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CLASSIFICATION OF EUROPEAN BIOMASS POTENTIAL FOR BIOENERGY USING TERRESTRIAL & EARTH OBSERVATIONS

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WP3 – CURRENT TERRESTRIAL METHODS AND ACTIVITIES FOR BIOMASS POTENTIAL ASSESSMENT

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REPORT ON PAN-EUROPEAN METHODS

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SEVENTH FRAMEWORK PROGRAMME

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1. Introduction

This document was prepared within the framework of the CEUBIOM project which is funded by the European Commission's FP7 programme. The overall objective of the project is to develop a common methodology for gathering information on European biomass potential using terrestrial and earth observations. The intention of this report is to describe the status of the assessment of terrestrial biomass for energy in European Countries working as partners in CEUBIOM. The items to be discussed in the report are listed below:

- Routines and ongoing terrestrial biomass assessment activities,
- Biomass potential assessment methods through collecting regionally-specific data on current agricultural production, environmental impacts of potential crop changes, current biomass use and future prognosis, socio-economic issues and relevant legislation and support measures,
- National data on plant growth and primary productivity, indicators of vegetation health etc.,
- Assessing the feasibility of promoting non-food agricultural products including energy and shifting towards sustainable farming as measures to insure against overproduction.

Countries addressed in this report are

1. Austria
2. Bosnia and Herzegovina,
3. Bulgaria,
4. Croatia
5. Czech Republik
6. Germany
7. Greece
8. Hungary
9. Italy
10. FYR Macedonia
11. Romania
12. Slovakia
13. Slovenia
14. Serbia
15. Ukraine

In a former report (D3-2, November 2008) the situation in the South East European countries was discussed. This report takes outcomes of the report on South East European countries as a starting point, completes it with the reports from other European countries, and gives a systematic overview of methodologies used for terrestrial biomass potential assessment in Europe.

Data was collected using a questionnaire, developed as part of the project. The questionnaire asked for information on methods used for assessment of biomass-for-energy potential and for information on activities utilized to perform the assessments (only methods and activities for terrestrial assessment were investigated). The questionnaire, along with comments and suggestions for filling in the Information, is attached to this report as attachment A16.

The questionnaire was circulated to the partners in the countries studied (Serbia is not a partner in CEUBIOM, but the information on Serbia was provided by the Slovenian partner University of Ljubljana). The completed, returned questionnaires are attached to this report as attachments A1 to A15.

In addition to the information in the questionnaires, the partners provided country reports following a specific template and collecting more general information on the country. Chapters 2.1 to 2.15 of this report present these country reports.

The present report is a working document and will be sent to the Public Authorities of the contributing countries and depending on comments on their sides an updated version may be produced later this year.

2. Country reports

For each country CEUBIOM partners have provided a country report containing the following information:

General information (country, author, organisation)

Overview on the country's situation

General status of biomass-for-energy politics and biomass-for-energy use

Methods and activities

A short overview of methods and activities summarizing the following items:

- Kind of data used (statistical data combined with expertise, other data collection)
- National or regional assessment
- Kind of potential assessed (theoretical, economic, etc.)
- Snapshot view or scenario calculation
- Environmental considerations for impact of included crop changes.

National data on plant growth and primary productivity

Feasibility of promoting non-food agricultural production (as a measure to prevent overproduction and shift towards sustainable farming and energy production).

Conclusions

The country reports are integrated in the report as chapters 2.1 to 2.15.

2.1 Country report for Austria

Author(s)*: Maximilian Lauer

2.1.1 Overview

In Austria the use of wood as an energy source for room heating and also for electricity production is a long-standing tradition.

Total Energy supply in Austria is about 1400 PJ/a (2007). Renewables constitute up to about ~360 PJ or ~25 % of this total. Renewable energy sources include biomass (mostly wood ~ 210 PJ), hydropower (~134 PJ) and other sources, e.g. wind, solar, etc. The share of renewables in Austria's energy supply is traditionally high but in the last years has been falling rather than rising because energy consumption is growing faster than use of renewable energy. In Austria, several facts need to be considered when looking at bioenergy potentials and bioenergy use:

- A large share of forestry by-products and wood industry by-products is used by the pulp and chipboard industry (~40 %).
- A considerable share of wood waste from the wood processing industry is used as fuel (~30 % of the total wood fuel).
- A considerable share of round wood processed in sawmills is imported rather than not grown in Austria (25 – 35 %)

Biomass used for energy purposes in Austria has a composition quite unusual in Europe:

30 % Fuel wood
27 % Wood chips from industry (by-product of sawmills etc.)
14 % biogenic wastes
12 % black liquor (used as fuel in the pulp industry)
6 % wood chips from forestry
11 % others (biogas, RME, wood pellets etc)

Biofuels are used in Austria for heat production (about 80 %); for CHP (18%); and for other uses (automotive fuel, RME).

Traditional use of biomass for energy was not a focus of political considerations until recently. Recently, considerable effort has been devoted to research and technical development of clean and efficient combustion through development of burners for wood chips and pellets etc. Some subsidies have also been made available for installing biomass heating systems in buildings and for the production of "green" electricity (Data taken from Austrian Biomass association and Austrian Energy Agency).

2.1.2 Methods and Activities

In Austria various bioenergy potential assessment activities have been undertaken by Joanneum Research, Austrian Energy Agency, Austrian Biomass Association etc. As the methods used are very similar, the activities of these institutions are not discussed separately. The objective of the activities

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is to assess the realistic bioenergy potentials of the terrestrial biosphere under different boundary conditions.

The methodologies used in the potential assessments are in principle the same. Assessments are based on a combination of statistical data on land use, agro-production, forestry inventory, forest production, energy statistics, etc.; agriculture and energy expertise; and by establishing a set of boundary conditions. Due to use of different boundary conditions, results can vary in spite of use of the same basic data. Fortunately, differences in results are easy to explain.

Many of the biomass potential assessments are done in the context of lobbying. Consequently they need to be interpreted in conjunction with the boundary conditions utilized.

The biomass potential assessments provide sound information on future possibilities to use biomass for energy and a good basis for evaluating the possibility to reach (or fail to reach) political goals.

2.1.3 National data on plant growth and primary production

In principle the availability of official data on plant growth and primary production in Austria is excellent. Data is collected and published by "Statistik Austria", Vienna, and is available at www.statistik.at .

The most important statistical sources for biomass potential assessments are:

- The forest inventory (regularly updated)
- Production statistics (quantities and qualities of agricultural and industrial products, including feedstock used for production)
- Land use statistic (areas in agriculture, use, fertility class, changes in use etc.)

2.1.4 Feasibility of promoting non-food agricultural production

In Austria there is no overproduction in agriculture. As most of the biomass used for biofuel production is produced by forestry, and as the potential in forestry seems to be larger than in agriculture, at least to date there are no specific intentions to use a significant share of agricultural land for production of biomass for energy. For the future, and due to climatic change and political difficulties in energy supply, some initial land-use changes are under consideration. A first estimate of biomass-for-energy from agriculture is based on 20 % of agricultural land being dedicated to energy production (primarily with SRC, corn, and other cultures)

2.2 Country report for Bosnia and Herzegovina (BiH)

Author(s)*: Prof. Dr. Sci. Hamid Custovic, Doc. Dr. Sci. Sead Vojnikovic,
Mr. Sci. Semin Petrovic

2.2.1 Overview

The tradition of biomass use in BiH has existed for a long time, but biomass has a very low rate of utilization. It is mainly used in rural and sub-urban areas as primary source for heating and cooking purposes in households and buildings. Today, biomass in BiH contributes 9 % of total primary energy supply, mostly as firewood and wood waste. In the past, biomass has never had an important role in the energy policy of BiH. General status of bioenergy use can be characterised as following:

- TPS (Total Primary Energy Supply) - 230, 47 (PJ) in 2005
- RES (Renewable Energy Sources) used - 30 (PJ) (hydro energy + biomass) in 2005
- Biomass for energy used - 20 (PJ) in 2005

Note: There are some unofficial data on: total energy used, RES used and biomass for energy used, that are very different from the data from this source (especially for biomass for energy used)

When we talk about general status of bioenergy politics, it can be summarized briefly as:

- No national programs for bio energy use
- No national goals (GHG-emissions, RES use etc.)
- No legal restrictions on energy use
- No incentives for renewable energy use

There were some efforts to change the existing situation in energy sector at state level, but several attempts to get the energy strategy at the state level were not successfully up to now. Although, the adoption of BiH Energy Development Strategy was set up as one of the priorities in Poverty Reduction Strategy Papers (PRSP) – 5-year development strategy (2003-2007), the activities are moving forward very slowly.

Associated with development/supply options and sector strategy priorities within PRSP, the priorities associated with biomass and other RES (renewable energy sources) set up by the PRSP are to encourage application of renewable and alternative energy sources, research, and the application of new energy technologies and other technologies improving energy efficiency (intensify construction of planned hydro power plants through a concessionary model, and build small hydro-power plants, install pilot facilities for utilization of wind, solar, geothermal and biomass energy). Almost nothing has been done associated with these tasks till now.

2.2.2 Method and Activities

Short overview of the finished project of biomass potential assessment realized in the period 2004-2007 thought EC project/FP6 program.

This project is also mentioned in the questionnaire.

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One of the aims of this project was: "Identification of Biomass potentials in Bosnia and Herzegovina" (Mapping Biomass and its status (legislative, technological, economical, social acceptance)).

Specific goals of the study were terrestrial assessment of current status of biomass for energy use.

Methodologies used in this project:

- Analytical potential assessment of agriculture and forest biomass (input data – statistical bulletins, data from economy chambers; system boundaries – national level; output data: report and maps);
- Economical calculation (input data – statistical bulletins, literature, data from economy chambers; system boundaries – national level; output data: report); and
- Analysis of the vulnerability of ecosystems (input data –literature; system boundaries – national level; output data: report).

Information/data management

- Type of database: paper based
- Accessible information : pdf-file, report

Forestry – ongoing project – The Second National Forestry Inventory for large areas in BiH:
In the first part of Lojo et al (2008), the goals, tasks and methodologies of the inventory are described. Realization: Second forest inventory (SNFI) was divided in two phases: phase 1 testing methodology; phase 2 applying methodology on all forest and forest lands in the country. In preparation of sample for terrestrial measurements, different sources were used: maps, satellite images, aerial photos, etc..

Planned activities on biomass potential assessment in BiH
In present time there are no official planned activities for assessing the biomass potential in BiH. Nevertheless, there are on-going research activities on the biomass potential, mostly associated with PhD thesis, but, for now, there are no officially published research results.

2.2.3 National data on plant growth and primary production

Forestry (data's from First National Inventory 1964-1968)

-Total area 2.501.000 ha (51%)
-Total woodstock 278.829.000 m^3
- Annual volume increment 7.336.000 m^3
- Annual cut 6.822.000 m^3
- Production of forest assessments 3.752.936 m^3 (2007)

Agriculture

- Arable land 1.064.706 ha
- Sown arable area 553.000 ha (2007)
-Orchards (83.259 ha) and vineyards (5.046 ha)
-Meadows (423.864 ha) and pastures (946.125 ha)

2.2.4 Feasibility of promoting non food type agricultural production

There is no overproduction in agriculture in BiH. One could even say there is under production. In our opinion and knowledge in agriculture and forestry sector, crop changes could be feasible, but there is currently no research on this theme.

