Vision for a sustainable energy development for EU – 27, 2000 – 2050
- A European vision based on INFORSE's Sustainable Energy Vision

Background note, December 2008, INFORSE-Europe

This background note gives an overview of the assumptions used for the vision. This include potentials for renewable energy and energy efficiency that is used in the sustainable energy vision developed by International Network for Sustainable Energy (INFORSE) – Europe. For the EU-15 the vision is further based on a vision of a slow growth in the energy consuming sectors for the EU-15 with modest growth in demand for housing area, service sector area and electric appliances, stable production in industry and agriculture, and a modest decrease in the demand for transport. For the 12 new member countries the vision includes considerable growth in many sectors.

The current (December 2008) version of this paper will be improved base on comments and further development of national visions.
The scenario is built as:
-a detailed scenario for the EU-15
-national detailed scenarios for Bulgaria, Romania, Latvia and Lithuania
-an overview scenario for Poland
-an overview scenario for the remaining countries together (Czech Republic, Cyprus, Estonia, Hungary, Malta, Slovakia, Slovenia)

The overview scenarios are less developed than the detailed scenarios, but given the small share of the energy consumption from these countries compared to the entire EU-27, even larger errors in the overview scenarios will not change the overall conclusions substantially. The total primary energy supply (TPES) of the countries covered by the overview scenarios is about 13% of the TPES of EU-27.

This note describes the detailed scenario for the EU-15 and gives an overview of the overview scenarios. The detailed scenarios for Bulgaria, Romania, Latvia, and Lithuania are described in separate papers available at http://www.inforse.org/europe/Vision2050.htm.

Assumptions for EU-15

Windpower:
For windpower is used a potential of a maximal 425,000 MW and an average capacity factor of 30% equivalent to 2615 hours of full-load production during a year. This gives a total potential power output of 1111 TWh equivalent to 4000 PJ. This is a combination of 88,000 MW off-shore with a capacity factor of 40% and 337000 MW onshore with a capacity factor of 27%. The figures are based on the Windforce'10 report made by European Wind Energy Association, Greenpeace and Forum for Energy & Development and later updated by INFORSE-Europe for Europe, see http://www.inforse.org/europe/Vision2050.htm. The potential in Windforce'10 includes Norway which is excluded from these figures, both off-shore and on land.

The installed capacity for EU-15 is expected to be:

- 75,000 MW in 2010 (similar to other forecasts[1])
- 220,000 MW in 2020[2]
- 380,000 MW in 2030 and later, using 90% of the above-mentioned potential with an electricity production of 1000 TWh, about 5% higher than the forecast of the European Wind Energy Association

Solar Energy

The area used for solar energy is divided between solar collectors for hot water (for district heating or directly used domestically) with an annual yield of 400 kWh/year in average (about 40% efficiency) and solar electric cells (PV-cells) with an annual yield of 100 kWh/year (about 10% efficiency). This does not exclude that some of the area will consist of other types of solar applications, such as solar thermal power that can replace some of the PV development in parts of Southern Europe.

The solar heating installations are expected to be divided among sectors consuming low to medium temperature heat (below 150'C) and district heating.

The development is expected to continue from current trends. The solar thermal collector area is expected to reach 80 mill. m2 in 2010, similar to the expectations of the European Solar Thermal Association's forecast for a strong development. Then the development is expected to take off and reach 360 mill. m2 in 2020 and 1 billion m2 in 2030. In the end is expected This will result in solar thermal collector area of about 2 billion m2 by 2050 equal to 4.1 m2/person by 2050. The development after 2010 is considerably stronger than forecasted by EREC[3]

The use of solar energy is for the energy consuming sectors limited to:
- 1/3 of buildings heat demand (limited because of seasonal variation)
- 2/3 of low-temperature process heat (assuming equal demand throughout the year)
-15% of medium-temperature heat (use limited to sunny parts of EU
-no high-temperature heat (is spite of the theoretical possibilities, this is not expected to be cost - effective)

To cover 1/3 of buildings demand for space heating and hot water will in some parts of EU require some energy storages of 1-3 months. This will be relevant after 2030.

