal, and electricity will need to be replaced. The IEA is quite frank that there is no guarantee at all that the needed investments will be forthcoming (OECD/IEA, 2006). The level of investments will in the end depend on government policies, geopolitical conditions, unexpected changes in costs and prices, new technologies, etc. It should be remembered that some 80% of the proven reserves of fossil fuels are concentrated in *volatile* regions (Newell, 2006). The IEA questions "whether investment in Russia's gas industry will be sufficient even to maintain current export to Europe and to start export to Asia" (OECD/IEA, 2006). Thus, also from a financial point of view there is a high risk that there will be *supply and price volatility* of the energy supply.

2.3 Maintenance and Efficiency

In spite of tremendous profits by the energy industry, the needed investments in maintaining the existing energy infrastructure have not materialized. Hautojärvi (2006) assesses that the productivity of the energy sector in the EU has improved by 15% during the last 45 years. At the same time, labor productivity grew by 350%. Herold and Lovegrove (2006) assess that the global petroleum industry needs to invest over $200 billion annually to maintain current reserves and current production rates but this has not happened during the last five years and in 2005 the upstream capital investment was $277 billion, whereby $128 billion was channeled back to shareholders through dividends and buybacks of shares. In fact, *buybacks* exceeded purchases of proven reserves by 20% and were nearly 80% higher than exploration outlays (see Figure 3).

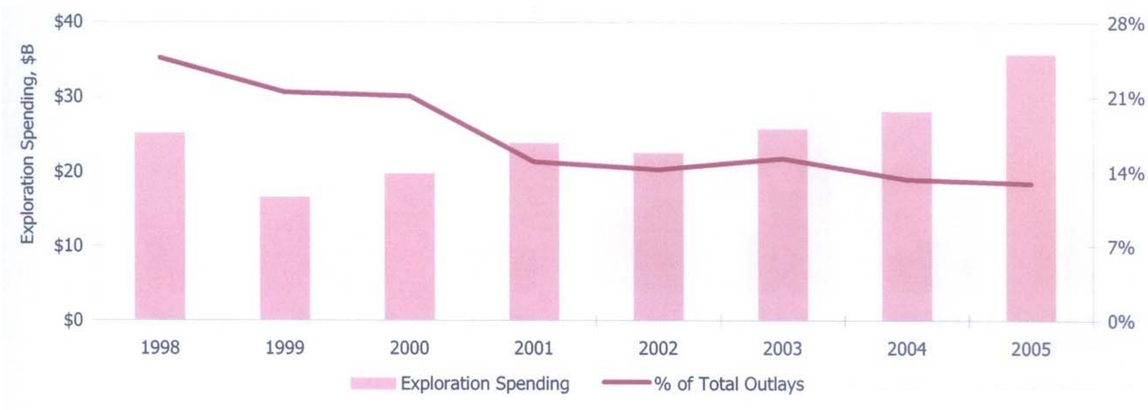


Figure 3: More exploration is needed. Source: Herold and Lovegrove (2006).

As stated by the IEA, Russia has neglected maintenance investments in the infrastructure of gas, oil, and electricity (OECD/IEA, 2006). Several specialists have warned that there is the risk that Russia will have an oil and gas production crisis in the future due to the dearth of investments (e.g., Wood Mackenzie, 2004; Juurikkala and Ollus, 2006). Since the late 1980s, the Russian electricity sector has suffered from the lack of investments and the current generation capacity is deteriorating. Even a moderate growth in Russian electricity consumption will lead to serious supply shortages already in 2008 (e.g., Kurronen, 2006). Gheorghe *et al*. (2006) have made a detailed review of the European electric power system. From this review, it can be concluded that the European electric power systems are bound to fall short in the coming years due to aging generation and transmission equipment. There are doubts that current and planned generation plants will meet demand. Political decisions were taken for the establishment of an internal market in electricity but nothing was made to remove the physical constraints of power transmission. There has been substantially increased interconnection of electricity systems but no central control mechanism has been established. Therefore, the European electricity market is not optimal and lacks efficiency which pushes the prices upwards. In the case of Europe, there is an urgent need to upgrade and secure the electric power system.

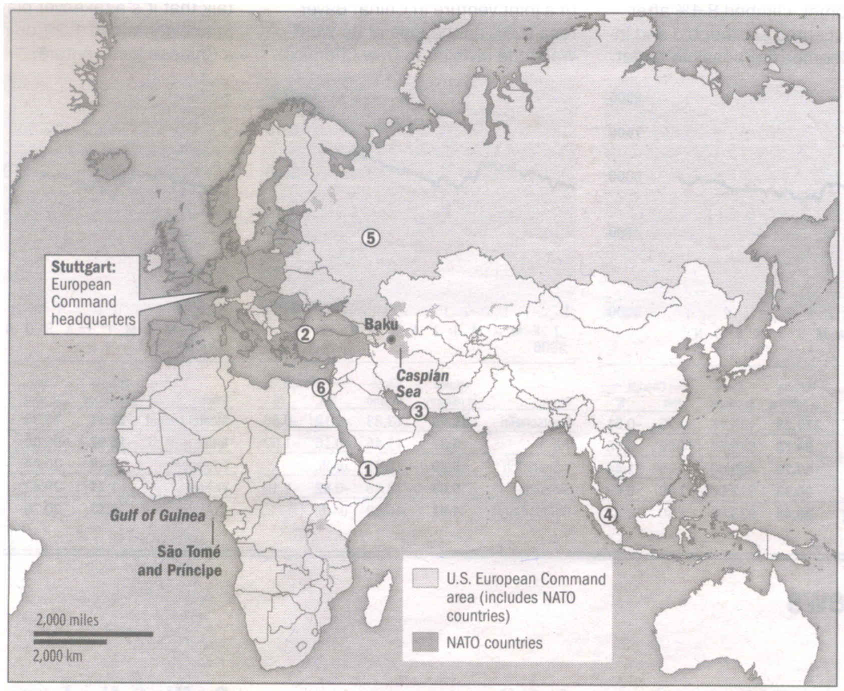
The neglect of maintenance of the energy infrastructure is causing disturbances and volatility in supply and prices. Recent examples are the explosion in March 2005 in BP's Texas City Refinery and a string of disasters in BP's infrastructure in Alaska in 2002, 2005 and 2006. All are the result of cost cutting in safety and maintenance (FT, 2006b, c).

The explosion in Nigeria of a pipeline during Christmas 2006 was claimed to be caused by thieves vandalizing the pipeline but experts are questioning this. Corruption and mismanagement have forced much of Nigeria's energy infrastructure into decay and this was the major cause for the explosion.

The lack of sufficient security and maintenance of the energy infrastructure will cause volatility in supply and prices of primary energy in the future.

2.4 Sabotage

As stated earlier, some 80% of the proven fossil fuel reserves are located in volatile regions. This, coupled with increased intensity in globalized terrorism, increases the risks for sabotage of the existing energy infrastructure. The risks for sabotage are illustrated by Figures 4 and 5 with respect to oil and gas.



World oil transit choke points

CHOKE POINT	OIL FLOWS, millions of barrels per day*	SECURITY CONCERNS
① Bab el-Mandab	3.0	Terrorists attacked an oil tanker in the area
② Bosporus and the Turkish Straits	3.1	Less than a kilometer wide at narrowest point and difficult to navigate
③ Strait of Hormuz	17	In the midst of volatile region
④ Strait of Malacca	11.7	Piracy is frequent
⑤ Russia	2.0 (Also natural gas)	Gas supplies controlled by Moscow
⑥ Suez Canal/ Sumed Pipeline	4.2	If closed, some tankers would have to go around Africa

*2004 estimate.
Source: Energy Information Administration.

Figure 4: World oil transit choke points.

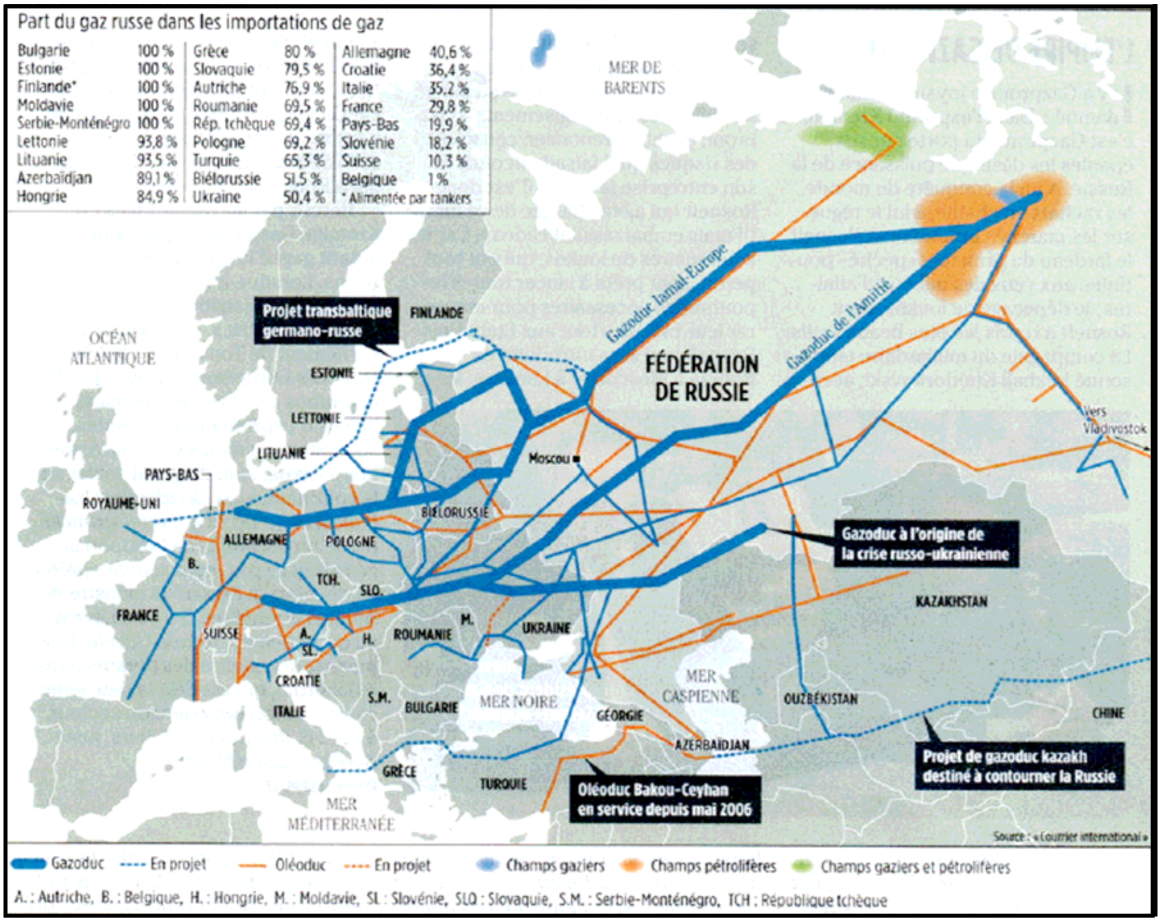


Figure 5: Russian gas pipelines. Source: Vasara (2006).