At the present time, there is no production of biomass fuel from forestry. There are some intentions for future changes some aspect of forestry in this direction.

2.2.5 Conclusion

Status of biomass (for energy) resource assessment in BiH
The most significant source of biomass for energy production in Bosnia and Herzegovina is wood mass from forestry (firewood, forestry residues) and wood waste from wood processing industry. However, agricultural residues also have a significant energy potential in the regions of northern, central and southern BIH.
The three-year EU/FP6/INCO project about the potential of renewable energy sources in the countries of West Balkans (Advanced Decentralized Energy Generation Systems in Western Balkans - ADEG) –ended in 2007. It included a precise analysis of all biomass sources in BiH. Within this project, special attention was directed to the possibilities for the application of different kind of biomass resources, proposal for the optimal technological and, in economical sense, profitable solutions for that application, spatial distribution of biomass resources, and other issues essential for beginning of use of this energy resource important to Bosnia and Herzegovina as well. Through the first part of this project, named WP1, the precise analysis of biomass potential and its density and mapping in BiH's regions has been made.

Quality of available statistic information
Statistic information is available only for fire wood (within Bulletins of Agency for statistics of BiH), and there are no available information on biomass of other origin. Also, there is no reliable data on the exploitation of different biomass sources in BiH, especially of wood waste from wood processing industry. It is estimated that in BiH operate a number of saw mills (about 1,500-1,600). From this number only 800-900 are readily identifiable. There are no reliable data how much of the wood waste is used or dumped into open fields.

Comments on already accepted methods and principles
There were plans with local authorities for a district heating in some places (municipalities with the large wood processing industry plants), but because of a lack of funding it has so far not been possible to put these into practice. In addition to these global aims of environmental protection further, locally important advantages of biomass resources utilization become effective in developing countries such as BiH

- reduction of dependence to energy imports,
- creation of an additional market for the domestic agriculture and forestry,
- creation of jobs in the de-centralized recycling industry,
- creation of jobs in engineering and plant construction and its research and development facilities,
- saving of fossil, finitely available raw materials,
- protection of the environment by the absence of illegal tipping sites or unregulated burning down; and
- reduction of air pollution.

Status of research and policy making related to biomass
Through the abovementioned ADEG Project, some additional research has been identified. In order to achieve a more significant application of biomass in BiH till 2020, it is necessary to carry out the following research by 2010:

- definition of target areas where detailed research of economically and ecologically sustainable use of biomass should be performed,
- quantification of different flows of non-used biomass in target areas,

- estimation of biomass costs as a fuel in the future and a comparative analysis with the costs of other fuels,
- identification of the possibility for suitable, financially competitive solutions of biomass application,
- identification of the most suitable technologies, investment methods and incentive measures for selected solutions of biomass application,
- identification of obstacles in legislation and regulations that influence the selection of technologies for biomass application in the target areas in a most efficient way,
- identification of institutional obstacles for accepting the most efficient solutions for the construction of a biomass-fueled system for production of thermal and/or electrical energy

Implementation of the above mentioned steps would clearly show the real economical and ecological potential and solutions for the application of biomass-fueled facilities in the target areas in BiH, and it would help the competent authorities to plan the construction of such facilities. The identified activities greatly depend on the agriculture and forestry development strategy and the ministry of energy should plan and implement them together with the competent ministries for these areas. In conclusions it is safe to say that BiH is open to the take-up of new methodologies especially the research and academic institutions.

2.3 Country report for Bulgaria

Author(s)*: Anna Aladjadjiyan, Nikolay Kakanakov, Aleksandar Zahariev

2.3.1 Overview

The use of biomass in Bulgaria is presently confined to heat production from residues and officially this contributes 3,7 % (409 ktoe) of final energy supply. In practice, this contribution is almost certainly larger as considerable quantities of biomass in the domestic and small industry sector may go unrecorded.

Recently *biomass-for-energy* politics in Bulgaria has been developing very fast. The most relevant political programmes concerning the development of biomass for energy include:

- Energy Strategy (2002)
- National Long-Term Programme to Encourage the Use of RES 2005-2015
- National Long-Term Programme to Encourage the Use of Biofuels in the Transport Sector 2008-2020
- Renewable and Alternative Energy Sources and Biofuels Act (2007)
- National Long-Term Programme to Encourage the Use of Biomass 2008 -2020

The mentioned documents have been based on the national goals:

- Bulgaria has signed Kyoto protocol and took the commitment to reduce GHG emissions by 8% (based on 1988 levels) for the first commitment period 2008-2012 (National inventory report 2008 for Bulgarian GHG emissions)
- According to the National Long-Term Programme to Encourage the Use of RES for the period 2005-2015 the share of RES in the electric power production in 2010 must surpass 8% of the total electric power production, and in 2015 – 9%.

As shown in the National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020, the final energy consumption for 2005 represents 20137 ktoe (843 PJ), of which from biomass and biofuels 745 ktoe or 68 PJ (8%).
The primary energy production in 1997 was 10 395 thousand toe and increased up to 10 282 thousand toe till 2000 and 10 539 thousand toe till 2005, whilst the biomass production moved from 251 thousand toe up to 550 thousand toe and 691 thousand toe in the aforementioned years resulted 6.6% share in total production in 2005 (National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020).
The share of RES in 2005 in Bulgaria is 10,4% of the generation of primary energy, thus larger corresponding to the value for EU-25, where it is 12% for 2004. The structure of RES used in Bulgaria in 2005: biomass – 63%, hydropower and wind energy – 34% and geothermal energy 3% (National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020).

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2.3.2 Methods and Activities

Most of published documents concerning biomass use have as a basis the data from Statistical Yearbook, released annually by the National Statistical Institute (NSI), combined with expert data from relevant institution (Ministry of Agriculture and Food and State Agency for Forests). Data collected by NSI are based on several kinds of surveys conducted on regional level and then summarized for the needs of statistics.

The most relevant and recent activity is the *National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020.* It represents a national assessment, based on statistical data and data collected from specialized institutes in frames of National Academy of Agricultural Sciences. As written in this programme, "biomass is a resource whose wider use will allow for a reduced dependence on the import of energy resources, contribute for the security of energy supply and have a relatively smaller environment impact as compared to conventional fuels".

The currently unused quantity from branches and twigs is 315000 m^3/yr (energy equivalent 65100 toe/yr), 1431000 m^3/yr (energy equivalent 306800 toe/yr), which can be released from timber harvest forecasted for 2020, and 50000 tons dry matter/yr (energy equivalent 23000 toe/yr) from industrial waste (*National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020*).

The energy equivalents of these additional quantities of wood fuels are respectively:

- in 2015 – 24 500 toe/yr for softwood (coniferous) and 111 200 toe/yr for hardwood (deciduous);
- in 2020 – 47 200 toe/yr for softwood and 259 600 toe/yr for hardwood.

An estimate on the utilisation of the biomass energy potential in Bulgaria is prepared in the *National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020* presented in the next table:

Estimate of key energy indicators and the share of biomass, thousand toe

Indicator	2005	2010	2015	2020
Gross domestic consumption	20137	20500	22400	25600
Final energy consumption	9276	10400	11400	12500
Gross domestic consumption of biomass	750	1192	1514	2181
Share of gross domestic consumption	3,7%	5,8%	6,8%	8,5%
Final energy consumption of biomass	745	1090	1197	1344
Share of final energy consumption	8,0%	10,5%	10,5%	10,7%

In 2020 in case of full utilization of the biomass energy potential, it will reach 8,5% in gross domestic energy consumption. About 38 % (about 8,37 ktoe) of the biomass utilized in 2020 is expected to be used for the generation of electric and heat energy,. From the above total quantity about 70% of the biomass will be used for the generation of heat energy, and respectively 30 % - of electric energy.

The share of biomass in final energy use will reach 10,7%. The largest relative share will be that of households – 55, 8% followed by transport – 25,4%, industry – 12%, agriculture and others – 6,8% in 2020 (*National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020*).

The share of biomass use by households (80,5%) and industry (16,9%) in 2005 is expected to decrease due to the implementation of more efficient biomass combustion technologies.

2.3.3 National data on plant growth and primary production

The most complete data on plant growth contains the National collection of plant genetic resources of the Institute of Plant Genetic Resources in Sadovo, district Plovdiv. This computer database includes information on 2916 cereal plants, 410 grain-leguminous and 2154 vegetable cultures. The database includes cultivated and wild plants grown in Bulgaria (wild and local forms, breeding lines and cultivars). The information about plants concerns seed and germplasm material, information about species according to the international standards of IPGRI. The database is accessible on web address www.genebank.hit.bg. The responsible manager of the database is Ms. Siyka Stoyanova, e-mail: s_stoyanova@gbg.bg .

2.3.4 Feasibility of promoting non food type agricultural production

The feasibility of non-food plants production in Bulgaria has been studied in 2000 as part of the project, “Let’s give the floor to farmers” Contract Altener No.XVII/4.1030/Z/99-092. BgBiom conducted a number of inquiries with farmers and the conclusion was that the farmers are willing to produce energy crops with some governmental support. Having in mind that about 8% of the agricultural land in Bulgaria is not used, promoting non-food crops seems to be attractive. The problems are related to the absence of detailed studies of the potential of those crops, lack of organization of their buying up and the fact that the land has many small-scale owners.

The future aspects of forestry production of biomass fuels are discussed in the *National Long-Term Programme to Encourage the Use of Biomass for the Period 2008-2020*. On the basis of the draft National Strategy for Sustainable Development of Forestry Sector in Bulgaria 2006-2015, it is expected that in 2015 the total quantity of wood harvested would reach 7 million m³, which is equal to 24 % growth in forest production.

2.3.5 Conclusion

It should be pointed out that the authors were not able to find any scientific works dealing exactly with the methods of assessment of biomass potential.
Most of the works related to the concept of biomass potential have used statistical data from Statistical Yearbook or similar publications of related Ministries and institutions.
Data for the Statistical Yearbook have been produced on the basis of surveys methodologically based on the EU legislation.
The available statistic information is not satisfactory enough.
The number of research works in the field of biomass last years is increasing but funding still is not well organised.
The theoretical biomass energy potential in Bulgaria is considerable. It has been assessed as 2 Mtoe per year, which equals to 90,5 PJ and represents about 22 % of primary energy supply of the country.
Bulgaria has the resources and the willingness to achieve the RES targets listed below:

- 11 % share of the RES electricity in the gross final energy consumption for 2010.
- 5,75 % share of the biofuels in the fuel consumption in transport sector for 2010.
- 10,7% share of the biomass energy in the final energy consumption for 2020;
- 10 % share of the biofuels in the fuel consumption in transport sector for 2020.

2.4 Country report Croatia

Author(s)*: Robert Pašičko

2.4.1 Overview

As an EU candidate member state, Croatia has followed the EU policy by setting compulsory percentage of total electricity produced from RES. Croatia has determined that 5.8% or 1100 GWh electrical energy produced from RES in 2010. Large hydro power plants were not included in these figures. That portion was set accordingly with EU Directive 2001/77/EC, and to achieve it, 220 GWh from RES should be linearly increased each year.