The area used for solar electric generation is expected to reach 30 mill. m2 in 2010 (0.08 m2/person) and then take off as solar thermal with an installation of 28 mill. m2/year 2010-2020, 46 mill. m2/year 2020-2030, 73 mill. m2/year 2030-2040, and 105 mill. m2/year 2040-2050. With this development, 0.64 m2/person will be used for solar electric generation in 2020 and 5.3 m2/person in 2050. Until 2030 most solar electric development is expected mainly in the EU-15.

The development 2010-2020 is close to previous forecast from EREC[4]

[1] European Wind Energy Association expect 80,000 MW installed but 10% lower electricity production because of lower capacity factor, see www.ewea.org, publications, report "Pure Power", page 10.
[2] This assumes a 20% higher installed capacity and energy production than in the EWEA forecast for 2020 in the report "Pure Poower". This is caused by the assumption of a 11.5%/year increase in capacity 2010-2020 in this vision In any case the expected growth is considerably below the growth 1995-2001 of 37.9%/year.
[3] "*Renewable Energy Target for Europe 20% by 2020*", see www.erec.org.
[4] "*Renewable Energy Target for Europe 20% by 2020*" op. cit.

The total area for solar collection will in this way be 4.5 billion m2 or 4500 km2 in 2050, equivalent to almost 10 m2/person. A large part of this is expected to be on roofs. This area is of course not an absolute maximum; it leaves room for additional solar installations after 2050, if the energy demand should increase.

Bio-fuel

The use of liquid bio-fuels is expected to reach 390 PJ, which can be achieved with about 7% of agricultural land being used with crops for first generation biofuels. The crops can at the same time also yield other products. For instance rape-seed can in addition to oil give fodder that can replace the unsustainable import of fodder. The assumption for energy is for first generation production without genetically modified plants: annual oil production 1 t/ha with an energy content of 10 MWh/ton equal to 10 MWh/ha. 58% of the potential is expected to be used until 2010 and 93% 2020. This is well below the EU target for renewable energy in transport, but this target can also be achieved with electric and hydrogen vehicles.

With other crops and more land-use it is possible to get more from energy from oil-crops or plant-based ethanol, but there is no consensus on the level of sustainable use of bio-fuels for energy. In this vision we have limited the land use for liquid biofuels to 7% of agricultural land, used in a way where the land also provides other products (e.g. fodder).

With second generation biofuels other higher yields and other sources are possible, reducing the land demand. In this vision there is no celluloses based liquid biofuels as this is all used in cogeneration of heat and power that is a substantially more efficient way of using these wood-based products.

Solid Biomass

The potential for solid biomass is expected to be 4100 PJ (wood and straw only) following a number of studies collected by WBGU[3](2003). It consists of:

Timber residues & firewood	828 PJ
Small branches etc.	465 PJ
Industrial wood residues	1246 PJ
Old timber	498 PJ
Landscape management	154 PJ
Straw	915 PJ

More than 1200 PJ equal to 52% of this potential is already utilised today[5] and the trend 2005-2007 was an increase from 49% of the potential. With the many initiatives started for use of solid biomass end the increasing heating prices, it is expected that the trend is tripled and that by 2010 90 % of the total will be used, aiming at a development slightly smaller than in the EU White Paper for Renewable Energy, but higher than in the forecast of EREC[6] . In 2020 the total potential is expected to be utilised.

[5] According to "Biomass Barometer" 2007 (see www.eufores.org), the biomass used in 2006 was 2600 PJ in the EU-15 of which 460 PJ in the 10 "new" countries.

[6] "*Renewable Energy Target for Europe 20% by 2020*" give a total heat and electricity production based on solid biomass + biogas of 3400 PJ. This vision gives a sum of biogas + biomass for 2010 of 4300 PJ from which is subtracted a conversion loss.