The leader of Turkmenistan recently passed away, leaving a vacuum at the top of a dysfunctional institutional structure controlling the world's fifth biggest gas reserve. Political instability could threaten the gas supply to its main customer, Ukraine, with potential knock-on effects for the rest of Europe. Gazprom, due to lacking investments, relies increasingly on cheap central Asian supplies to meet domestic and international demands, including Europe.

The oil and gas infrastructure is too big to protect as a whole and the risks of sabotage must be counted for. The threats to oil supply multiply but the world is not ready to handle this development (Wall Street Journal, 2006).

2.5 Energy as a Political Pressure Tool

A tight supply/demand situation, as described above, will open the possibilities for producers to use the energy supply as a political tool and the consumer countries may be forced to accept political and economic policies that are not really acceptable to the consumer countries.

3 Price Development

Under the conditions outlined above, the probability is high that the prices of primary energy will remain at a high level. But nobody knows what the price level will be in reality because the outlined development leaves room for a lot of speculation that could influence the price development strongly.

The IEA has been brave enough to present an assessment of future oil prices (OECD/IEA, 2006). It is pointing at a level of $50/barrel in real costs and $100/barrel in nominal costs in 2030 (see Figure 6).

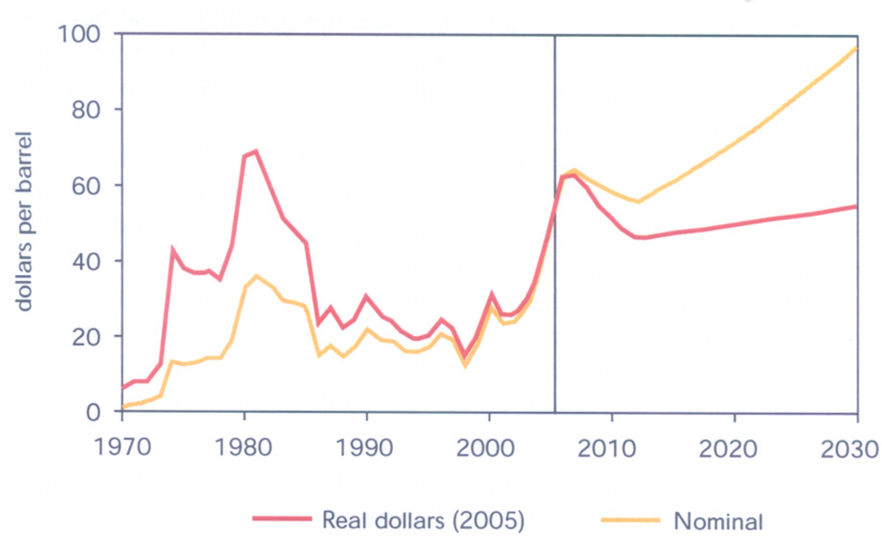


Figure 6: Average IEA crude oil import price in the reference scenario. Source: OECD/IEA (2006).

4 Environment/Climate

Sir Nicholas Stern (2006) has recently made policy makers and the public aware that climate change presents serious global risks and requires urgent responses. The majority of the emissions of greenhouse gases (GHG) stems from the production and combustion of energy.

Some of the foreseen damages affecting the European forest sector will be highlighted. Ecosystems in Europe will be vulnerable to the foreseen climate change. Increases in the extent and intensity of storms and hurricanes are foreseen. Increased and perhaps dramatic outbreaks of insects and pests with climate change will also cause increased damage of infrastructure.

There is also a chicken and egg problem between increased climate change damage of infrastructure and the production of primary energy carriers, which can be illustrated by the shutdowns of refineries and pipelines caused by hurricanes Katrina and Rita in 2006 resulting in price spikes.

Stern (2006) estimates that emissions following a business-as-usual path will cause an average loss of global GDP of 5–10%.

Stern (2006) argues that the concentration of GHGs in the atmosphere has to stabilize at 500–550 ppm in order to avoid the huge economic losses of 5–10% of the global GDP by climate change. In order to achieve this, the global emissions need to be 25% below current levels by 2050. In this context, it should be pointed out that in 2050 the global economy may be 3–4 times larger than today. This means huge reductions of emissions in a business-as-usual development. This can be illustrated with the increase of CO_2 emissions according to the OECD/IEA (2006) scenario (Table 1). This increase in primary energy demand will increase the CO_2 emissions by 14.3 billion tonnes (or 55%) during the period 2004 and 2030 and reach 40.4 billion tonnes. Stern (2006) claims that the above stabilization can be reached through emission reductions at accumulated costs of around 1% of GDP by 2050 (although Stern has been criticized for this estimate and it is argued that it is an under-estimate).

But the overall conclusion of the Stern review is that the costs for emission reductions will be substantially lower than the costs of the foreseen climate change. However, actions have to be taken now.

5 Energy Policies

Unfortunately, we do not have any solid energy policies or strategies either in the individual countries of Europe or in the EU. Without solid energy policies or strategies it is rather difficult (meaningless) to discuss mobilization of more wood for energy purposes. Without these instruments we do not know what magnitude we are speaking about with respect to possible mobilization. I regret to state that I am rather pessimistic about the establishment of efficient energy policies and strategies in Europe. Even if the politicians have identified the severity of the energy balance they do not know what to do. There is a political collective of no-action problem and "After you, Sir" syndrome with respect to energy policies and strategies.

I hope I have made it clear that the current situation is severe and that the policy and strategy setting has to operate within the *triangle of economic growth, energy security (vulnerability to supply disruptions)* and *climate and environment*. This means there is a need to reduce the vulnerability and to diversify the energy supply. It is far from enough to just look at "high oil prices" in setting priorities.

The key to effective policies and strategies is the correct identification of which parts of the energy equation or matrix to solve.

In order to start to make this kind of identification I have produced an "energy matrix" for 2030 at the Pan-European level, but excluding Russia, over economic sectors and different primary energy carriers (see Table 2). The basic input for the "matrix" is the reference scenario of OECD/IEA (2006).

How much do we have to reduce oil and gas in Table 1 in order to avoid vulnerability/volatility in supply and prices? How much do we have to reduce the fossil fuels in order to make a contribution to climate stabilization? In which sectors can we make substantial reductions of fossil fuels? How much can we reduce fossil fuels and still maintain economic growth? How can we replace coal, gas, and oil in the generation of electricity? How much can the rate of renewables be increased in the generation of electricity without threatening economic growth? Should biomass come from agriculture or forestry? And so on.

Table 2: Total final energy consumption in Pan-Europe in 2030 (million toe). Calculated from OECD/IEA (2006), EEA (2006a), Eurostat (2006) and IEA Energy Statistics (www.iea.org).

	Coal	Oil	Gas	Electricity	Heat	Biomass	Biofuels	Other Renewables	∑
Industry	22	146	169	146	16	43			
Transport		486					32	16	
Households	5	71	166	152	48	33		5	
Services, Agriculture, Others	3	38	89	81	26	19		3	
∑	**30**	**741**	**424**	**379**	**90**	**95**	**32**	**24**	**1815**
Renewables				49					
Nuclear				118					
Coal				117					
Gas				70					
Oil				20					
Others				5					

It is rather obvious that the forest sector alone can not address these kinds of questions for building energy policy and strategy frameworks. It must be done from a total societal point of view.

Policy Recommendation I. *European countries and the EU are strongly recommended to develop overall energy policies and strategies based on integrated analysis of the triangle of economic growth, energy security, and climate and environment*.

I will return to Table 2 later in the discussion of the wood balance for Europe.

6 Biomass Opportunities

The need for energy policies discussed in the former section is aiming at identifying an energy policy framework *but not to dictate in which sector which fuel and to what extent it should be used. The market should decide this allocation*.

So what can biomass contribute in the form of energy?

Bioenergy: Electricity and Heat from Biomass

With recent increases in energy prices, heating with modern bioenergy systems can compete with oil and gas and the generation of electricity with biogas from biomass undercutting costs of oil and gas-fired power plants. These technologies are well established and the development is on its way.

Liquid Biofuels for Transportation

Examples of liquid biofuels are ethanol, methanol, biodiesel (FT-Diesel), RME, DMR, etc.

The first generation of liquid biofuels is mainly produced from agricultural products like starch and sugar. Included in the first generation of liquid biofuels are ethanol and RME. The second generation of liquid biofuels (post 2010) will use woody biomass, tall grasses and lingo-cellulosic residues and wastes.