In July 2007, feed-in tariffs for electricity production from RES were established. This provides fixed tariffs for electricity produced from renewable sources, depending on the RES type, size and the origin of the biomass used. Duration of contracts for electricity purchasing from RES was set as twelve years. Until recently, Croatian power utility HEP was setting direct contracts for purchasing electricity with independent electricity producers from RES, as 90% of the market price per kWh. With introduction of HROTE (Croatian Energy Market Operator) things change, as HROTE becomes responsible for purchasing electricity.

According to studies made for various types of biomass, technical potential is assessed as 39 PJ plus additional theoretical potential of 11 PJ. A major source for such energy is the wood mass (fuel wood, residues and wood waste from the wood processing industry). Such amount could theoretically cover 10% of energy usage in Croatia. Various different studies estimate this potential of biomass in the range between 50 – 80 PJ available in 2030. This makes biomass the second most significant renewable source of energy after large hydroelectric facilities. In 2000, it is estimated that only 15.64 PJ from biomass was used, as already mentioned mostly in inefficient way for household heating.

Installed capacities for heat and electricity production from biomass in Croatia in 2006 are 512 MW for heat generation and 2 MW installed electrical power. Throughout the year the country generates 6 GWh of electricity and 14 767 TJ of heat in total.

2.4.2 Methods and Activities

Methodology that was analyzed was the one used for biomass assessment in Croatia within national project BIOEN. The objective of BIOEN was to enhance use of bioenergy in Croatia by assessing biomass potential and suggesting further activities. It mainly consisted of statistical data combined with expert`s judgement, mostly in form of defining constraints and looking for figures within this constraints (social, economical, environmental etc.). Data collected is not in a database, and is available in printed format only. It is openly accessible to anyone, and is available at Energy Institute “Hrvoje Pozar”. Scale of methodology is on national level with some special considerations on specific regions (for example, forestry biomass data was given in accordance with forestry regions). The methodology uses existing data – snapshots few years in the past. Snapshots were not universally used for all biomass types, but depend on data availability. Future trends are predicted for few years in the future, mostly until year 2015.

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For assessing possibilities of bioenergy use, few main potential categories were identified and assessed:

- theoretical,
- technical (reduced by various factors like biological minimum that needs to be left on the fields or in the forests, or biomass potential that cannot be used because of diversification of livestock fund),
- additional theoretical potential (that could be obtained if some advanced techniques are being used - fast growing energy forests, investment in degradated forests, using burnt sites or growing energy crops) and
- realizable potential (usually shown as a percentage of theoretical available potential).

Different environmental assumptions taken in account were: to leave between 10-30 percent of permanent crops residues on site for maintaining soil quality, forest management, effects on local biodiversity and potential beneficial effects on environment in form of CO2 emissions and other GHG, SO2, NOx and PM10 particles.

The main activity concerning biomass assessment in Croatia is the one performed within national energy project BIOEN. It was funded by Government of the Republic Croatia and performed by Energy Institute “Hrvoje Požar” (completed in 2001). It was started with intention to set up long-term system for energy production from biomass and waste. It assesses all technological, technical, legislative and other measures that would enhance the use of biomass in energy production. Also, it was set to ensure all necessary conditions and to identify and remove barriers for enhanced use of all types of biomass in energy production. This activity attempts to forecast future use of biomass for energy (until year 2010 for which biomass use was estimated to triple on level of 1995.). Several pilot programs were proposed for enhanced biomass use.

Other studies used for biomass assessment were IEA BIOENERGY Task 29: Socio-Economic Drivers in Implementing Bioenergy Projects, Energy potential of biomass from wood processing industries in Zagreb County, Energy potential of biomass in Istria and in Split County, Acceleration of the Cost-Competitive Biomass Use for Energy Purpose in the Western Balkan Countries and Strategy for a modern charcoal industry in Croatia.

2.4.3 National data on plant growth and primary production

Upon request from the Ministry of Regional Development, Forestry and Water Management, Forest Management Plan was being prepared and should be finished and publicly available at the end of year 2008 or beginning of the year 2009. Forest Management Plan will keep data on all private and national forests about: forest area, wood resources, yield, forest protection data, list of tree types, age classification, data on regions, balance for each region, wood consumed per capita etc. It will consists of textual chapter, chapter with tables and chapter with maps (including GIS data).

2.4.4 Feasibility of promoting non food type agricultural production

Agriculture production in Croatia does not have overproduction, but non food agriculture might be possible in vast area of uncultivated land – around 300,000 ha (which makes it 10% of all agricultural land area in Croatia). On the other hand, the potential of energy forests has been explored within National biomass programme BIOEN. Research has been started and first results have been gathered on planting different tree species regarding planting area, distance between trees or type of tree clone. Tree types analyzed were willow, aider, birch and poplar. More information on energy forests in Croatia is given in parallel project BEE by Croatian partner.

2.4.5 Conclusion

Biomass as a modern energy source in not yet quality recognized in Croatia – practically all biomass in Croatia is used inefficiently for household heating. Even though studies on biomass potential are showing that energy from biomass is the second highest renewable potential, after big hydro power plants. Although feed in tariffs were introduced in Croatia for electricity production from biomass (which are the highest in the region) there are very few projects being planned. There are few reasons for such. Probably the most important is the lack of knowledge about modern use of biomass, for example for efficient household heating where biomass can be used in automatically operated stoves like fuel oil or gas. Another important reason is lack of biomass market in Croatia – governmentally owned company Croatian Forests holds 78% of all the forests, but has not yet started selling the biomass and forming the market. Therefore, potential developers of biomass power plants are downhearted to start the project because a lot of uncertainties exist on fuel availability and fuel prices.

In the BIOEN programme, a wide range of data was prepared and gathered together for the first time. Most data collected were statistical data, but that data were combined with expert`s judgement and the result was recognized as a quality work. Results from it were used in defining each energy strategy that came afterwards. What might be improved with further effort is that biomass overview is not given completely on a regional scale but mostly on a national, and the fact that time scale was mainly focused for two years only (both very outdated), and progress in future is shown only for biomass from forestry.

Therefore, new studies that would follow the same methodology, or new methodology that would overcome the weakness points from the existing one would improve understanding of biomass potentials in Croatia and help in planning biomass use in energy production.

2.5 Country report for the Czech Republic

Author(s)*: Andrea Sikyrova

2.5.1 Overview

In the long term, biomass has the best prospects as a source of renewable energy for electricity and heat in the Czech Republic.
Current energy policy of the Czech Republic has an objective of increasing the share of renewable energy to 8.9 % of total primary energy consumption by 2010 and to approximately 15.7 % by 2030. Biomass should contribute about three-quarters of the renewable share. In 2006, however, renewable energy constituted only around 4.3 % to primary energy consumption and only one-quarter of this came from biomass. The slow development of production and use of biomass has multiple causes. In the last ten years the main cause has been ambiguous state and departmental policy, especially on the part of the Ministry of Agriculture, Ministry of the Environment, and Ministry of Industry and Trade, which has not allowed sufficient development of certain types of biomass. The past years have also witnessed several conflicts which may, in coming years, complicate the use of biomass for energy. For example, there is a conflict between traditional use of raw material for wood-plates, brick making, paper, etc. and use of wood chips for energy. Another conflict is between the use of food crops (energy crops 1st generation) for the production of biofuels (FAME, bio-ethanol) and consequent increases in the price of food.

It is expected that the use of biomass for energy will increase in the coming years and that this will contribute to the development of agriculture and the countryside in the Czech Republic. An integral part of long-term support for the development of biomass should be significantly higher and better-coordinated support for basic and applied research.
The main documents which regulate use of renewable resources for energy are the State energy conception of the Czech Republic (from the year 2004) and the State program for supporting saving of power and use of renewable sources of energy for 2006-2009. Finally, the Czech Government Resolution No. 47 of January 12, 2009 approved the Biomass Action plan for the Czech Republic for the period 2009 – 2011.
In the Czech Republic, there are a number of incentives and subsidies for the production of phytomass for energy use, e.g. the Rural Development Program (Diversification into non-agricultural activities), the Operational Program Environment (Sustainable use of energy resources) etc.

2.5.2 Methods and Activities

Available and economically exploitable potential of biomass for energy use, as well as the proportions of different forms of biomass, in the Czech Republic are questions that will probably continue to be debated for a long time and on many levels.
Analyses of the biomass potential made during the last decade are quite different from each other. Differences include differences in methodology, tasks, and results. Results differ in regard to absolute amounts, distributions between the main sources, and the geographical distribution. .
The division of the total potential into three main sources of biomass (agriculture crops residues, forest residues, and biomass from energy crops) also varies considerably.

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An accurate tool for estimating the viable potential of biomass from the landscape is a methodology which was created in the Ministry of Agriculture project "The Methodology of Analysis of Biomass Potential as a Renewable Energy Source in Selected Areas". This project was carried out between 2004-2006 at RILOG Pruhonice (Silva Tarouca Research Institute for Landscape and Ornamental Gardening in Pruhonice).
The project's goal was creation of tool for landscape analysis (GIS) of the potential of biomass as regional renewable energy source in selected areas. This tool could be utilised for regional, strategic decision-making especially in programs for revitalization of agriculture production. The tool could be utilized to assess production, economic and landscape-ecology factors. The tool could also be used to harmonize agriculture revitalization with regional energy plans and landscape planning. The Pilsen region (south-west of the Czech Republic) was chosen as a model area. The sources of biomass analyzed were: wheat straw, grass, forest residues and fast growing trees. For each source an economic evaluation was perfomed using economic models. Input data to models were collected from experimental testing plots of fast growing trees and from expert assessments in the case of grass and forest residues. Two methods for biomass potential assessment were used. The first is a calculation method, which uses state and regional statistical data from forest and agriculture databases and data on regionalisation and productivity of energy plants. Different biomass potentials were calculated through use of formulas and coefficients.
The second method used GIS. This method is based on assignment of yields for separate sources of biomass by BPEJ (Valuated Soil Ecological Unit).

2.5.3 National data on plant growth and primary production

The Czech Statistical Office is the main institution in the Czech Republic providing statistical data to other institutions and the main information source for national data on plant growth and primary production. All statistics are available online (http://www.czso.cz) and each year a statistical yearbook is published. Estimates of yields and harvests of selected crops (cereals, rape etc.) can also be found in these sources.

2.5.4 Feasibility of promoting non food type agricultural production

- The financial value of total agricultural output has been gradually declining in the Czech Republic. The value of gross agricultural production in 2006 was 15.5% lower than it had been in 1993 at constant 1989 prices. The changed structure of plant production was responsible for this decline with production of cereals, potatoes, and sugar beet falling and a rise in oil production (mainly oilseed rape).
- Estimating potential biomass from agriculture is the most complex component of biomass potential assessment in the Czech Republic. Within the restructuring of agriculture, food commodities are being replaced with alternative technical or energy crops. Overproduction of traditional agricultural products only began very recently -- in the past three to four years – so the extent to which energy crops will be planted to avoid such overproduction is highly uncertain.
- At present, the most frequently produced fuels from biomass are liquid fuels, referred to as first generation biofuels. For production of a bio-component as an alternative to diesel fuel, oilseeds are used. The primary petrol substitute is ethanol produced by fermentation. Production of ethanol from biomass has a long tradition in the Czech Republic. In the 1930s ethanol was made from potatoes and used in a mixture with petrol.
  In the near future production of second generation biofuels made from non-food biomass (cellulose) is expected. These biofuels can make a greater contribution to reducing emissions of greenhouse gases.