For total biomass for heat and power (solid biomass, biogas, and energy forest) the expected consumption by 2020 and later is about 10% below the forecast of EREC[7].

Biogas

For the the potential for biogas from waste water, landfill and agriculture for EU-15 is taken the figure of 209 TWh = 750 PJ from "*Biogas potential from BIOGAS IN EUROPE - a general overview*[8]

The use of biogas was growing from 192 PJ in 2005 to 216 PJ in 2006[9]. We expect that this trend has increased 1.5 times from 2005-2006 to 2006-2010 with additional measures for biogas. Then by 2010 the utilisation will be 375 PJ, equal to 50% of the potential. This is below the EU White Paper Target of 630 PJ (15 Mtoe) in 2010, but anyway an increase. We expect that the full potential is used in 2020.

Energy Crops

The potential for energy crops is dependant of the excess land of agriculture. It is estimated that a maximum of 7% of the 1.3 mill km2 of agricultural land in EU-15 can be used for energy crops such as energy forest. Some of the new EU countries have larger areas laying as unused land, but in other countries it might even be hard to reach the 7% for energy plantation. areas. Therefore an average of 7% is seen as reasonable. With a yield on the land of 9 tons dry matter/ha and an energy content of 4.9 MWh/ton[10] of dry matter, the corresponding energy potential is 400 TWh = 1450 PJ.

The development is expected to take off after 2010 and be utilised fully by 2020.

Geothermal energy

The WBGU[11] gives a global potential of 30,000 PJ incl. hot-dry-rock utilisation which is not cost-effective today; but gives no potential for Europe. In this vision the use is expected to raise to 450 PJ, or 2,5% of the world potential until 2050. Of the current use of 150 PJ, the electricity production is 17 PJ. The electricity fraction of 11% is expected to continue.

The development is expected to lead to an increase of 60 PJ 2000 - 2010, similar to the growth forecasted by EREC[3,] reaching 210 PJ in 2010, and then continue as forecasted by EREC with a growth of 120 PJ 2010 – 2020, to reach 330 PJ in 2020. Then the development is expected to continue with 12 PJ/year to reach 450 PJ in 2030.

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[7] "*Renewable Energy Target for Europe 20% by 2020*" op. cit.

[8] "*Biogas potential from BIOGAS IN EUROPE - a general overview*" by Jens Bo Holm-Nielsen, MSc. & Teodorita AI Seadi, Sc, Southern Danish, available at: University.http://www.ecop.ucl.ac.be/aebiom/articles/biogas/biogas2.htm

[9] Biogas Barometer 2007 (converted from ktoe), available from www.eufores.org

[10] Biomass includes humidity and the calorific value depends on this. As an example coniferous wood with 40% humidity has a lower calorific value of 2.9 MWh/ton, but relative to the dry matter content (60%) the lower calorific value is 4.8 MWh/ton. For beech wood with 20% humidity the lower calorific value is 4.1 MWh/ton and relative to the dry matter the lower calorific value is 5.1 MWh/ton. For straw with 15% humidity the lower calorific value is 4.0-4.2 for different types of straw and relative to its dry matter content the lower calorific value is 4.7 – 4.9 MWh/ton. As an average the (lower) calorific value is set to 4.9 MWh (17.6 GJ) / tons of dry matter.

[11] German Advisory Council on Global Change (WBGU), Hartmut Grass et. al., World in Transition – Towards Sustainable Energy Systems, 2003. Available from www.wbgu.de, co-published with Earthscan, London.

Hydropower

WBGU[1] states the economic hydro-power potential in Europe to 2800 PJ of which 2100 PJ 75% of the economic potential is already used, while the technical potential is 3700 PJ. In EU-15 countries the hydropower use production was 1150 PJ (IEA, data for 2000), and it is expected that it can increase with 20%. The first half of the increase is expected to be until 2010, while the other half is expected to be in the period 2020-2030. Statistics show that hydropower production did not increase 2000 to 2006 in spite of construction of small hydropower and improvements of all hydropower, but the reason is annual fluctuations that are normal with hydropower.