Biogas—An In-between Biofuel

Biogas can be upgraded to substitute natural gas and can feed into existing natural gas pipeline systems (local, national and international). It can be produced as compressed natural gas to be used in gas-engineered vehicles. But biogas can also be processed into a *gas-to-liquid* and be available as a powerful and very clean-burning liquid fuel.

Hydrogen

Hydrogen can be produced from biomass and coal and can be used as a transportation fuel. Hydrogen is classified as the third generation of fuels.

There is intensive development going on about biomass fuels and we do not know yet what will be the most efficient utilization of biomass in the future. One of these developments is the *biorefinery*. The concept of *biorefinery* is to optimize the output of the biomass feed-stocks so it reflects the highest revenues. The overall concept is presented in Figure 7.

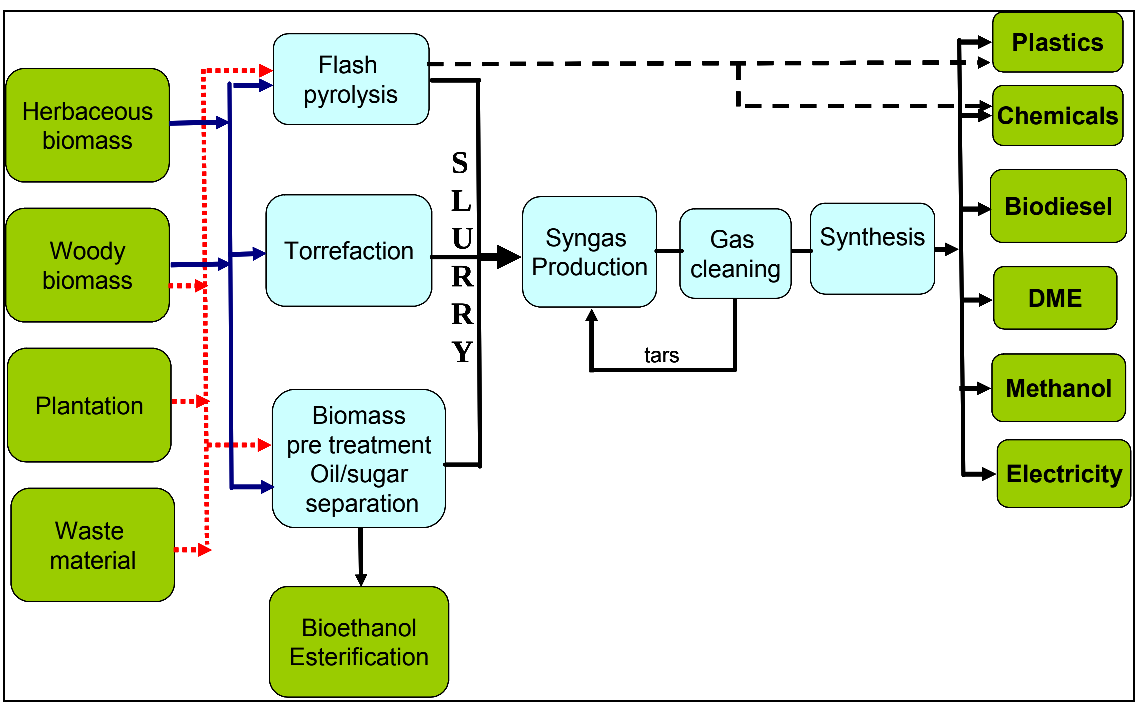


Figure 7: The integrated biorefinery approach. Source: Girard and Fallot (2006).

The biorefineries are regarded as a second generation producer of biofuels. Biorefineries can be established and integrated with traditional pulp and paper production (the old Soviet combine concept). The biorefinery generates a substantial increase in value added production, which can be illustrated by the Domsjö biorefinery in Sweden (see Figure 8).

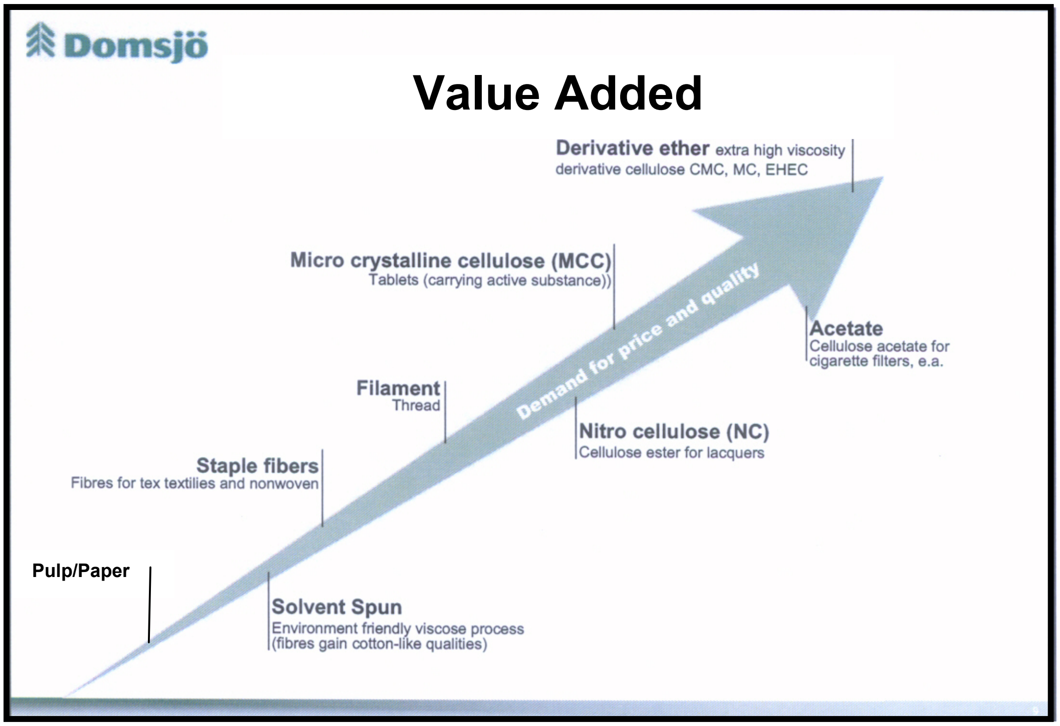


Figure 8: Example of value added production in biorefinery — Domsjö, Sweden. Source: Hildingsson (2006).

As seen from Table 2, Europe is very dependent on oil and gas in the generation of energy. The costs of bioenergy have to be compared with the fossil fuel equivalents in order to identify how competitive these fuels are. I have already stated that heating and electricity generation from biomass are already competitive with gas and oil. For biofuels, the uncertainties and unknowns are much bigger. Table 3 is based on Fritsche and Jenseit (2006) giving an indication of the competitiveness of biofuels.

Table 3: Competitiveness of biofuels.

Agriculture-based ethanol	~70$/bbl
Brazilian ethanol	~50$/bbl (including fuel economy penalty)
First generation biodiesel	Hardly competitive
Second generation (post 2010) biomass-to-liquid from forest biomass	~50$/bbl
Second generation (post 2010) lingo-ethanol	~50$/bbl

If this is compared with IEA's long-term price development for oil around 50$/bbl in 2005 dollars, it can be concluded that biofuels from forest biomass feed-stocks may become competitive with oil and gas around 2020 (OECD/IEA, 2006).

There are, however, also other dimensions to this picture that need to be taken into account. For agricultural-based biofuels, the net energy balance and the resource efficiency is so bad that the net economy is insufficient. For example, Farrel *et al*. (2006) conclude that agro-based ethanol production in the USA requires a primary energy input corresponding to 80% of the energy contained in the ethanol output. This also means that the reduction costs for GHG emissions vary a lot among the fuels, which is illustrated in Figure 9. But even in this respect the products based on cellulose seem too have a favorable outlook.

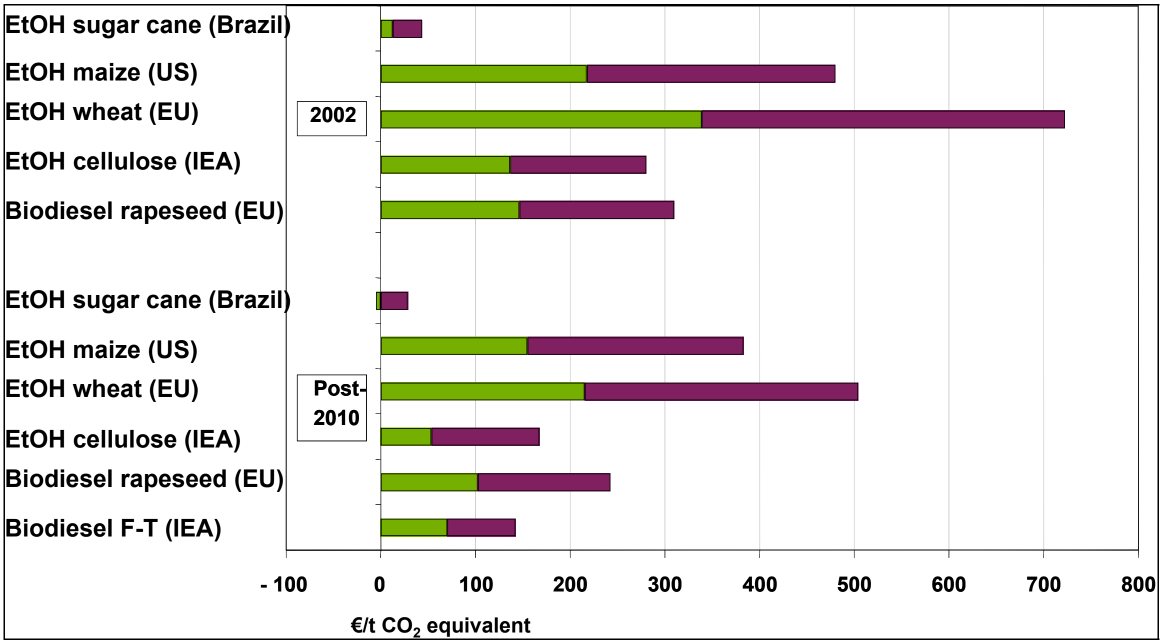


Figure 9: GHG reduction cost expectations for 1st and 2nd generation biofuels (lower light green bars indicate lower limit, upper dark violet bars indicate higher limit). Source: Adapted from WWI/GTZ (2006).