2.6 Country report for Germany

Author(s) *: Dr. Vanessa Heinzel

2.6.1 Overview

For Germany the framework for using the energy potential of biomass is defined in the **Renewable Energy Sources Act (EEG)**. On 17 December 2003 the German Cabinet presented a Government Draft for a comprehensive amendment to the EEG. On the 2nd April 2004 the Bundestag passed a comprehensive amendment to support its further implementation. The purpose of the EEG is "*to facilitate a sustainable development of energy supply, particularly for the sake of protecting our climate, nature and the environment, to reduce the costs of energy supply to the national economy, also by incorporating long-term external effects, to protect nature and the environment, to contribute to avoiding conflicts over fossil fuels and to promote the further development of technologies for the generation of electricity from renewable energy sources.*" Renewable energy sources include energy from biomass, including biogas, landfill gas, and sewage treatment plant gas as well as the biodegradable fraction of municipal and industrial waste. On 6 June 2008 the German Cabinet enacted the EEG and the Renewable Heat Source Act (EE – WärmeG), defining the national targets: the contribution of renewable energy to electricity supply was increased to a minimum of 30% by the year 2020 (doubled) and the contribution of renewable energy to heat supply was increased to 14% (roughly equivalent to a doubling of current levels over the next 12 years).
Binding legislation for the use of energy produced from biomass is contained in the ordinance "Ordinance on Generation of Electricity from Biomass (Biomass Ordinance – BiomasseV)" which was decreed in 2001 and last adapted on 9 August 2005 (BGBl. I Nr. 49 vom 17. August 2005 Seite 2419). This Ordinance sets forth, for the scope of application of the EEG, what substances shall be considered biomass, what technical processes for generating electricity from biomass fall within the Act's scope, and what environmental standards must be met in the generation of electricity from biomass.

In 2007, more than 2 million ha of renewable raw materials were cultivated, mostly for energy production (Fig 2.6-1). The area corresponds to approximately 17 % of the land used for agricultural production in Germany. In 2007, there was an apparent rise in the production of electricity from biomass (not including landfill and sewage gas and biogenic waste), increasing to 17.4 billion kWh from its 2006 level of 13.5 billion kWh). The share of total gross electricity consumption attributable to biomass amounted to approx. 2.8 % (2006: 2.2 %) The total contribution of renewable energy sources to electricity generation in Germany has increased from 3.4% (1990) to 14.2% (2007) (Figure 2.6-2).

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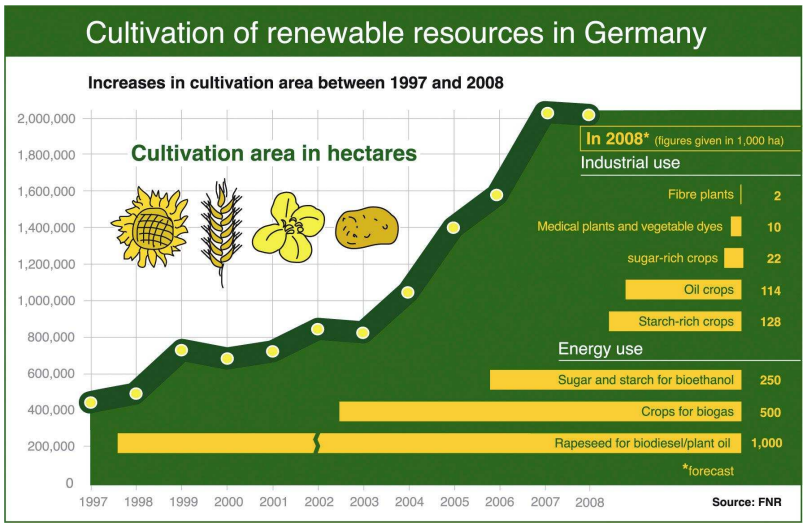

Figure 2.6-1: Cultivation of renewable raw materials in Germany (FNR 2007)

	Hydropower	Wind energy	Biomass	Biomass share of waste	Photovoltaics	Geothermal energy	Total electricity generation	Share of gross electricity
				GWh				
1990	17000	40	22	1200	1	0	18463	3.4
1991	15900	140	250	1200	2	0	17492	3.2
1992	18600	230	295	1250	3	0	20378	3.8
1993	19000	670	370	1200	6	0	21246	4
1994	20200	940	570	1300	8	0	23018	4.3
1995	21600	1800	670	1350	11	0	25431	4.7
1996	18800	2200	853	1350	16	0	23219	4.2
1997	19000	3000	1079	1400	26	0	24505	4.5
1998	19000	4489	1642	1750	32	0	26913	4.8
1999	21300	5528	1791	1850	42	0	30511	5.5
2000	24936	7550	2279	1850	64	0	36679	6.3
2001	23383	10509	3206	1859	116	0	39073	6.7
2002	23824	15786	4017	1945	188	0	45760	7.8
2003	20350	18859	6970	2162	313	0	48654	7.9
2004	21000	25509	8347	2116	557	0.2	57529	9.3
2005	21524	27229	10495	3039	1282	0.2	63569	10.4
2006	20000	30700	15490	3639	2220	0.4	72049	11.7
2007	20700	39500	19500	4250	3500	0.4	87450	14.2

Figure 2.6-2: Developement of renewable energy sources in Germany from 1990 – 2007 (Source: Graphics and tables are based on statistical data from the Working Group on Renewable Energies / Statistics [March 2008])

2.6.2 Methods and Activities

Within Germany three different large projects testing different methodologies for biomass assessment are worth mentioning (small studies or university studies are neglected).

EFSOS – The European Forest Sector Outlook Study

EFSOS and its methodology analyze past trends to derive future outlooks for the supply and demand of goods and services provided by European forests. The study focuses on the supply of industrial wood and demand for forest products, as well as on a detailed analysis of the outlook for non-wood forest products and services, forest management, and policy in former centrally planned economies,. Special emphasis is paid to cross-sectoral policy linkages[1]. The study covers 38 countries, including all major European countries and seven of the former-USSR countries. For the sub-regional analyses, countries were grouped into Western Europe, Eastern Europe and CIS sub-regions. The project is an activity of the UNECE Timber Committee and the FAO Forestry Commission. The statistics and additional information used in the study came from the FAO and ECE databases, supplemented with additional information supplied by national correspondents. Based on harmonized historical statistics and information, the European Forest Information Scenario (EFISCEN) model is used for projective modeling (1961 to 2000; 2000 to 2020). This model assesses the potential of the forests (roundwood production, future growth, and development of European forest resources) using different scenarios. All scenarios are based on driving forces affecting the European forest sector. Exogenous factors, which are likely to have substantial impacts are changes in forest products prices and future rates of economic growth. Changes in policies and market frameworks were also taken into account.

EFORWOOD

The aim of the EFORWOOD project is to develop a general method to assess the sustainability impact of complete industrial sectors. Within the project tools for sustainable impact assessment are developed, taking into account economy, society and the environment.

The tool ToSIA will give answers to WHAT IF? questions, based on different scenarios using external and internal drivers[2]. The EFORWOOD consortium comprises 38 organizations from21 countries. The consortium partners include some of the best scientists in the relevant fields as well as the key representatives from the forest-based industry.

The ToSIA operates with a database of sustainability indicators. Generally, data can be introduced into the data base from various sources. Within the project reliable and complete input data are collected and undergo quality control. Different storylines and scenarios describing the future world are defined. They characterize the underlying assumptions regarding the development of key variables (environmental and socio-economic). Final scenario selection will be made after extensive stakeholder consultations.

Four different case study structures for assessing prospective potential have been defined so far: forest-defined, industry-defined, consumption-defined, and region-defined.

Different storylines and scenarios describing the future world are defined.

Growth Simulator SILVA

Objective of the study was to develop a forest-growth simulator using a distance-dependant, individual-tree approach, in a 3-dimensional system where single trees influence each other.

An exemplary application of the simulator was realized in the study: Connection of the Growth model SILVA to data sources of the forest management sections[3].

Silvia is a Forest Growth Simulator, where the user has to provide the specific data. There is also a very complex data base available for the parameterization of the growth simulator for the tree species Norway Spruce, Silver Fir, Scots Pine, Common Beech, Sessile Oak and Black Alder.

* [1] http://www.unece.org/trade/timber/efsos/
* [2] http://www.eforwood.com
* [3] http://www.wwk.forst.tu-muenchen.de/research/projects/silvafedb/

Main data source is the Institute's trial plot network located in Bavaria, Rhineland-Palatine, and Lower Saxony. For the parameterization, 288 trial plots and 528 investigations from 1952 to 1998, with more than 155,000 tree observations were taken. Also data from numerous time-series applied to mixed forest stands within the last 15 years contributed to the data base. The site-specific model is based on 3120 investigations staring in the 19th century. Inventories were additionally carried out on trial plots of the Forest Research Institute of Lower Saxony and the Research Institute of Forest, Snow and Landscape in Birmensdorf/Switzerland. Thus, the spatial data gradient ranges from Northern German Lowlands to high mountain regions in Switzerland[4]. The effects of different user-defined scenarios can be modeled in time steps of 5 years up to the maximum of 30 steps, thus a maximum time slot of 145 years can be modeled. The prospective potential under different scenarios is assessed. No detailed description about possible environmental assumptions could be found, except that CO_2 and NO_X emissions and water drainage affect forest growth. However, different forest management strategies/treatments can be considered, e.g. thinning from below and above; selective thinning; final crop-tree system; target tree system, interval between cutting.

In addition to the above studies, one large specific activity needs to be mentioned:

BWI/HAM
The current "Bundeswaldinventur" (BWI) / Holzaufkommensmodellierung (HAM) form an essential background for all forestry, business and economic, and- political decisions for substantial forest use. The BWI is also the foundation of all instruments for controlling and optimizing the forest economic system on regional and national levels.
Complementing this national forest inventory, each of the 16 federal states in Germany collects their own information about federal forests at 2 year intervals.
The methodology used is a forest inventory taking into account 150 different characteristics. The inventories include: apparatus preliminary sedimentation, angle-count method, circular sample area, and road inventory.

2.6.3 National data on plant growth and primary production

Within Germany three different large databases on plant growth and primary productivity are available.

Daten und Fakten zu nachwachsenden Rohstoffen – Data and facts about renewable resources
The commissioning institution is the Agency for Renewable Resources (Fachagentur Nachwachsende Rohstoffe e.V./FNR) with financial support from the Federal Ministry of Food, Agriculture and Consumer Protection. It is the first database summarizing all tables and graphs from different German federal states in one complete official document. The first report was published in 2007, but it is intended to be the first publication in a row that will be published on a regular basis. The purpose of the data base is to collection all available data on renewable resources from the respective federal states, in order to publish a common report. The report summarizes both the status quo of renewable resources also their development. The published data come from third parties, but in future the FNR also hopes to collect its own data.

Renewable energy sources in figures
The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety publishes, on a yearly basis since 2002, a brochure containing up-to-date figures and information on the development of renewable energy sources in Germany, the European Union and worldwide.