The development until 2020 is very close to the forecasts of EREC[12]. Only minimal increases are expected after 2020.

The EU White Paper expects an increase of 4.15 Mtoe (175 PJ), 1995-2010, equivalent to a 15% growth.

Renewable Energy Potentials for the 12 "new" EU countries

For the potentials for renewable energy is used the values in the table below. This is not table of absolute maximal potentials, but an overview of the use of renewable energy by 2050 according to the current version of the vision.

RE-Potentials Used until 2050(PJ)	Poland	11 other countries	12 New countries
Windpower	36	181	216
Solar heat	49	428	477
Solar PV	65	146	212
Bio-fuel, liquid	n.a.	63	63
Solid biomass	450	1294	1744
Biogas	50	75	125
Energy Forest	183	355	538
Geothermal heat	80	249	329
Hydro	26	169	195

For sources for data for Poland, see special note on Poland. For the other nine countries are used the following:

- for windpower is estimated a total potential of 22,000 MW and an average load factor of 2075 hours/year. Large contributors are Romania (3400 MW). Bulgaria (3000 MW), Czech Republic (3000 MW), Slovakia (2500 MW), Lithuania (2200 MW), and Estonia (2000 MW).
- for solar heating is included an expansion to 4.2-8 m^2/capita in 2050 with a power production of 400 kWh/m^2, except for Bulgaria, where the insulation is higher (see report on Bulgaria)
- for solar electricity (PV and solar thermal electric) is included an expansion to 3 m2 (in Romania) to 10 m2 (in Hungary that has less alternatives, Czech Republic and Slovakia) with a power production of 100 kWh/m^2
- for liquid biofuel is used a potential of 7% of the agricultural land except for 5% for Estonia, Slovakia, and Slovenia. No contribution expected from Cyprus or Malta. The expected annual energy output is (modestly) set to 10 MWh/ha similar to the EU-15.

[12] "*Renewable Energy Target for Europe 20% by 2020*" op. cit.

- for solid biomass is used national estimations for Bulgaria, Romania, Czech Republic and Bulgaria and for the other countries estimations based on surplus wood resources from Biofuels[13], plus own estimates for straw
- for biogas is used national estimates for Bulgaria, Latvia and Lithuania (see national reports) and for the other countries simple estimate based on data for Czech & Slovak Republics
- for energy plantations is expected use of 7% of agricultural land, except for Slovakia, where the expectation is 40% according to official plans The Slovakian contribution is 5% of the new EU countries except Poland. The yield is expected to be 4.4 GWh/km^2, equal to a harvest of 9 tons of dry matter/ha and an energy value of 4.9 MWh/ton
- for geothermal heat is made a simple estimate based on country estimates from Czech Republic of 108 PJ and Slovak Republic of 23 PJ. National estimates are used for Bulgaria, Romania, Lithuania and Latvia.
- for hydropower is expected a potential up to 35% higher than current use except for Bulgaria (40% increase), Lithuania (60% increase), and Romania (60% increase), based on national plans. The technical potential is higher, but there are substantial environmental constraints that have limited the development included in this vision.

Efficiency Potentials

For the vision is used the finding that the efficiency can be increased a factor 4-10 with known technologies. This has been shown to be possible for Western European energy consuming sectors, see e.g. "Factor 10 Club" (www.factor10.de). Even though the increase of efficiency is cost effective, it will not happen by itself, as the decision-makers, e.g. the designers and manufacturers of equipment are not dedicated to supply and install energy-efficient products for a number of reasons. The increase in efficiency is in this regard measured as decrease in the specific amount of energy used to provide a certain energy service (heated floor space, transported persons or amount of goods, amount of industrial production, use of electric appliances etc.)