If we specifically look into woody biomass, it can be assessed that one ton of wood replacing oil reduces the CO_2 emissions by 1.3 ton. If the same ton of wood replaces coal-based electricity production the CO_2 emissions are reduced by 1.5 tons. But, if that ton of wood is used for biofuel the reduction of CO_2 emissions will be only 0.8 ton.

In addition, we do not know today the technologies that will be the most efficient in 10–20 years. Perhaps the technologies of electric batteries and hydrogen will have breakthroughs, which would mean that biofuels are less interesting. Furthermore, the prices for biofuels will largely be determined by the international price of crude oil and we will not avoid oil price shocks of biofuels. The only way we can do that is to use alternative energy sources not competing with oil (like electricity and hydrogen).

Based on this situation, it is important to keep high research intensity and a broad research agenda on many different kinds of energy sources from wood. If the other technological developments prove to fail we have to fall back to woody biomass for biofuel production.

Policy Recommendation II. *Europe should intensify research and development for production of alternative energy carriers. This is an important step in developing future energy security.*

7 Internationalization of Bioenergy Trade

I think there is a misconception in the debate today about bioenergy. My impression is that the bioenergy market is regarded as a European market, a national market, or a subnational market. Already today, there is a long-distance import of bioenergy from Brazil and Canada to Europe. The trade of bioenergy is one of the most rapidly growing sectors for international trade. It is not the transportation distance being decisive but the transportation costs and today there are many inexpensive options for long distance transportation of bioenergy due to globalization. There are many factors in favor of more efficient production of bioenergy outside Europe. For example, there are a lot of unutilized hardwood resources in Russia that could be used for the production of biogas, which could be transported in the existing network of pipelines for export to Europe.

The allocation of the bioenergy industry will, in the same way as the traditional pulp and paper industry, be driven by the costs of the production of the feed-stock of biomass. At IIASA we have made a large number of grid-based global scenarios on the most economically efficient future production of biomass for energy production. One of the scenarios is presented in Figure 10.

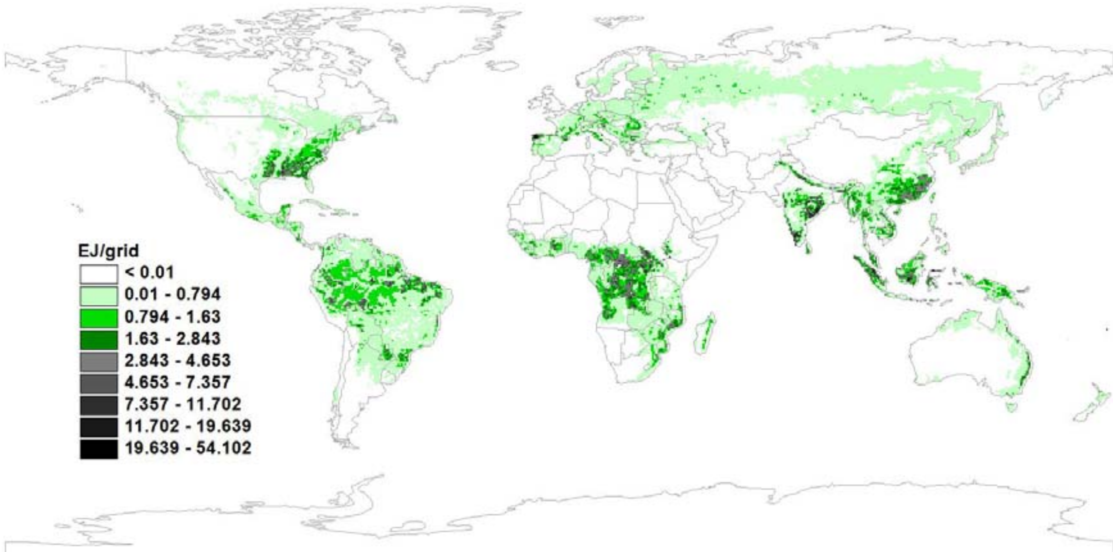


Figure 10: Cumulative biomass production (EJ/grid) for bioenergy between 2000 and 2100; A2r scenario (country investment risk excluded). Source: Obersteiner and Nilsson (2006).

All the scenarios show the same picture with the majority of the biomass production for bioenergy taking place in the tropical regions. Therefore, from an energy, economic and climate point of view the question whether there will be sufficient wood resources in Europe for demanded energy production is not that exciting. A global view is required.

Policy Recommendation III. *Europe should globalize its view on future bioenergy and investigate future import opportunities for different bioenergy sources.*

8 Traditional Industrial Forest Sector in Europe

I will now turn to the other side of the coin, namely the traditional forest sector consumption of wood. After this assessment I can approach the issue of a wood balance for 2030.

In the discussion of the traditional forest industrial utilization of wood I will use EFSOS (UN, 2005) as a platform. But first I will describe the forest resources of Europe (see Table 4). As a definition of Europe I have included EU/EFTA and CEEC (including Ukraine). Thus, European Russia, Moldova and Belarus are excluded in the analysis/discussion.

Table 4: Forest resources of Europe around 2000 in million ha.

	Forests (FAO, 2006)	**Forests available for wood supply (FAWS)** (Schelhaas *et al*., 2006)	**Other wooded land** (FAO, 2006)	**Other land with tree cover** (FAO, 2006)
EU/EFTA	132.0	103.0	23.0	2.0
CEEC	52.5	47.5	2.5	1.5
Total	**184.5**	**150.5**	**25.5**	**3.5**

Thus, the Pan-European forest area available for wood supply is around 150 million ha, which is nearly 20% less than the total area of forests. In addition, there is 29 million ha of forests/trees outside the FAWS area also contributing to the wood supply in Europe.

9 The EFSOS Analysis

I am not able, in this connection, to carry out a complete evaluation of the EFSOS analysis. But I will bring up some aspects, which may influence the assessed possible wood supply for Europe.

The EFSOS analysis (UN, 2005) is using two independent models, as illustrated in Figure 11. The demand model (Kangas and Baudin, 2003) is using an econometric approach in order to assess the industrial demand on industrial forest products through 2020. The demand on industrial forest products is converted to “required fellings”. The wood supply model (Schelhaas *et al*., 2006) is a simulation model using aggregated silviculture regimes formulated by national correspondents and generates sustainable supplies of wood through 2040. The two models are not linked in an interactive mode. The “interaction” is made by comparisons of the demand requirements and the supply possibilities.

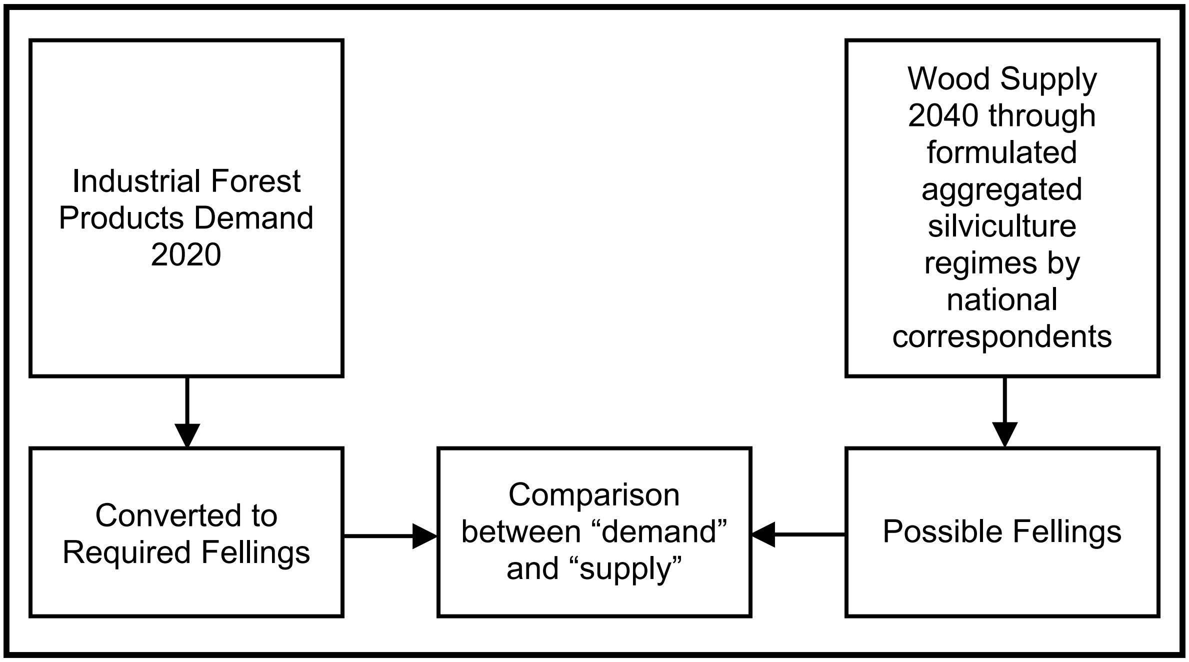


Figure 11: Main models used in the EFSOS analysis.