* [4] http://www.wwk.forst.tu-muenchen.de/research/methods/modelling/silva/kriterienliste/anhang2_html

DESTATIS
The Federal Statistical Office publishes on a yearly basis (January of the each year) a national database, with the intention of providing everybody interested high quality, objective, independent statistical information for free. The type of information included is rather large, covering e.g. harvest production of different cereals, others crops planted and comparisons with previous years and others areas.

The potentially of agricultural biomass from the federal states for substance-energetic use
"The potentials of agricultural biomass from the federal states for the substance-energetic use" project is a federal state activity aimed at increased use of renewable energy sources in total end-use energy. There are separate studies for each federal state. The study focuses on the years 1996 to 2004 and takes a retrospective look at these data. The study assessed the potential of agricultural biomass for renewable energy generation.
Types of information include: information on the production of cereal straw, rape straw, rangeland, fallow and other agricultural products, and their use for renewable energy production.

2.6.4 Feasibility of promoting non food type agricultural production

The German agricultural sector, as is the case across Europe, is dominated by over-production of food. Thus fallow land, non-food production and extensification of agricultural areas is systematically subsidized[5]. In Thrän et al. the potential area for biogas production was estimated based on the years 1999-2004. For that period they estimated a potential of 2.4 Mio ha agricultural areas (~ 14% of the total agricultural area), which could be used for planting renewable raw materials. Currently 2 Mio ha are already in such uses. Based on these findings they estimated that in the period 2010 to 2020 7.3 Mio ha (43% of the agricultural area) (economic potential) could be used for production of biomass for energy. In their assumptions they took into account a decrease in population growth an increase in per capita consumption, increased urbanization, and enhanced yield. Local conditions and crop rotations could limit the potential of area available for biomass-for-energy production[6].
In the context of the recent troubles concerning gas deliverables from Russia another study stated that by 2020 Europe could be independent from Russia, covering its entire gas consumption needs with biogas[7].
In Germany the yearly increase in timber is roughly 12 m³ per ha/a, with only half of this growth actually used. In Germany at total of 20 Mio m³ of wood due to re-growth is not being used and could be available for energy use. In 2005 only 25 % of the roughly 70 Mio m³ of logged wood was used for energy. Unused potential is especially high within the private forests. Overall Germany is a wood-exporting country[8]. In total wood for energy in Germany increased from 1.7% of total energy consumption in 2003 to 2.4% in 2007 [9].
However while wood use is increasing, the German Federal Parliament states that the forests have to be sustainably managed; and all their functions and environmental services (including soil moisture and biological diversity) have to be maintained.

* [5] Fritsche, U.R. (2000): Biomasse: Renaissance einer Energiequelle. Ökonomy 3/2000.
* [6] Thrän et al. (2006): Nachhaltige Biomassenutzungsstrategien im europäischen Kontext. *http://www.ie-leipzig.de/Biomassenutzung/downloads.htm*
* [7] Möglichkeiten einer europäischen Biogaseinsparungsstrategie. Studie im Auftrag der Bundesfraktion Bündnis 90/ Die Grünen. 2007.
* [8] Agentur für Erneuerbare Energien: http://www.erneuerbare-energien.de/inhalt/
*
* [9] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

2.6.5 Conclusion

According to the Federal Environment Ministry[10] the expansion of renewable energy sources has been an unprecedented success. Since the beginning of 2000 the share of the total final energy consumption from renewable sources has more than doubled to (2008) 8.6%.
In regard to use of biomass as a climate-compatible, regional energy source, there has been a sharp upturn since the improved framework conditions created by the Renewable Energy Source Act (EEG) (2004). Additionally, various alternative heating sources (e.g. pellet heaters) have become popular due to rising energy prices. Of all renewable options, biomass has the advantage that is a reliable energy supply. In 2007 alone, energy production from solid and liquid biomass and biogas increased rapidly growing from 13.5 TWh in 2006 to to 17.4 TWh.
In 2007, biomass contributed around 84 TWh to heat supply, accounting for 93 % of the total contribution of renewable energy sources in this sector. The contribution from biofuels increased by around 15 % in comparison to 2006, to 4.6 million tonnes, covering around 7.6 % of total fuel demand.

Overall the recent developments within Germany demonstrate that the country is well on the way to meet its ambitious plans for expanding the use of renewable energy sources. In just 5 years the contribution of renewable energy to total final energy consumption has doubled to 8.6%.
The national target of meeting 12.5% of gross electricity consumption from renewable sources by 2010 has already been significantly exceeded with currently 14.2% of gross electricity consumption coming from renewable sources.

Overall the quality of the statistical data found was very good. Once it was even stated that comparison to other countries could be difficult due to different estimation methods within Europe.
The principles are accepted, research is on a high level, and policy making is on its way, even adapting orders to new conditions (e.g. in June 2008 the EEG and the EE – WärmeG).

* [10] Renewable energy sources in figures. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. 2008.

2.7 Country report for Greece

Author(s)*: Dr. Dimitris Zianis

2.7.1 Overview

There is no a national or regional project for estimating biomass production for bioenergy purposes from agricultural and agro-industrial residues and energy crops in Greece. Several research scale projects (coordinated mainly by Center for Renewable Energy Sources) have been taking place for energy crops (annual and perennial). The standard approach to estimate biomass production by these crops is the destructive sampling of a representative unit of land and extrapolation to the total area occupied by these species. Some efforts to estimate energy production from forest and agricultural crops were made at prefecture level (Crete, Thessaloniki and Thessaly) as well but the analysis is based on local level and generalising to country scale could introduce significant errors.

Recently, a study about biomass as an energy source in Greece was conducted by Stamouli (2007) in a MSc thesis submitted to the University of Piraeus. The quantity of agricultural crop residuals was calculated for several species and several coefficients were used in order to estimate the potential electrical energy that could have been obtained for the country in 2000. This approach was actually based on a system of three simple equations that relate the residual quantity to available energy at prefecture level. The approach is briefly analyzed in the Introduction section of Appendix A4. It is not included in the Investigation Matrix since most of the sections (Section 3 onwards) would have been remained empty. It should be mentioned that the energy potential from the energy crops and from the forest sector was not taken into account in this study.

However, firewood and residues (mainly branches) derived from managed forests are being used for energy purposes in Greece. They are bought by the rural population at low prices for heating and cooking purposes. Apart from naturally regenerated forests, short rotation systems were established in Greece since 1973 for energy production with plane trees, willows, poplars and eucalyptus. There is only one national scale study contacted in 1989 by Kokkinidis for the VALOREN project that estimated the biomass of Greek forests for energy use (see Appendix A4). The main drawbacks in that approach are the use of several conversion factors which were derived from the literature (and not developed for Greek ecosystems) and the lack of a digital database. Thus, the results may be based on erroneous estimations and the repeatability of the methodology is believed to be quite time consuming and in turn not easily implemental.

In spite the fact that there are 10 units, located mainly in north and central Greece with a potential production of 114,000 m^3 bio-diesel, there is no energy crop cultivation of commercial scale in the country and inevitably production is based on imported raw materials (mainly from Italy).

The main legislative and incentive framework regarding RES in Greece consists of the following initiatives: Landfill Directive (99/31/EC), Law 2244/94, Renewable Energy Directive (2001/77/EC)-Greek Law 2773/99, IPPC Directive (1996/61/EC), CO_2 Emission Trading Directive 2003/87/EC, Development law 2601/98, Ministerial Decision Δ6/Φ1/OIK. 8295/19.4.1995, Directive 96/92, Development law 1892/90 together with its amendment 2234/94, which was a general “development law” that provided subsidies (40-60%) for investments by the private sector, including renewable energy sources, and finally the Renewable Energies Sub-programme of the Operational Programme for Energy (1994-1999), which was the main funding mechanism for RES installations.

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2.7.2 Methods and Activities

There is only one study so far in Greece that estimates the biomass of Greek forests for energy use (see Appendix A4). The methodology was based on aggregated data only [from preliminary results of National Forest Inventory (NFI) that was finalized on 1992] and on values reported in literature for specific indices. It was stated that different sources were used to derive appropriate datasets for biomass estimation. For example, NFI report was used for determining the spatial extent of i) broadleaved and coniferous forests, ii) evergreen broadleaved forests and iii) rangelands and Grasslands. The forest management plans (compiled by the Forest Directorate in the Ministry of Agriculture) were based on stand scale (20-40 ha) and used for estimating biomass growth and harvested amount. Finally, several reports (found in scientific and 'grey' literature published by national and international organizations and institutes) were used to derive biomass expansion factors and energy content values of biomass, irrespectively of the location of the stands.

The compiled values of standing stem volume (m^3 ha^{-1}) were transformed to standing stem biomass (tons of dry matter per ha) using appropriate factors. For example, the factors that related standing stem volume to standing stem biomass were 0.42 for conifers and 0.56 for broadleaves while percentage values were used to derive biomass estimates for other tree components (branches, foliage, bark, stumps and roots). All the factor and percentages values were obtained from an Italian study. The understorey biomass of forests was estimated as the product of 8 tons of dry matter per ha times the total area (in ha) occupied by the forests while for rangelands a value of 2.2 tons ha^{-1} was used. It should be mentioned that the author was skeptical in using the aforementioned values for understorey biomass estimation and reported that the obtained results should be considered as preliminary.

The reported results could have been used for the regional and prefecture planning activities as well as by the central administrative system for strategic purposes (national level) but a thorough description of boundary conditions upon which the outcomes could be applied was not provided. It is stated that the forest resources should not be overexploited and sustainability principles should be taken into account when removing biomass for energy purposes from the stands. As a rule of thumb about 55% of the total annual growth should be removed and the rest (45%) should remain in the forest for ecological processes. Concerning the grasslands biomass potential for bioenergy purposes, an amount for grazing should be left in the ecosystem while the protective aspects of these sites should be taken into account as well. Thus, only 20% should be used for energy purposes. For shrublands, the rotation time was set at 10 years and only 30% of the growth should be removed since these ecosystems provide soil protection, contribute to hydrological cycles and used for grazing activities. No information is provided in the study about any socio-economic assumptions and no analysis on environmental impacts had been conducted.

The assumptions made in the proposed methodology are quite simple, hold valid in terms of scientific and statistical context (given the limited monetary resources) and are clearly explained. On the other hand, biomass flows are not described; a sensitivity analysis was not performed and the obtained results are based on factors derived from Italian case studies. Finally, the outputs are not available in a digital database and therefore can not be connected to a georeferenced system in order to be readily updated. The report is written in Greek and can be accessed through CRES library but it is not in digital format. The text of the report is 61 pages long and 23 Tables are reported on 171 pages. One map of biomass distribution and one map of the energy content of forest biomass (at the prefecture level) are also presented.

Concerning agricultural research activities on biomass potential assessment, the Centre for Renewable Energy Sources (CRES) and the Agricultural University of Athens (AUA) are the most active organizations in Greece. CRES contributes to primary research in the bioenergy sector by establishing several experimental plots throughout Greece and consulting farmers associations and policy makers for bioenergy related issues. The AUA mainly focuses on the modeling of an integrated platform

which is based on the managerial, economic and environmental needs of biomass use for bioenergy. Both organizations are active for more than 15 years in research projects funded by European and national bodies.