For transport, electric appliances, and industrial production, the energy consuming vehicles and equipment will be changed several times during the 45 years that the vision covers. Thus, there will be no technical limitations for raising efficiency a factor of 4 or more. In the transport sector the realisation of the efficiency will require a technological shift from present internal combustion engines with 15-20% efficiency to electric vehicles with up to 80% efficiency including battery charging losses, hydrogen fuel cells with >60% efficiency. In addition is expected implementation of technologies to regain brake-energy from vehicles.
The following increase in efficiency is included in the vision for road transport except cars, industrial appliances and electricity use:

- 2000 – 2010 5% in total
- 2010-2020: 2%/year
- 2020-2030: 3%/year
- 2030-2040: 4%/year
- 2040-2050: 4.6%/year

[13] Trade in Biofuel. NUTEK, Stockholm, 1993, ISSN 1102- 2566

For cars for the EU-15 is included that they will increase efficiency 41% from 2000 until 2020 based on the agreement to decrease CO2 emissions to 95 g/km in 2020 in average and that the average in 2000 was 160 g/km. Almost all the efficiency increase is expected 2010 – 2020. to increase further 13% 2020 – 2030 and then 25% 2030 – 2040 and 36% 2040 –2050 with the change to electric and hydrogen cars. The efficiency in 2050 will then be 4 times higher than in 2000 similar to other energy using products.

For agriculture, construction, rail and water transport the following efficiency increases are included until 2050: 40% for agriculture and 50% for construction, 40% for rail transport (as it is already partly electrified), and 25% for navigation. Also for these sectors the start is expected to be slow: 5% increase 2000 – 2010 for agriculture and construction and no increase in efficiency in rail transport and navigation.

For space heating there will not be the same rate of replacement as for energy using equipments or vehicles, and it will be difficult to realise the factor 4 efficiency gain until 2050, even though the technical potential is higher. The limitation is given by the rate of heat conservation. In the vision is included fopr EU-15 a reduction of specific heat demand of 5% 2000 – 2010 and 2%/year after 2010. This gives a reduction in specific heat demand of 57% in the period 2000 – 2050. In addition is included an increase in efficiency of the heating systems in the buildings of 15% (from 80% to 95%) calculated as the ratio between heat demand and final energy demand for heating.

For energy supply is expected an increase in the conversion efficiency in the electricity-and heat sector, leading to a decrease in the average loss in power and CHP plants. For EU-15 is expected a change from currently 35% loss in CHP plants and 66.6% loss in power-only plants to 11% loss in CHP plants (electric efficiency 50%) and 45% loss in power-only plants (electric efficiency 55%). Heat stations' efficiency is expected to increase from 69% in 2000 to 88% in 2050 in EU-15.
Also the efficiency of the electricity network is expected to increase; in EU-15 from currently 7% to 4%, - a development that will be possible with new DC technology, but because of increase electricity storage demand, the losses in the electric system (lines and storages) is expected to remain at 6% (the plan is 58% intermittent power production in 2050, 22% is used for flexible consumption, and 25% can be used with regulation of other power production and demand side measures including charging of electric cars while the remaining 11% of the power will need additional electricity storage loosing 15-20% of that power). The losses in heat networks (district heating) is expected to remain constant as the increasing use of networks and the increased use of heat storage tanks will increase losses, while new super-insulation (e.g. vacuum insulation) will reduce losses. The use of CHP-based electricity is expected to increase in EU-15 from currently 13% of thermal electricity production to 35% of thermal electricity production in 2020 and to over 90% of thermal electricity production in 2050 (less increase expected in the 12 new EU countries as geothermal will cover a larger share of heating).

Efficiency Potentials for “new” EU countries

For the vision is used the finding that the efficiency can be increased a factor 4 with known technologies as mentioned above. With the approximation of the 10 new countries to EU standards, it is also expected to be achievable in the 10 “new” countries. The above proposed increase for different sectors in the EU-15 are also applied for the “new countries”. Given their lower level of the efficiency,. The absolute efficiency potential is higher; but the investment ability is lower, leading to generally higher demands for shorter pay-back periods of investments.