According to my opinion this approach generates rather conservative assessments of the wood supply possibilities. The "dynamism" of the forest resources is not fully utilized. I think Table 5 supports my argument.

Table 5: Wood supply and forest dynamics on FAWS according to EFSOS (Schelhaas *et al*., 2006) baseline scenario.

	2000	**2030**	**2040**
EU/EFTA			
Total Growing Stock (billion m^3)	16.2	20.0	20.5
Net Annual Increment (million m^3)	515.5	495.0	491.0
Fellings (million m^3)	348.5	416.0	438.0
Removals (million m^3)	260.0	311.0	327.0
Growing Stock (m^3/ha)	157	190	194
Fellings/Net Annual Increment (%)	68	84	89
CEEC			
Total Growing Stock (billion m^3)	10.5	12.0	12.0
Net Annual Increment (million m^3)	269.0	244.0	239.0
Fellings (million m^3)	149.0	216.0	223.0
Removals (million m^3)	110.5	159.0	164.0
Growing Stock (m^3/ha)	191	210	211
Fellings/Net Annual Increment (%)	55	89	93
Pan-Europe Fellings (million m^3/year)	497.5	632	661

As stated in EFSOS (UN, 2005), in spite of the fact that the levels of fellings can not be increased above the presented fellings for 2030 and 2040, there is at the same time a substantial increase of the growing stock of 5.5 billion m^3 between 2000 and 2040. There is no objective of the analysis in building up already high growing stocks during the assessment period. To me this is a strong indication that the wood supply possibilities are under-estimated. Back of the envelope calculations indicate that more dynamic management at a Pan-European level could generate at least an additional 90 million m^3 in 2030 and 65 million m^3 in 2040 compared to EFSOS without decreased 2000 growing stock levels. This is also supported by the alternative scenarios produced by EFSOS having lower growing stocks but higher fellings than the baseline scenario.

As seen in Table 5, there is currently some 29 million ha of forests outside the forests, which contribute to the wood supply. The supply from this resource is rather unknown, and can not be treated appropriately in the existing supply model. The EFSOS (UN, 2005) has to some extent taken into account this resource but not fully. Back of the envelope calculations indicate that the harvest from this resource could increase by 25 million m^3 in 2030 and 30 million m^3 in 2040 compared to the EFSOS analysis.

There is also a remarkable difference between “fellings” and “removals” in the analysis. This means that huge volumes are left behind in the forests. The difference for 2030 is 162 million m^3 or some 35% and for 2040 it is 59 million m^3 or 10%. If this is correct there is a big potential of bioenergy to secure at least up to 2030 in the magnitude of 125 million m^3/year.

10 Under-utilization of Forest Resources

Currently the European forest resources are under-utilized and under-managed. According to Table 5 the rate of fellings in relation to net annual increment in 2000 was 68% for EU/EFTA and 55% for CEEC. However, the EFSOS (UN, 2005) analysis assumes a much higher utilization rate in the future. In 2030 and 2040, the utilization rates for EU/EFTA are 84% and 89%, respectively. The corresponding rates for CEEC are 89% and 93%. If the net annual increment was going to be fully utilized on the FAWS, there would be an additional supply of some 105 million m^3 in 2030 and 70 million m^3 in 2040.

A more intensified forest management will also have a positive impact on the annual increment. Over time there has been a substantial increase in the increment/ha in Europe. This is illustrated in Figure 12. EFSOS is *not* assuming any improvements in the future growth in the baseline scenario (Schelhaas *et al*., 2006). Also, the management regimes in the EFSOS represent the forest management in Europe in the 1980s and 1990s (Schelhaas *et al*., 2006).

If the long term trend would continue, and I see no reasons why it could not, the increment per hectare would increase by about 1 m^3/ha in 2030 and 1.5 m^3/ha in 2040 compared with 2000. This would mean an addition of some 160 million m^3 in 2030 and 240 million m^3 in 2040 of net increment and harvest potentials on FAWS.

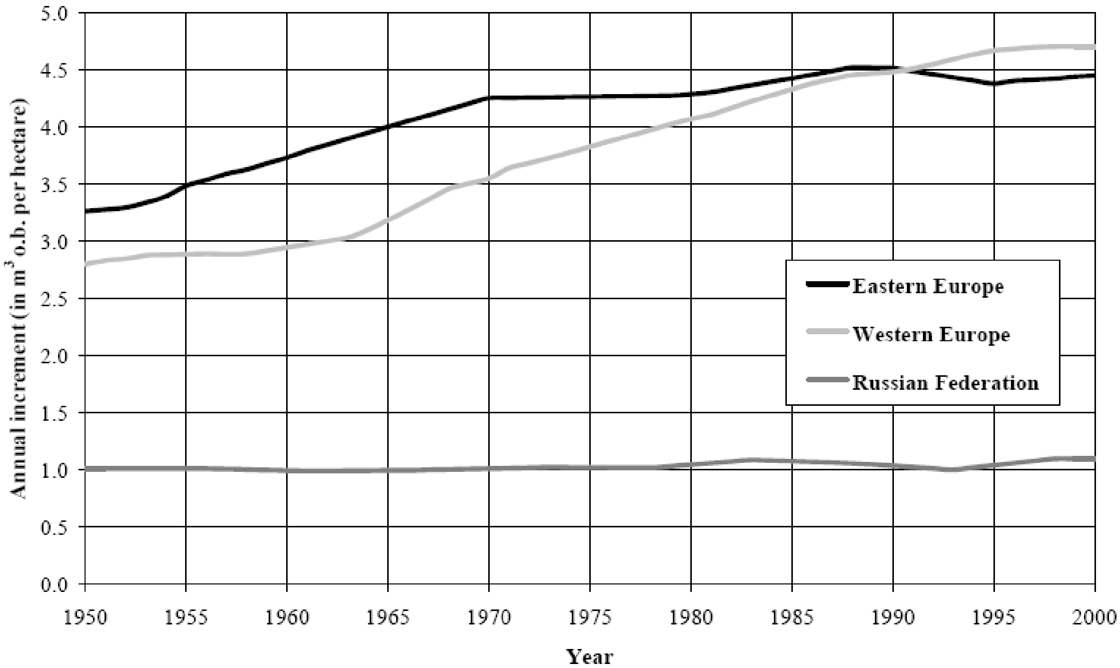


Figure 12: Trends in annual increment per hectare in selected European countries from 1950 to 2000. Source: derived from Gold (2003, Annexes 5.1, 5.3). Note: the Eastern Europe region excludes the Baltic States and four of the five countries of the former Yugoslavia. The annual increment shown here is for FAWS, except for a few countries where statistics were provided for other definitions of forest area. See UN (2005, Section 1.4.1) for further details and explanation.

11 Land Use Change

The land use and corresponding land cover is not a fixed entity over time. It changes due to natural, anthropogenic and economic factors. EFSOS (Schelhaas *et al*., 2006) took into account the historical trend in land use change and historical increase in FAWS according to FAO statistics. By this Schelhaas *et al*. assume that the FAWS will increase by 8% in the EU/EFTA between 2000 and 2040, and by 1.9% in CEEC. The latter number seems low given that this is the region for which we can expect the most dramatic changes of agriculture land.

The EEA (2006b) has recently presented detailed land accounts for EEA-24 for 1990 and 2000 and by that an assessment of the land cover changes over this period. The assessment is based on CORINE land cover mapping. CORINE is a land cover inventory derived from satellite imageries. The land cover distribution for 2000 is presented in Table 6.

Table 6: Land cover account in million ha for EEA-24 in 2000. Source: EEA (2006b).

Artificial areas	17.1
Arable land and permanent crops	116.8
Pastures and mosaics	81.8
Forested area	103.6
Semi-natural vegetation	26.0
Open spaces/bare land	5.2
Wetlands	4.6
Water bodies	4.7
Total	**359.7**

During the period 1990–2000, there were substantial movements between the different land classes. Rough analyses indicate that the future trend increase, on average for the Pan-European level, of forest areas would be +11% between 2000 and 2040. This would generate an additional harvest in 2030 and 2040 of some 25 million m^3/year in comparison to EFSOS. Further down the road, the impacts would be substantially higher. Thus, this is just trend developments. Substantial land areas in Europe are not efficiently utilized. Active land use planning would probably allocate much larger areas to forestry, especially in trying to solve the issues of energy security, climate change and economic growth.

On the other hand, these are theoretical potentials from changed land use and increased FAWS. We know that there are major difficulties, due to socioeconomic constraints, to get full utilization of the FAWS (e.g., EFSOS, UN, 2005). Thus, one of the more difficult issues/questions is how to move the future "socioeconomic supply" to correspond to the "potential supply" from the future FAWS.

Policy Recommendation IV. *Europe should carry out future relevant land use assessments and policies for Europe based on future demands on energy security, climate change/environmental demands and economic growth. At the same time analysis should be made on how to get socioeconomic supply to correspond to the theoretical potentials.*

This means that land cover dynamics have to be linked to economic, social and environmental functions in order to suggest relevant future land use policies. In the end, future land use depends on choices made by the society. Thus, this requires a wide involvement of European stakeholders and not only "forestry".

12 Harvest Biomass Residues

EFSOS (UN, 2005) did not take into account any harvest biomass residues for bioenergy production. This utilization of the forest resources is taking place in a number of European countries but it is a sensitive operation with risk for harming the environment. EEA (2006c) has recently done a study on how much bioenergy EU-25 can produce without harming the environment taking environmental suitability into account. The environmentally compatible bioenergy potential from forest harvest residues in EU-25 is assessed to be 15 million toe in 2010 and 16.3 million toe in 2030. I have used this analysis and results for scaling up to a Pan-European level (Table 7).

Table 7: Assessed environmentally compatible bioenergy potential from forest harvest residues at Pan-European level in million toe.