2.7.3 National data on plant growth and primary production

To the best of my knowledge there is not a specialized national database about plant growth and primary production data in Greece. The National Statistical Service compiles datasets for the agricultural sector about primary production of several crops and classifies the productivity of each species on an annual basis. However, it should be mentioned that productivity refers to the economically exploitable part of the plant (e.g., productivity of apples or cherries, etc) and not to the total growth of the individual plant (e.g., stem, branches, roots, foliage, etc).

2.7.4 Feasibility of promoting non food type agricultural production

In spite the fact that there are five potential biomass resources for energy production (agricultural residues, forestry residues, agro-industrial residues, energy crops and animal wastes) and ten biodiesel units in Greece, the bioenergy production is rather low. This status mainly originates from the fact that farmers are reluctant in investing on energy crops (revenue rates are lower in comparison to food production agriculture) and the inadequate funding support (45 euros per ha) for energy crop production. Thus, in 2007 only 11,000 ha were used for energy crops in Greece and imports (mainly from Italy) fed the industrial units. However, a wide variety of crops and specifically of field agricultural residues can be used for bioenergy production. The main crops producing considerable quantities of residues in Greece are winter cereals, rice, corn, cotton and tobacco while the main arboricultural residue resources are grapevines, peach, almond, orange and olive-oil pruning. Nowadays, the main volume of the aforementioned field crop residues are either incorporated into the soil, burned in the field or collected and used for various purposes (domestic heating) but at small scale.

Although there are sufficient quantities of residues in Greece, the following issues should be taken into account before developing a strategy for sustainable farming and energy utilisation:

- Small farm size (increases harvesting and transportation costs).
- Environmental risks caused by the removal of the residues from the field (erosion in sloping and low fertility areas, etc.).
- Opportunity cost (e.g. cereals straw has already a market price as it is sold for animal feeding purposes).
- Lack of commercial harvesting machinery for certain residue types (e.g. cotton residues).

2.7.5 Conclusion

The main factors negatively affecting the penetration of energy crops and in turn the use of biofuels in Greece are: i) the economic restrictions manifested mainly by the lack of substantial funding, increased costs of bioenergy production and high taxation of biofuels; and ii) the lack of infrastructure e.g., distribution network of biofuels. Thus, in spite the fact that there is an area of 360,000 ha potentially to be used for energy crops, farmers are reluctant to invest in these crops. In order for investment to be attractive, the funding support should be 2 to 20 times larger than the present subsidy (45 euros per ha) depending on the species, but no political agenda has been opened on this issue yet.

We have to bear in mind that Greece has to conform to the European Directives 2003/30/EC and 2001/77/EC by 2010 which regulate the contribution of biofuels in transportation and biomass contribution to electric energy production, respectively.

Significant contribution to standard research so as to delineate land areas suitable for cultivation of energy crops, the plant species to be used and their potential growth have been made by CRES throughout Greece. However, there is not a standard methodology to estimate biomass for energy purpose at the country level. Standard extrapolation methods from plot data to larger areas are used in order to estimate the potential energy from agricultural crops and residuals. It is believed that a substantial amount of biomass could be derived from forest biomass and residuals from silvicultural treatments and wood processing industries but an integrated approach has not been used to obtain statistically sound estimates in the country level.

The studies made so far in Greece were based on terrestrial methods and no use of earth observation (EO) approaches was made. Thus, it would be quite useful to adopt an integrated methodology (for example the one that will be developed in CEUBIOM project) that combines field work with remote sensing data in order to estimate the potential biomass available for energy production. Both the infrastructure and the “know-how” information exist in several universities and research centres in Greece and an added value of such an approach could be manifested since it can be used for other activities as well (i.e., Kyoto Protocol mechanisms). Finally, it should be mentioned that the legislative framework and related funding initiatives have already been formulated in Greece but a coordinated effort to estimate bioenergy potential through biomass exploitation is still missing.

2.8 Country report for Hungary

Author(s)* Peter Gyuris

2.8.1 Overview

In 1993 a Parliamentary Resolution established objectives concerning energy policies, supporting safe energy supply, mitigating import dependency and increasing the renewable energy sources share on the market - 21/1993.(IV.9.) OGy. The Energy Efficiency and Action Programme (1107/1999(X.8.)) established criteria to reach and supported the increase of renewable energy sources.

The Electrical Energy Act by the Hungarian Energy Office defines the "green-energy" (coming from renewable energy sources) prices in different energy periods, priority order and the amount of financial support. It is also stated that the Hungarian Energy Office cannot deny paying for green-energy if its efficiency is over a certain limit (Act XLII of 2003 on natural gas supply). In order to achieve the EU directives and to fulfil the country promises the 2233/2004. (IX.22) Enactment ensures forcing the support of the usage of biofuels. During the period 2007-2013 the Environment and Energy Operative Programme and the New Hungary Rural Development Strategy Plan, both part of the New Hungary Development Plan (approved by The Committee), support those investments and projects, which are increasing energy efficiency, aiming to use the renewable energy sources and to improve their infrastructure.

Energy consumption in Hungary was around 1100 PJ in recent years. The approximate 55 PJ green energy used in 2006 was around 5% of the total consumption. In 2004, 18-19 PJ of green energy had been used by equipments under 40 kW capacities (individual heating for single households, cooking and for hot water.
Regarding biofuels, the compulsory amounts of bioethanol and biodiesel, that need to add to fossil fuels, have been defined. These restrictions are in operation. The capacity, to assure the needs, had been established through tenders opened by the Hungarian oil company MOL Zrt. Hungary has the capacity to provide 150 thousand tons of biodiesel through a single producer facility, operated by Rossi Biofuel Zrt., located in Komárom. Under a previous tender issued by the Hungarian oil company, two facilities became the supplier for bioethanol needs, with the capacity of 80 thousand tons of bio-ethanol production. There are 10 stations all over the country, allowing consumers to tank gasoline E85 that contains at least 85 percent of bioethanol.

2.8.2 Methods and Activities

In general, the methods are based on existing statistical data and present available literature analysis. Two activities, the Survey of renewable energy sources in Baranya county (Hungary) and Osijek-Baranja (Croatia) and "All the knowledge" about renewable energy sources in the Southern Great Plain region of Hungary, focused on regional potential, furthermore the Intelligent Energy Europe project, called REDUBAR, assessed the whole country's potential. All three reviewed research-works estimated the theoretical potential of the given area of interest.
The intentions to prepare these studies were different. The two regional studies give basic information about the available renewable energy sources, including biomass, with the goal to report the general status of them. The REDUBAR project assessed the available biomass feedstock, calculated from the database of the Hungarian Statistical Office, in order to convert it to bio-methane based on available

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technologies. The latter used international literature to convert the accessible biomass in order to utilize the biogas in the existent gas-supply systems. The two regional studies took into account the aggregated extent of the available land use forms and their crop types, also calculated from the database of the Hungarian Statistical Office and expressed the given biomass in energy content.
All three projects used databases from past years and gave a snapshot of recent status. The estimated potentials take into account only the present agricultural production and forestry sources when the studies had been compiled. These were basically: agricultural residues (straw, corn-stalk) orchards and wine yard lopping and forest residues. The amount of these raw materials was calculated without affecting the present economic structure. Thus no environmental considerations needed to be done on the impact of crop changes.
The study that assessed Baranya county potential gives details that the used area for energy crops growth can be extended in the future.

2.8.3 National data on plant growth and primary production

The available databases that concern biomass amounts are the Hungarian Statistical Office's referring chapters on agricultural and forest area with harvested amount and the periodic assessment by the Agricultural Special Office Forestry Management Department.

The Hungarian Statistical Office yearly compiles the incoming data from its regional offices and publishes the data.

The Forestry Management Department collects information about the stocks from various aspects like:

- Forestation (regeneration and afforestation)
- Felling
- Forest land area and ownership categories in the counties
- Distribution of forests by primary function
- Changes in forest area and afforestation
- Nature-oriented forestry
- Tree species distribution
- Age class distribution by area
- Current annual increment and growing stock
- Health conditions
- Damages in forestations caused by game
- Indicators for biomass qualification: productivity and vitality.

2.8.4 Feasibility of promoting non-food type agricultural production

The change of agricultural production structure is supported at governmental level. The New Hungary Rural Development Strategic Plan and the Environment and Energy Operative Programme clearly reflect these purposes. State subsidies help farmers change the types of growth plant; investors and factory holders replace the fossil energy source to any kind of renewable energy sources.

2.9 Country report for Italy

Author(s)*: Gaetano Pace, Letizia Compagnone

2.9.1 Overview

There exist both national and regional programs in Italy that contain biomass utilization policies. The National Energy Plan, has been gradually evolving. One of the most important rules, found in Law 10/91, is related to incentives for installation of energy production plants using renewable energy.
The production of energy from biomass in particular has been regulated in the "White Book for Energy Exploitation of Renewable Sources", approved with CIPE resolution no. 126/1999, which provides the guidelines for the renewable energy in Italy. The following National Program for Exploitation of Agriculture and Forestry Biomass, approved with CIPE resolution no. 217 /1999 is the first instrument for stimulating public and private initiatives towards the goals. Most of the actions foreseen are indicated in the National Programme for Bio-combustibles approved by CIPE on 15th February 2000.
The Italian national goal is to double the contribution of renewable energy from the current 12 MTPE (Million of Ton Petroleum Equivalent) to 24 MTPE by 2012.
Entities that produce or import energy are obliged to include at least 2% of energy produced or imported from renewable sources. Various mechanisms, including Green Certificates and White Certificates, to stimulate a competitive market in producing and demand for the respective certificates, are in place as incentives.
Green certificates are granted by the GSE (Managing Authority of Electric Services), the former GRTN (Managing Authority of National Transmission Network), and they certify the production of energy from renewable sources. Each green certificate attests to the production of 100 MWh within a year. The demand for certificates comes from entities that produce and/or import energy, which have a 2% renewable energy obligation. The certificates are offered to entities needing them by private plants that have obtained them from the GSE.
The white certificates represent energy savings and improvements in energy efficiency. These certificates are offered to institutions that distribute natural gases and electric energy. At least 50% of the savings are to derive form reductions in consumption.
These programs will foster installation of plants that produce renewable energy for civil applications, and also promote awareness among energy distributing entities. Other incentives are available for biomass district heating, liquid bio-combustibles, and utilization of biomass in civil applications. These incentives typically involve tax relief.

2.9.2 Methods and Activities

A major study that describes the results of Italy's biomass potential assessment has been commissioned by the Italian APAT, the National Environment and Territory Protection Agency. The name of the study is (original title is in Italian): "Wood biomass: a survey of the potential of the Italian forestry sector for offering energy sources". Its specific goals are: to assess current biomass utilization for energy production, to assess current supply of wood biomass and, to assess the potential biomass available for energy production.

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Most data related to assessments of the agricultural and industrial sectors are retrieved from the Italian ISTAT, the National Institute of Statistics. These data are aggregated according to the various scopes of the collection methods, and a set of coefficients or rules has been applied to the data. The resultant tables of aggregated ISTAT data are available in the study report mentioned above. Based on the ISTAT statistics on combustible wood extraction, the method uses these following types of analysis:
Aggregated data (from statistics sources)
Application of coefficients derived from independent studies
Data extrapolation

No specific name is given to this method.
Authors come from governmental authorities and Universities
Specific goals are:

- Assessment of current biomass utilization for energy production
- Assessment of the current supply of wood biomass
- Assessment of potential availability of biomass for energy production

The methodology was applied at the National level.