Some national variations to the above are included for Romania, Bulgaria, Latvia, and Lithuania, see national reports.

Demand for energy services

Development for the 15 "old" EU countries
The demand for energy services (heated floor space, transport etc.) is expected to increase as follows:

Heating (district heating + heating from fuels)**:**
-households: 1%/year until 2020 and then stabilising in 2040 on the level of 130% of 2000
-private and public service: same as for households
-industry, construction, and farming: unchanged production volume during the period (but the value of the production will of course increase)

Electricity:
-households: 10% higher growth than the increase in floor space, leading to a level from 2040 of 143% of the 2000 level
-public and private service: same as for households
-industry, construction, and farming: flat

Transport:
Passenger car use: 15% increase until 2010 following increase 2000-2007, then decrease to 90% of the 2000-level (78% of the 2010 level) until 2020 and further decrease of 1%/year until 2040, where it will remain at a level of 65% of today's level. This is a vision for sustainable development, and this development follows the visions that many transport NGOs are for, often with decrease of car use realised faster than in this vision).
Passenger trains: increase 3%/year until 2030, where it will remain at a level of 2.5 times today's level
Buses: increase of 1%/year until 2020, then stable at 1.2 times the 2000-level
Road freight: 10% increase 2000-2010 following increases 2000 – 2007, then decrease to the 2000-level in 2020 and from 2020 to 2050 reduction by 50%. This sharp reduction is expected with an increase of rail freight to 2.5 times the 2000 level and an introduction of environmental costs in road freight, so the freight all the freight of low-value goods is limited to the shortest possible distances.

Rail freight: same as for passenger trains

Navigation: stable 2000 – 2010, then 2%/year increase until 2030, then stable at 1.4 times the 2000-level

Pipeline: stable until 2010, then reducing because of less European gas demand till 70% of today's level in 2050. In 2050 the main role could be transport of hydrogen around in Europe.

(air transport is not included in this vision)

Demand for energy services in the 10 "New" EU countries
The demand for energy services (heated floor space, transport etc.) is expected to increase as explained below. Some national variations are included for Romania, Bulgaria, Latvia, and Lithuania, see national reports.

Heating (district heating + fuels):
-households: 1%/year until 2020 and then stabilising in 2030 on the level of 130% of 2000
-private service: 3%/year 2000 – 2030 and then stabilising on a level of 250% of 2000
-industry, construction, and farming: unchanged production volume during the period (but the value will increase)

Electricity:
-households are: 10% higher than the increase in floorspace, leading to a level of of 143% of 2000 from 2040
-public service: same as households, leading to a level 275% of the 2000-level from 2040
-private service: 10% higher than the increase in floor space, leading to a level of 275% of 2000 from 2040
-industry, construction, and farming: increase of 2%/year until 2020 (because of increased mechanisation) until 2020, then stable

Transport:
Passenger car use: increase of 3%/year until 2030, then stable on a level of 250% of the 2000-level
Passenger train: same as for cars
Buses: increase of 1%/year until 2020, then stable
Road freight: same as for passenger cars
Rail freight: same as for passenger cars
Navigation: stable 2000 – 2010, then 2%/year increase until 2030, then stable
Pipeline: stable until 2010, then reducing because of less European gas demand till 70% of today's level in 2050
(air transport not included)

Fuel shift
Fuel shift is in general limited to max 3%/year increase or decrease in a sector of a specific energy source, but the total can be more as more fuel shifts can happen simultaneously. A few instances are foreseen more rapid fuel shift:

Nuclear power is phased out in the EU-15 until 2020.
In the 15 new EU-countries, nuclear power is reduced with 77% in 2020 from 2000 and fully phased out before 2030.