	2030	**2040**
Pan-Europe	22	22

13 Forest Industrial Product Demand

Forest demand model (see Figure 11) in the EFSOS analysis is based on econometric demand analysis (Kangas and Baudin, 2003) with a time horizon of 2020. However, in the analysis of the wood balance for 2030 and 2040, the demand estimates for these latter years were just prolongations of the demand estimates for the period 2000–2020. This will probably give an over-estimate of the consumption of forest industrial products at the Pan-European level because rather dramatic shifts will take place in demographics during 2020–2040. The population will decrease in absolute numbers and it will grow older. The population of working-age people will decrease by 6–7% during 2020–2040 (UN, 2002) at the Pan-European level. This will result in less consumption of forest industrial products but also less available workforce for the sector.

The EFSOS analysis (UN, 2005) assumes an annual growth rate of the consumption of paper and paperboard in Western Europe of 2.3% during the period 2000–2020. This means an increase in consumption of 45 million tons during this period. Other studies (e.g., Juvonen, 2005) have a substantially lower growth rate in consumption during the same period for Western Europe, namely an annual growth rate of 0.8% in paper and paperboard consumption (see Figure 13).

This corresponds to an increase of some 11 million tons, which means a difference of 34 million tons in the assessments. In turn, this corresponds to a difference in wood consumption of some 120 million m^3 of wood. Schulmeyer (2006) has, in an unpublished paper, compared the EFSOS scenarios with real development during 2000–2005. The paper and paperboard consumption has been flat in Western Europe during this period and is about 12% below the scenario (~10 million tons) after five years development. Thus, the real development speaks for the lower growth rate in consumption of paper and paperboard, which also is in line with the development in North America. On the other hand, during the period 2000–2005, Western Europe has managed to compensate the decreased “domestic” consumption of paper and paperboard by increased export resulting in a situation with a close correlation between scenario and real development for production of paper and paperboard. The question is how long Western Europe can keep this position given rapid globalization.

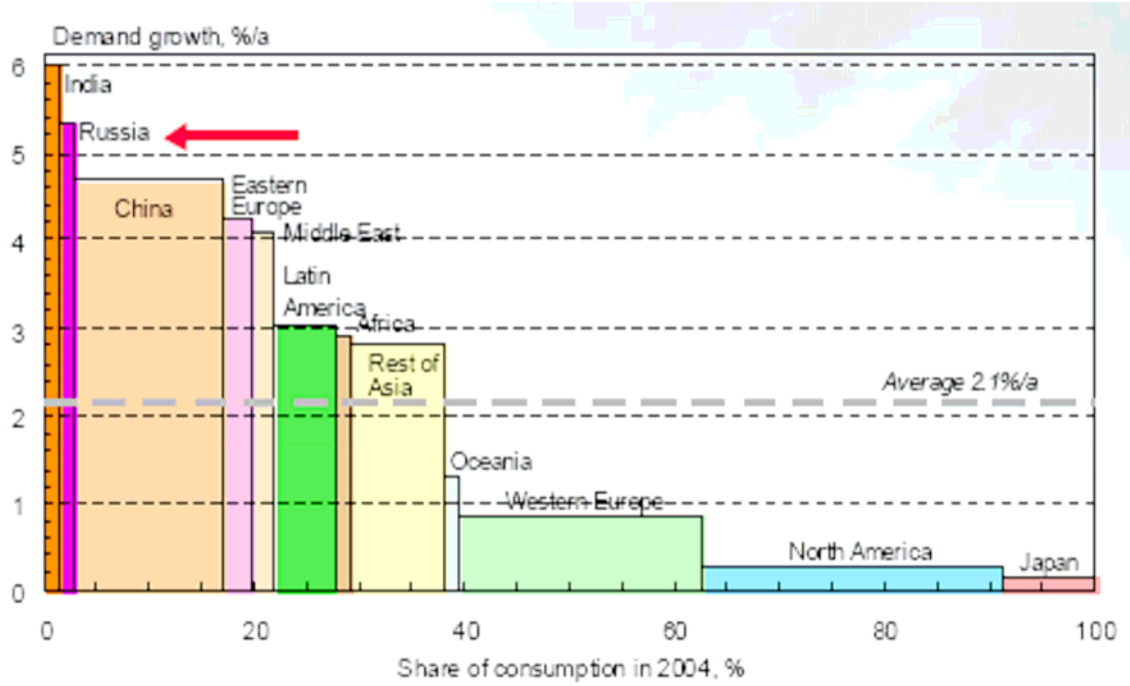


Figure 13: Annual growth rates in consumption of paper and paperboard through 2020. Source: Juvonen (2005).

Given the demographic and related socioeconomic changes expected in Europe up to 2040, it is plausible to assume that the consumption estimates on industrial forest products in the EFSOS study are over-estimated.

14 Woodfuel Demand

The woodfuel demand was not included in the EFSOS demand model (Kangas and Baudin, 2003). Instead an FAO study (Broadhead *et al*., 2005) on global trends in the use and production of woodfuels was employed in assessing the woodfuel development in Europe. The result was an assessed decline in woodfuel consumption as illustrated in Figure 14.

As demonstrated in the background paper for this conference by Becker *et al*. (2006), the wood energy supply and use is much larger than recorded (including the EFSOS study). This is not at all any new phenomena but was stressed already, e.g., by Nilsson (1996). Becker *et al*. (2006) present a rough estimate at the Pan-European level on the current woodfuel supply of 250 million m^3/year instead of the 60 million m^3 used by EFSOS.

The right approach with respect to bioenergy, as I see it, is to start from the overall energy demand and energy strategies (if available) and from that try to assess the contribution by wood fuel to the overall energy demand. And that platform I have tried to establish by the earlier discussed Table 2.

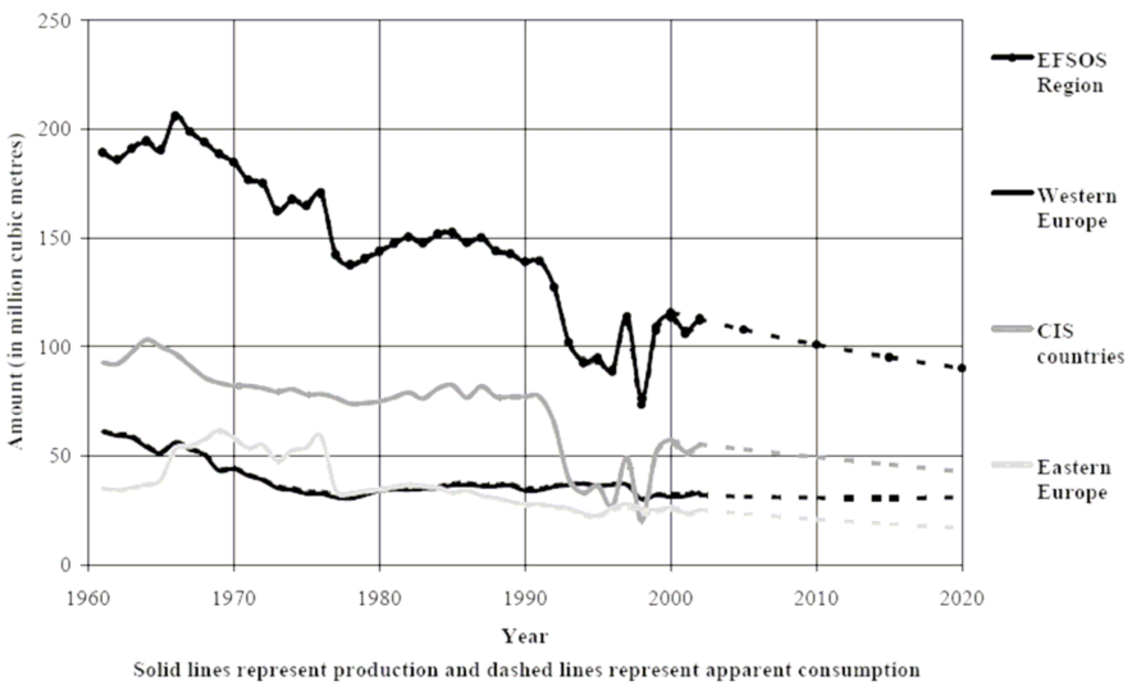


Figure 14: Trends and projections for the consumption of woodfuel in Europe. Source: Broadhead *et al*. (2005).

15 Globalization

The globalization process has changed the rules of the game of the traditional European forest sector rather dramatically. The long-distance transportation costs have been reduced, stimulating the trade of forest products. The globalization process has generated a consolidation of the forest industry, especially the pulp and paper industry, as illustrated in Figure 15.

Globalization has also reduced the dependence by the forest industry on local supplies of raw materials. Companies are now utilizing materials from different sources and locate the manufacturing where the markets develop. Thus, the location and development of the forest processing sector is now influenced less by the availability of forest resources and more by the prevailing investment climate and general economic conditions (Brown, 2000). This has resulted in a shift, especially in the pulp and paper industry, from the traditional producer regions to the South. This is illustrated by Figure 16.