Only statistical data are used in this methodology, as it adopts statistical values from a certain period for its assessment. This has the drawback that it reduces the level of the accuracy. However, the consistency of the analyzed results seems good, due to the methods consistency and simplicity.
The uncertainty of the results is directly linked to the uncertainty of the input data. In the case of the assessment of the official values of wood extraction, the sources of error are due to:

- Informal collection of wood residues
- Incorrect classification of extracted wood (e.g. wood extracted for furniture production is classified as for energy production).
- Illegal extraction of combustible wood (exceeding the allowed amounts, or extraction of wood for combustion in areas where this is not allowed)

Final values are given in volume (millions of m3/year of biomass). The volume of theoretical potential assessed, including agricultural and forest residue biomass, is about 33Mt as dry matter per year.
The accessible resource is estimated to consist of about 17Mt, but technical and social limits lower this to the order of 7.5- 9.5Mt per year. Thus, biomass that could actually be utilized represents about 25 % of the accessible amount of residual biomass produced every year. In addition to residues, biomass could be obtained from appropriate cultivation on surplus food-crop lands or lands abandoned for lack of sufficient agricultural income.

2.9.3 National data on plant growth and primary production

The official name of the Italian database of plant growth is 'INFC, inventario nazionale delle foreste e dei serbatoi forestali di carbonio' (in English: National Inventory of Forests and Forest Carbon Sinks). It is not directly a primary productivity database. Its founding institution is National Forest Management Institution, Ministry of Agriculture, Food and Forestry Policies (Contact details: Via Giosuè Carducci, 5, 00187 ROMA, Tel: 06.4665.1, e-mail: urp@corpoforestale.it, fax: +39.06.4782.3877, web: www.corpoforestale.it).
The database is paper based and it is founded on a set of tables, which indicate forest size at various levels of disaggregation (forest type, physical indicators, etc.), for each Italian region. There are approximately 30,000 entries. The last round of data was completed in 2007. A new version is currently underway. This database encompasses indicators of vegetation health such as:
1) Indicators of Biomass quality:

- Yearly volume increment of the various categories of woods

- Biomass divided into the components of the trees (live biomass, branch leaves, etc. and dead biomass)
- Renovation rate for the trees

2) Approaches and methods for measuring primary biomass productivity:
The approach adopted throughout the entire study has been to take field samples at a total of 7000 sampling points, with all measurements taken directly with appropriate instruments.

2.9.4 Feasibility of promoting non food type agricultural production

A precise assessment of the entire biomass sector is a very difficult owing to the wide dispersal of biomass producing sites and users across the national territory. Millions of households use small scale individual heating systems, while only 40 district heating plants are in operation in the North of Italy. Moreover, a lot of wood processing industries use their own wood residues for satisfying the thermal need of the wood factory. As a consequence, the official statistics - based on certified trade of biomass (especially firewood) - must be integrated with unofficial ones, based on spot enquiries about the production and use of biomass (especially agro-industrial residues) outside the commercial networks.
Considering 5 sources of biomass (firewood, lignocelluloses residues, municipal solid waste (MSW), biogas, and biofuels), leaving out for the moment energy crops and short rotation forest (SRF), we an say that at present the biomass sector provides about 5 Mtoe to the national energy balance, representing 3% of the national primary energy supply.
Of that amount: 4 Mtoe is converted into thermal energy (9% of national heat consumption), 0.8 Mtoe is converted to electric energy (1.3% of total electricity consumption), and 0.2 Mtoe is used as liquid biofuels (0.5% of fuels for transport).
Each biomass source contributes a different amount to the total and has shown a different trend in the last years.
The most important sources of forest biomass are woody-biomass, essentially firewood and woody residues used for heat and power generation in small and medium size plants.
Other biomass could be obtained from appropriate cultivation on surplus food-crop lands or lands abandoned for lack of convenient agricultural income.
In Italy residual biomass is already available.
It is necessary to point out that marginal land, of which there are a few million hectares, could be used as forests. In fact, there is a need of reforesting and managing low-productivity agricultural lands to preserve them from hydro-geological disruption. Consequently, the care and maintenance of marginal lands could produce new raw materials for energy and industrial purposes.
However, there are constraints to increased use of biomass. Rural property is highly fragmented (two million farms are less than two hectares in size); residues and wastes are widely dispersed throughout the country; and surplus agro-land is often marginal, with low-level services which make investments unprofitable whereas reforestation involves high management costs (from FAO Corporate Document Repository available at:
http://www.fao.org/docrep/003/x8876e/x8876e17.htm#P1429_86191).

2.9.5 Conclusion

The last official report published in Italy by ITABIA provides information for the year 2003. It shows the following situation for the national scenario:
In 2003 the overall gross consumption of energy was approximately 192 Mtoe, of which slightly over 17 Mtoe (9%) came from Renewable Energy Sources (RES). Among RES, energy produced from biomass in 2003 exceeded 5 Mtoe, which corresponds to approximately 31% of all RES, yet is still far from the desired levels.

The disparity between current trends and objectives proves the need for more incisive actions to stimulate development of RES.
Several of the negative factors could be removed with some effort. Italy still does not have a complete and extensive body of technical regulations for biomass, despite efforts of the past few years made by institutions appointed to create them.
The following table shows current regional energy and environmental plans.

Region	Status	Approved by D.G.R n. 1189 5/12/2001
Abruzzo	In force	Approved by D.C.R n. 220 26/06/2001
Basilicata	In force	
Calabria	To be approved	
Campania	To be approved	
Emilia Romagna	To be approved	Draft B.U.R. n. 221-16/01/03
Friuli V.G.	To be completed	
Lazio	In force	Approved by D.C.R n. 45 14/02/2001
Liguria	In force	Approved by D.C.R n. 43 2/12/2003
Lombardia	In force	Approved by D.G.R n. 12467 21/3/2003
Marche	To be approved	
Mouse	To be completed	
Piemonte	In force	Approved by D.C.R n. 3513642 3/02/2004
Puglia	To be completed	
Sardegna	In force	Approved by D.C.R n. 15/42-28/05/2003
Sicilia	To be completed	
Toscana	In force	Approved by D.C.R n. 1/2000 B.U.R n. 1/03/2000
Umbria	In force	D.C.R. n. 402-21/07/2004
Valee D'Aosta	In force	D.C.R. n. 3146/XI-3/04/2003
Veneto	To be completed	
Prov. Aut. Bolzano	In force	N.A.
Prov. Aut. Trento	In force	N.A.

Table 1. Regional energy and environment plans

Each PEAR has placed a different emphasis on renewable energy sources and biomass. Some have taken into consideration only selected biomass sectors (agriculture and/or silviculture, and/or agriculture industry) and only certain types of biomass have been considered to be available.
Program goals and strategies can be achieved by creating incentives capable of stimulating businesses and citizens to convert all or part of their energy consumption into RES and, in particular, to biomass-based energy.
The incentives can be economic or even limited to administrative simplification.
Starting in 2004, and through 2006, the minimum quota of electricity produced by RES for the national grid will increase by an annual rate of 0.35%.

Years	E.E. Quote %
2004	2.35
2005	2.70
2006	3.05

Table 2. Minimum target of renewable electric energy in Italy

This is only an example of the important changes of these last years.
There is still a long way to go to reach important bioenergy targets.

2.10 Country Report for FYR Macedonia

Author(s)*: Bojan Rantasa, Vlatko Andonovski, Dragi Pop-Stojanov

2.10.1 Overview

The total energy use in Macedonia for 2005 is assessed at 2738 *ktoe* (International Energy Agency (IEA) Statistics, 2008) while the consumption of Combustible Renewables and Waste, including biomass, for 2005 was assessed at 154 *ktoe* (IEA Statistics, 2008).

According to the State Statistical Office the total primary production of biomass for 2005 was 600.298.000 m^3.

FYR Macedonia is committed to implementing the Acquis Comminautaire of the EU in the field of energy, competition, environment and renewable energy sources with the signing of the Athens Memorandum in 2002.

The legal framework for utilization of biomass for energy is set in the **Law on Energy** (Official Gazette of RM, No. 63/2006) and the **Law for Amendment to the Law on Energy** (Official Gazette of RM, No. 36/2007). In the Law on Energy is a provision for a Strategy for Renewable Energy Resources Exploitation for the period of 10 years, however, this Strategy has not been developed yet.
The **Strategy for Energy Efficiency of the Republic of Macedonia** from 2004 does not tackle biomass issues. The Macedonian Academy of Science and Arts is in the process of preparing a **Strategy for the Development of the Energy Sector** by the year 2020.

Other measures are taken from the energy sector in promotion of Renewable Energy, including biomass, such as:

- A report of the Ministry of Economy on **Use of Renewable Energies and Energy Conservation (2003),** in its **Part D**, contains a report on the use of **Wind Energy, Biomass and Solar Energy**. The report was done trough PHARE programme, Contract No: 00-0328.00. It provides recommendation on use of biomass for energy.
- There is an ongoing programme, **"Sustainable Energy Programme"**, run by the Agency of Energy . The programme has a total budget of US$ 5,8 million and is supported from the Global Environmental Facility. The programme aims to stimulate investments in energy efficiency and use of renewable energy sources, including biomass.
- **Decision by the Energy Regulatory Commission** for favourable buyout price for electricity produced from biogas made of biomass, from 22 November 2007. A guideline has been produced from the Energy Regulatory Commission as well.

Other national strategies tackle the biomass issue as well:

- The **National Strategy for Clean Development Mechanism 2008-2012** elaborates the perspective in biofuels.

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- The **Strategy for Sustainable Development of Forestry in the Republic of Macedonia**, adopted in June 2007 promotes wood biomass based energy technologies.
- The **Draft Strategy for Sustainable Development of the Republic of Macedonia** from 2008. Provides a perspective in biofuels and measures for proper management of biodegradable waste.

2.10.2 Methods and Activities

Studies towards a biomass assessment in FYR Macedonia have been done.

The **State Statistical Office** provides an annual overview of the biomass quantities produced from the major crops and economically interesting forest tree species on national level. The data include an assessment concerning the quantity of agriculture dry matter – agriculture waste, equalling from 15% to 18% of the agriculture crop production. The results are publicly available.

The **Public Enterprise "Macedonian Forests"** assesses the quantities of wood biomass on the managed forest land. The managed forest comprises 90% of the total forest land. For certain cases standard or altered wood mass tables are used, or the wood mass is assessed trough sample plots where the plots are mostly stripes 10m wide, covering 8-10% of the assessed area. The activity is repeated every 10 years, however it is done individually for every of the 30 Forestry Units. The results are available on request.

A Dutch company **Haskoning** made a **Biomass Availability Study** in 2001. The activity was done in the framework of the bilateral FYR Macedonia – Netherlands cooperation to assess the possibilities for Dutch companies to invest in the biomass sector in FYR Macedonia. The study is private and cannot be acquired.

The **Faculty of Engineering, University of Ss Kiril and Metodij – Skopje**, has done a **Biomass study for Eastern FYR Macedonia**. The study was financed by the Ministry of Science, but is not publicly available.

The **Macedonian Geothermal Association** is currently conducting an **Assessment of the Biomass Reserves**. For the purpose of the study statistical data is used, and data from the forest and agriculture sectors.