Fossil fuels
The small remaining oil and gas production in is expected to decrease gradually. For EU-15 the reserve/production (R/P) ratio for oil was only 10 years in 2000. Because of that is included a fast decline in production, with no significant oil production after 2020 in EU-15. For gas the R/P ratio

was 18 years in 2000, and the development is a more gradual decline leading to no gas extraction after 2030 for EU-15.[14]
The remaining oil and gas demand is expected to be covered by imports.
For coal, lignite, and peat, exhausting of resources are not expected to have an influence, but the coal production is expected to be phased out until 2030 for EU-15 because of phase out of subsidies, starting with a 40% reduction 2000-2010.

For the 12 new countries internal oil resources cover 17% of current demand, while internal gas sources cover 31% of consumption. These are expected to decrease progressively following an R/P ratio of about 25 years. Coal use is expected to decrease with decreasing demand for the 12 new countries.

Energy storages
The high reliance on intermittent renewable energy – wind and solar- will require energy storages and flexible energy use. In the electricity sector is introduced flexible consumptions:

- heat pumps with heat storages that can be used to convert electricity to heat with a factor (Coefficient of performance) of 4.
- hydrogen production for transport.

For the 15 "old" countries the intermittent electricity production is expected to increase to 39% in 2030, but with 13% flexible electricity use, the need for additional electricity storages will be small minimal. In 2040 with intermittent production of 49% and flexible consumption of 16%, electricity storages will be needed. In 2050 with 58% intermittent production and 22% flexibility electricity use, there will be need for storage of a bit more than 10% of the power production, increasing power system losses with about 2%
For the 10 new countries there is not expected demand for electricity storages because the expected intermittent supply is less, in particular windpower.

In heating there will be need for seasonal storages after 2030 in some countries when solar thermal is expected to cover more than 10% of space heat demand.

The closure of nuclear power will free some existing electricity storage capacities (hydro pump storages); but the increase of geothermal electricity production will require a part of this storage.

About this note
This note was developed by Gunnar Boye Olesen, INFORSE-Europe for the Vision2050 for EU-25. Read more about the vision at www.inforse.org/europe. Please send comments to ove@inforse.org.

[14] According to BP 2004 Statistical Review of World Energy with R/P ratios for 2003 transferred to 2000-levels with addition of 3.

ANNEX

The target and the White Paper for Renewable Energy 1997

Just before the Climate Convention Conference in Kyoto in December 1997, where the Kyoto Protocol was agreed, the EU Commission presented a White Paper on Renewable Energy. The paper has proposals for increased use of renewable energy and an aim of doubling the use of renewable energy from 5.2% in 1995 to 12% in 2010. In the analysis behind the paper was proposed increases of all types of renewable energy. The sources were expected to be:

- solid biomass for cogeneration of heat and electricity, increase of 32 Mtoe
- solid biomass for heating, increase of 25 Mtoe
- liquid biomass, mainly for transport, increase of 18 Mtoe
- biogas & landfill gas, 15 Mtoe
- windpower, 40,000 MW, increase of 6.5 Mtoe
- hydropower, increase of 4.15 Mtoe
- solar heating, increase of 3,74 Mtoe
- geothermal for heat and for cogeneration, increase of 2.7 Mtoe
- Solar PV, increase of 0.26 Mtoe
- Passive solar, increase of 10-25 Mtoe

With passive solar increase of 10Mtoe, and increase of energy consumption of 16% this will increase renewable energy use to 12.0 % using the Eurostat Convention (with the "substitution principle" it will give 15%). The biomass sectors, together 90 Mtoe increase, are expected to be the most important. Almost half of the biomass is expected to come from energy crops (27 Mtoe as solids and 18 Mtoe as liquid biofuels though some biofuels could also come from residues). If the solid biomass comes from energy forests it would cover 6.3 mill ha (4.5% of the 141 mill. ha of total agricultural area), but with special high yielding crops it can be smaller.

(from INFORSE-Europe website, section on EU policy): www.inforse.org/europe