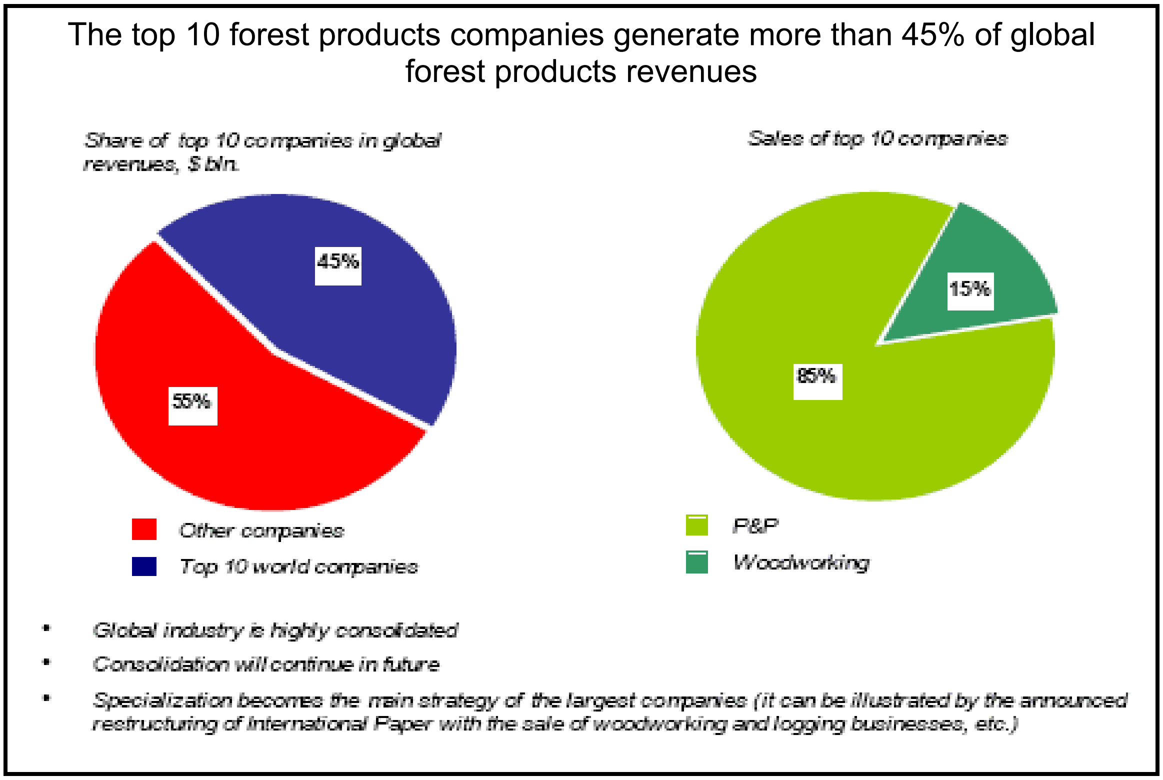


Figure 15: Trends in the Global Forest Products Industry. Source: Graves (2005).

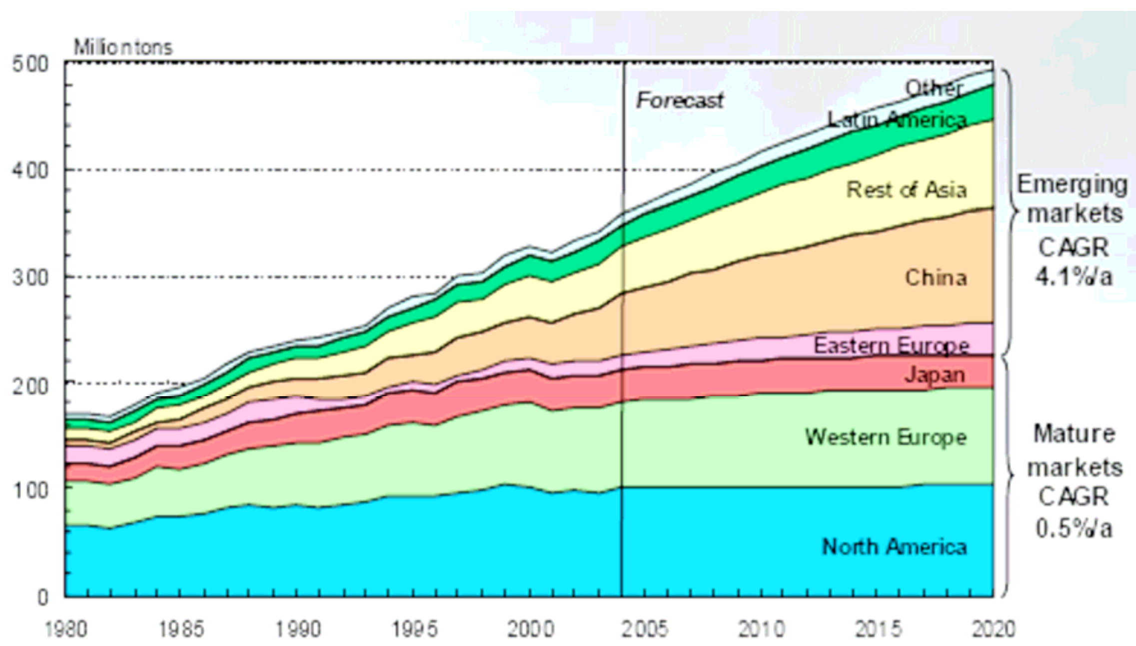


Figure 16: Scenario on world demand for paper and paperboard, 1980–2020. Source: Juvonen (2005).

This development is bringing in new global players. The development can be illustrated by China. China has limited forest resources, limited energy resources, limited water supply, etc., but has a rapid market development and access to inexpensive capital. The latter factor is crucial for the future development of the sector.

China has by far the fastest growing paper industry in the world. Recent expansion has been active with large, modern, high-speed equipment, which is very cost-efficient. This development can be illustrated by the capacity expansion in Table 8.

Table 8: Examples on paper and paperboard development in China. Source: after Flynn (2006).

Ningbo Xiaogang PM1	World's largest machine for white-lined chipboard.
Shandong Chenming PM4	The world's largest newsprint machine. China has the three fastest newsprint machines in the world.
APP/Gold Hong Ye	The world's second fastest tissue machine.
Shandong Bohui	The world's largest folding boxboard machine.
APP China Gold East at Dagang	Has set six world speed records for paper machines.
APP Gold East in Jiangsu	Building the world's largest printing and writing machine.

Low labor costs have *not* been a driving force for this development and the competitiveness of the Chinese Pulp and paper industry. The key factor is *high and inexpensive* capital investments. The expansion can be explained by *inexpensive government loans and subsidies*. This results in an *overcapacity* and *skewed competitiveness* with major implications for the *global pulp and paper industry*. However, the resource-growing pattern of developing Asia in general, here illustrated by China, has created severe environmental problems in developing Asia like, land degradation, deforestation, water shortage, deteriorating water quality and vulnerability to natural disasters. Such growth patterns will prove to be unsustainable (Park and Zhai, 2006).

In the EFSOS (UN, 2005) study, it was concluded that the globalization process would have impacts on the European forest sector as illustrated in Table 9.

Table 9: Impact of globalization on the competitiveness of the European forest sector (UN, 2005).

	Impact of Increased Globalization Compared to the Baseline				
	Area FAWS	**Fellings**	**Production**	**Trade**	**Consumption**
Western Europe	Unchanged	Higher	Higher	Higher	Higher
Eastern Europe	Higher	Higher	Higher	Higher	Higher

However, I think, based on the most recent experiences of globalization, that another matrix can be produced, with respect to the impact of globalization on the competitiveness of the European forest sector (Table 10). I have already discussed some aspects of globalization of the bioenergy in Section 7.

Table 10: Possible impacts of globalization on the European forest sector.

	Impact Compared to EFSOS Baseline Scenario (UN, 2005)							
	Energy costs	**Economic growth**	**Prices**	**Area FAWS**	**Fellings**	**Ind. Production**	**Consumption**	**Trade**
Western Europe	Higher[a]	Higher[b]	Higher[c]	Higher[d]	Higher[e]	Lower[f]	Lower[g]	Higher[h]
Eastern Europe	Higher[a]	Higher[b]	Higher[c]	Higher[d]	Higher[e]	Lower[f]	Lower[g]	Higher[h]

[a] The energy demand/supply will be very tight with high costs as a result.
[b] In spite of high energy costs the globalization has a positive impact on the economic growth (WB, 2007).
[c] Prices on both forest raw material and industrial products will increase due to energy costs and tight demand/supply on raw material.
[d] Due to increased energy prices the rate of conversion of agriculture land will increase.
[e] The fellings will increase due to increased prices and increased demand on bioenergy
[f] The production of industrial forest products may decrease due to increased global competition.
[g] The consumption of industrial forest products will be lower due to changed demographics and increased competition by globalization.
[h] The trade of forest products will increase due to increased globalization.

Where does it leave us with respect to future demand on forest raw material?

I think there is a high probability that the demand on wood for traditional industrial products will be lower than assessed in the EFSOS baseline scenario due to increased globalization and competition during the period 2000–2040. But the question is for how long this increased competition will last. Nilsson (2006b) has demonstrated that there is a substantial over-harvest taking place in Asia and in large parts of Africa and that the demand/supply situation in Latin America will grow much tighter in the future. In the same document, Nilsson (2006b) points out that the rate of industrial forest plantations have decreased substantially during the last decade and are foreseen to decrease further in the future. Given the uncertainties surrounding the impacts of globalization on the traditional forest sector, I think it is wise for the moment to use the existing baseline scenario of EFSOS with respect to industrial production of forest products in Europe for planning purpose with respect to wood utilization. However, I think it is crucially important for Europe to try to do solid impact analysis of globalization on the traditional forest industrial sector in Europe.

Policy Recommendation V. *Urgently, Europe should carry out solid assessments of the impact of globalization on the competitiveness of the European forest sector.*

16 Conclusions on EFSOS

I have discussed a number of issues, although far from complete, of the EFSOS analysis which may affect the resulting wood balance for Europe through 2040. This should not at all be regarded as criticism of EFSOS but rather as identification of issues important for the wood balance and important to follow carefully in the future. Given the debate and the developments foreseen, I think it is important to do yearly updates of the EFSOS wood balance based on available knowledge. At the end of the day, EFSOS is the most advanced instrument we have with respect to consistent future wood balances for Europe.

Policy Recommendation VI. *The ECE should carry out simplified yearly updates of the Pan-European wood balance through 2040.*

17 European Bioenergy Production from Other Sources than Forest Biomass

In order to approach a future wood balance for Pan-Europe, I think it is also important to assess how much bioenergy Europe can produce from agriculture and biowaste. EEA (2006c) has, in the same way as for forest biomass residues, analyzed environmentally compatible bioenergy potentials from agriculture and waste. I have used the data and results for scaling up to a Pan-European level and the results are presented in Table 11.

Table 11: Environmentally compatible bioenergy potentials from agriculture and waste at Pan-European level in million toe.

	2030	2040
Agriculture potentials	146	210
Waste potentials	125	128
Total	~270	~340

About 45% of the waste potential is stemming from forest related products like black liquor, waste wood and wood processing residues. Some 40–45% of the agriculture potential is assessed to come from short-rotation forest bioenergy and tall grasses.

Thus, there are huge potentials in agriculture energy production. However, earlier I have expressed concerns about energy farming because it is not energy, cost, and climate efficient. But there is a high risk that the current subsidies for traditional agricultural production will turn into subsidies for energy farming and in that case a development in this direction is difficult to change.

Policy Recommendation VII. *Europe should carry out Pan-European analysis of the energy, cost, and climate efficiency of agriculture energy farming.*

18 Wood Balance Through 2030/2040

In the following I will try to summarize the earlier discussion in the form of a calculation example of a wood balance at the aggregated level of Pan-Europe. The wood balance may give an indication of a possible need and magnitude of wood mobilization.

In this example, I will use EFSOS (UN, 2005) baseline scenario as a platform.

The industrial demand according to the EFSOS baseline scenario and the possible sustainable fellings according to EFSOS are presented in Table 12.

Table 12: Basic wood balance 2030/2040 in million m^3.

	2030	**2040**
Demand expressed as annual fellings (EFSOS, UN, 2005)	680	710
Over-estimated industrial demand (see Section 13)	560	587
Sustainable fellings (EFSOS, UN, 2005)	630	660

If we take the baseline scenario according to EFSOS there are difficulties to meet the industrial demand after some time around 2020 and there will be a deficit in supply for 2030 and 2040 of some 50 million m^3/year. But if I am right in my assumption that the industrial demand of paper and paperboard is substantially over-estimated there is more than sufficient wood supply of industrial wood also in the future and no mobilization is needed.

The picture will be more complicated when we try to incorporate the energy sector to the wood balance. If we do a partial energy balance for 2030 based on OECD/IEA (2006) reference scenario (Table 2) and an allocation of assessed bioenergy potentials (Sections 12 and 17) in an "optimal" way we get a result in line with Table 13. Of course, an "optimal allocation" will never happen in reality. But the approach will help in sorting out the magnitude of the problems concerning woodfuel demand.

Table 13: Partial energy balance for 2030 and Pan-Europe based on the modified OECD/IEA (2006) reference scenario; expressed in million toe.

Demand / Supply	**Coal**	**Oil**	**Gas**	**Heat**	**Biomass**	**Biofuels**	**Other Renewables**	**Nuclear**
Supply	147	761	494	90	95	32	30	118
Forest harvest residues					22			
Agriculture Biofuels						32		
Short-term rotation forestry-agriculture					70			
Agriculture biogas			41					
Waste-biogas			35					
Waste				90	3			

As seen in Table 13, an "optimal" allocation of the bioenergy potentials will cover the demanded amount of biofuels, biomass, heat generation and 76 million toe of the gas demand.

But this will not solve the overall problem of energy security in the form of volatility in supply and prices and improved climate. How much reduction of fossil fuels do we need in order to make a dent in the overall problem? Who knows?

But Stern (2006) assessed that to stabilize the climate by a GHG concentration of 500–550 ppm the emissions have to be *25% below the 2005 emission level by 2050*. It should be stressed that the increase of CO_2 emissions during 2005–2030 in the OECD/IEA (2006) reference scenario (Table 1) increases by 55% at the global level. This means that the 2030 emissions should be reduced by 80% in order to reach a stabilization of the climate according to Stern (2006). This is more than a daunting task.

How much has the fossil fuel consumption to be reduced in order to avoid volatility in prices and supplies? I do not know. But I would guess that we need a reduction of at least 25% in order to have any impact. Let us take 25% as our calculation example. This reduction corresponds to a reduction of 295 million toe (after the existing bioenergy potentials have already been used). This amount of energy can theoretically be replaced by increased renewable energy of hydro-, geothermal-, wind-, solar energy, etc. It can also be replaced by increased nuclear energy production. But it will be difficult to generate all the needed energy through these means. Perhaps 50% of the need can be secured this way. But this means 150 million toe needs to be covered by woodfuels. This corresponds to some 450 million m^3/year in 2030. As discussed in Section 7, some of this can be covered by import to Europe. Based on current trends, the import potential points may be in the magnitude of 50 million m^3 or 15 million toe in 2030. This means a needed additional demand of 400 million m^3 at the Pan-European level. If this additional "demanded" volume is inserted to our wood balance in Table 12, it can be seen that there will be *substantial supply problems of wood* and that there *will be strong competition between traditional industrial use of wood and the energy sector*.

I am fully aware that this is just a calculation example with all kinds of deficits but I think it illustrates the magnitude of the problem.

Thus, I would strongly argue that there are strong reasons for wood mobilization at the Pan-European level if we are going to tackle the overall problems of economic growth, energy security and a stabilized climate.

19 The Story Line

The story line that can be made based on the earlier discussion can be summarized as outlined in Table 14.

Table 14: Story line summary.

Assumption	Need for Mobilization
1. EFSOS baseline scenario and environmentally compatible bioenergy from forest residues, agriculture and waste.	Moderate mobilization of industrial roundwood is required. Some 50 million m^3/year.
2. As #1 but with less demand on industrial wood compared to EFSOS baseline scenario.	No mobilization required.
3. Contribution to the solution on economic growth, energy security and climate change/environment.	Dramatic mobilization needed. Several hundreds of million m^3/year.

20 Wood Mobilization

It is a Herculean task to find an efficient path of policies and actions for balancing energy security, improved climate, sustained economic growth and a sustainable industrial forest sector in Europe. The problem is not becoming easier by the fact that impacts of actions taken have to materialize rather soon in order to be efficient.

Based on the discussions in Sections 8–11 a number of possible actions for mobilization of increased wood supply can be identified. The list of actions identified is far from complete and there are many other actions to take. But the following wood mobilizing actions have been identified (without priority):

- Generate a better knowledge of the utilization possibilities and increased utilization of the tree cover located outside forests.
- Implement forest management regimes that give a more balanced development of the growing stock.
- Intensified management resulting in more efficient utilization of the net annual increment and improved net annual increment per hectare.
- Changed land use.

From a timing point of view, the highest efficiency in the mobilization will come through implementation of *management regimes with balanced development of growing stocks and intensified management and utilization of existing Pan-European forest resources*.

There are big potentials for increased forest biomass production by change and more efficient land use of the Pan-European land base. But the major impacts will come further down the road—beyond the time horizon discussed in this paper.

If we bring back the impact of the above discussed mobilization measures to the wood balance in Section 18, a rough assessment indicate that these actions could generate some 325 million m^3 in 2030 and 425 million m^3 in 2040, meaning that the earlier discussed gap in the wood balance can be nearly closed.

Thus, in theory there are big potentials resting in the wood mobilization.

But the mobilization of wood will not come for free. It will cost a substantial amount of financial resources. There is a need to cost out the mobilization measures discussed in order to set the right priorities in a mobilization program.

Policy Recommendation VIII. *Europe has urgently to cost out available wood mobilization options and assess the impact over time of the different measures.*

21 Policy Implementation

Thus, I think an effort to mobilize more wood resources in Europe makes sense as we see the problems today.

Markets alone will not take care of the needed resource mobilization, policy interventions are needed. These policy interventions must be based on cross-sectoral coordination. As seen from the earlier discussion, the complexity of the problems requires not just a mobilization of the forest sector but a *mobilization of the society*.

The current policy debate is for the moment colored as a conflict between traditional forest industry and energy interests. I think this attitude is dead wrong. *The current development will generate renewal of the existing industry with new businesses and products and enhanced competitiveness of the industry and forestry*. This should constitute the platform for the required future policy interventions.

Europe does not have any great record with respect to implementation of strong unified policies in the forest sector. Different policy formulations exist but the implementation is lacking (e.g., MCPFE process). The reasons for this are probably manifold. Among others, Nilsson (2005) and Byron (2006) have discussed the lack and difficulties of implementation of policies in the forest sector. One reason is that an economy- and society-wide approach in analyzing, formulating and implementing the policies is lacking. Another reason is lack of efficient institutions.

Policy Recommendation IX. *It is obvious that Europe has to invest a substantial amount of resources in the future on solid investigations of the problem area of economic growth, energy security, and stabilized climate and sustainable environment.*

Policy Recommendation X. *There is a strong need to identify who will be responsible for implementation of chosen policies and strategies for wood mobilization. What resources and authority will the implementers need in order to achieve results? Who will be held accountable for non-compliance of non-achievement? What arrangements will be made to monitor and assess performance?*

To finalize, I would like to make two citations.

Glesinger (1949) stated "Forests can be made to produce fifty times their present volume of end products and still remain a permanently self-renewing source for raw materials… Only forests—no other raw material resource—can yield such returns".

Nilsson (1996) stated: "There will probably be a rather substantial global shortage of industrial roundwood already in 2010. The shortage is driven by increased use of wood for bioenergy".

It seems like these insights are now becoming ripe for acceptance in the forest sector.

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