The **Faculty of Natural Sciences and Mathematics, University of Ss Kiril and Metodij – Skopje**, together with the **Macedonian Environmental Society** has conducted a research on the **Aboveground phytomass and primary production in the tree layer of the beech ecosystem (*Calamintho Grandiflorae-Fagetum*) in Mavrovo National Park, FYR Macedonia**. The study utilized Allometric regression methodology. The tree layer biomass was estimated by the methods prescribed by Newbould (1967) and Whittaker, Woodwell (1969) (Metovski et al, 1997). Though the research concentrated on a small region, it can be used on a wider, national level. The results of this research are made available trough scientific publications.

The **Faculty of Natural Sciences and Mathematics, University of Ss Kiril and Metodij – Skopje** has conducted a research on the **Biomass and the mineral quantity in the herb layer litter-fall in the beech ecosystem *Calamintho grandiflorae-Fagetum* in Mavrovo National Park**. The study utilized the following methodology: Herb layer litter-fall was measured in the investigated ecosystem in the period of 3 years (monthly during vegetation period: March-September). The method used was line transect with sampling frames of 1m2. About 100 samples in average were performed in the buffer zone. Frames were placed on the surface of the forest floor and all different plant species for the herb layer were collected in different paper bags. All collected material was dried to constant

weight at 105° C. The weight of different plant species was measured separately on 0.0001 g scale. The total litter fall biomass of the herb layer was estimated as sum of the maximum biomass of different species. The 34 plant species were analysed by standard chemical methods. The total nitrogen was analysed by semimicro Kjeldahl method, total phosphorous – colorimetrically by Fiske & Subarow method and other cations: K, Na, Ca, Mg, Fe, Mn, Zn, Cu, Cd and Co by atomic absorption spectrometer. (Melovski et al 2004) The research though concentrated on a small region, it can be used on a wider, national level. The results of this research are made available trough scientific publications.

In the forestry sector a lot of research been conducted concerning the productivity and utilization of the wood mass, as a part of the biomass. Examples include:

- Productivity of ***Quercus pedunculiflora K.Koch.*** forests in the conditions of the Republic of Macedonia (Ivanovski et al, 1994);
- Production of mixed beech (***Fagus Moesiaca***) stands and black pine (***Pinus nigra***) in dependence on the composition (Ivanovski et al, 1996);
- Growth and production characteristics of the artificial stands of black pine (Trajkov, 2002); and
- Analysis of the energy value of the beech tree (Nestorovski et al, 2004).

Projects that tackled the issue of biomass potential are:

- **Renewable Energy Coordinated Development in the Western Balkan Region**, a FP6 project where local partner was the Macedonian Geothermal Association. They made analysis of the current energy situation, energy strategy and policy, legal framework, distribution and use of RES, and the macroeconomic parameters in the Western Balkan Countries.

- **Acceleration of the Cost-Competitive Biomass Use for Energy Purposes in the Western Balkan Countries**, a FP6 project where local partner was the Macedonian Geothermal Association. One of their objectives was to assess the biomass potential (Black Sea Regional Energy Centre, 2008).

- **Rural Sustainable Development through Integration of Renewable Energy Technologies in poor European Regions**, a FP6 project where local partner was the Macedonian Geothermal Association. They made analysis of the balance of Renewable Energy Sources in the area of Kuklis and Murtino.

2.10.3 National data on plant growth and primary production

There exist two main national data sets on the plant growth and primary production.

The first dataset only concerns the forests. These data are managed by the Public Enterprise “Macedonian Forests” and are elaborated within the Forest Management Plans of each Forestry Unit, in total 30. Therefore the data consist of 0 independent sets of data on: wood stock volume, forest wood increment, forest wood density, forest age, species structure, plant associations, forest ecology, forest infrastructure, etc. The data are being roughly updated, using visual methods, every 10 years with the elaboration of a new Forest Management Plan for the Forestry Unit. The data can be obtained via an official request. Further information can be found on: http://www.mkdsumi.com.mk

The second dataset is the National Statistics, run by the State Statistical Office, where information about: total capacities and the production of public companies and enterprises, agricultural cooperatives and private agricultural holdings; data for area, establishment and care of forests, use of forests on total coverage; total damages to state forests, and fire damages includes state forests and

privately owned forests. The data are undated and made available annually in a publication that needs to be purchased. Further information can be found on: http://www.stat.gov.mk

2.10.4 Feasibility of promoting non food type agricultural production

In the agriculture sector, agriculture waste is not used to its full potential. In most cases farmers leave it on the fields and burn it to clear the fields, though illegally. For some crops, like the hay or some vegetables, residues are used as animal feed. In this sense the potential of utilization of biomass for energy from agriculture, even as secondary focus is still great and unused.

Promotion of energy crops is still new, though many farmers seek salvation of their businesses in shifting to energy crops. Currently the sunflower is being reappearing on the fields, but now as a crop for energy and not for cooking oil. In this relation, other energy crops may be promoted as long as there a stable chain from the farm, via the industry, to the consumer is established.

The forestry sector, on the other hand, shows greater organization of utilization for energy. Namely the Public Enterprise Macedonian Forests provides as main product fire wood used for household heating. What remains an open question is the efficiency of the utilization of this resource. The forestry sector focuses on certain species of trees, and only the tree trunk is used. As a result, great quantities of tree bark, tree branches and leaf mass are unutilized. This provides opportunities for production of wood brickets and/or wood pellets that can be utilized for energy. Further, the Public Enterprise Macedonian Forests, in line of the Strategy for Sustainable Development of the Forestry, seeks ways to promote wood energy as a renewable energy source and promotion of the use of biomass.

Other sectors like the wood and furniture industry and gardening represent sources of biomass that, to date are underutilized,. Residues are mainly disposed in landfills as wood mass waste. So, using these as an energy source could reduce greenhouse gas emissions from energy use and landfills.

2.10.5 Conclusion

Analysing the situation of biomass assessment in FYR Macedonia, it is evident that a reliable or comprehensive biomass assessment has not been conducted. All national or partial assessments are based on available data. However, since the data source is the State Statistical Office or Public Enterprise Macedonian Forests, the data are not very reliable as their method of surveying is in most cases visual and comparing it to old data.

Small scale studies in the field of forest biomass have been done both from the Faculty of Forestry and from the Faculty of Natural Sciences and Mathematics, University of Ss Kiril and Metodij, Skopje. The methodology provided can be utilised on a national level, however it will present a costly exercise.

Both the agriculture and forestry sector are in needed of an assessment/inventory to be conducted in order to provide basic and reliable data for further analysis of the potential use of biomass for energy. In the search of a cost effective methodology, the utilization of Earth Observations is more and more looked into as a tool, a solution that in a short time FYR Macedonia can obtain reliable and accurate data for further analysis of the potential of biomass for energy.

2.11 Country report for Romania

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2.11.1 Overview

Energy politics

Starting in 2003, Romania adopted various regulations for promoting electricity generation from renewable sources. The regulations apply to both energy generated from renewable sources (such as wind, geothermal, hydro, biomass, waves) and energy generated from hybrid plants, using renewable and conventional sources. In order to benefit from the facilities provided by law, the generators using renewable sources have to obtain a certificate for the guarantee of origin attesting the provenance of the electricity.

The regulations provide the principle of non-discriminatory access to networks of generators using renewable sources and the operators' obligation to guarantee the transmission and distribution of the electricity generated from renewable sources, in so far as it does not endanger the networks' viability and safety.

Energy Law No. 13/2007 the Energy Law No. 13/2007 sets forth among others the possibility of the Government to approve support schemes promoting electricity generation from renewable sources, including through accelerated depreciation of related investments.

GD (Governmental Decision) 443/2003 on the Promotion of Electricity Production from Renewable Energy Sources.- It establishes the legal framework that increases the contribution of renewable energy sources to the electricity production. The GD sets a target of 30% from the gross national electricity consumption for the electricity produced from renewable sources in the year 2010. The GD also defines the "guarantee of origin" for the electricity produced from renewable energy sources (RES). The guarantee of origin specifies the electricity source, the place and date of production (and the installed capacity for hydro power plants). The guarantee proves that the electricity sold by a producer comes from RES.

Government Decision 1535/2003 approving the National Strategy for Renewable Energy Sources Use approving the regulation regarding the origin certification for the Government Decision 1429/2004 electricity produced from RES

Government Decision 1892/2004 that settles the promotion system for the electricity produced from RES

GD 1069/19.11.2007 approving the Energy Strategy of Romania for the period 2007-2020

GD 890/2003 on approval the Roadmap in Energy in Romania

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HG 750/2008 " Decision for approval of the Scheme for regional state support on renewable energy sources valorization"

Romania adopted in the national legislation the European directives:

- *Directive 2001/77/CE* regarding promotion electricity produced from renewable energy sources *GD 958/2005*

- *Directive 2003/30/EC* for promoting the use of bio-fuels and other renewable fuels for transport *GD1844/2005 Energy Law (no.13/ 2007) – general provisions for renewable promotion*

Biomass use for energy

Romania's agricultural and forest land comprises 40% and 27% of the total land area respectively.

The share of biomass in the total energy of the country was 10.94% in 1998. Potential biomass is regionally distributed over Romania. Fuel wood and wood waste is mostly found in the Carpathians and Sub-Carpathians, while agricultural waste is available in the South Plain and Moldavia, and biogas in the South and Western plains.

In the Romanian statistical records, biomass is categorised as:
- Firewood & agriculture waste, etc., which accounts about 95% of the total and
- Wood waste from industrial processes with about 5%.

Currently, biomass is mostly for residential space, cooking and water heating purposes, District heating systems are the most immediate and low-cost application. About 95% of the biomass currently used is firewood and agricultural waste, the rest is wood waste from industrial processes: The average capacity installed in sawmills is 3.3 megawatts of thermal energy.

The potential market for biomass applications is very large but specific incentives will be needed for this potential to be realized. Direct burning in kilns, stoves for space heating, cooking and water heating is about 95 percent of the biomass use. These furnaces have a nominal capacity between 0.8 kW to 4 kW and are hand stoked providing an average efficiency between 15 and 50 percent.

From the total firewood & agriculture wastes it is estimated that only 30% is commercial biomass. The remainder represents the contribution of the biomass harvested by the owners from the private forests and gardens and agricultural wastes in the rural household. The share of other biomass resources, i.e. straw, is two thirds of the total biomass utilisation. The domestic use of firewood is almost 30% of the total, while the shares of industrial solid and liquid by-products are minor. These values can vary for different regions depending on climatic condition, the age of the plantations, etc.

In the Carpathians Mountains and Subcarpathians area, where firewood and wood waste are readily available, there are opportunities to develop district-heating plants. The size of boilers for the district heating in the identified projects range from about 1 MWth to 6 MWth (acc. to the 'RES Strategy'). The expected development of the wood industries will encourage the rehabilitation of the existing boilers from the existing auto producer's thermal plants.

Development of this energetic potential biomass could cover about 70% from Romanian commitment regarding the percentage of renewable energy in total energy consumption.

The most promising regions for the agricultural waste utilization could be the South Plain, especially Braila, Ialomita, Calarasi, Giurgiu, Teleorman counties and the West Plain, especially the counties of

Arad and Timisoara. In these counties the agricultural production is high, there are no private sources of fuel for heating and cooking.

Final energy consumption by sector (2006)

2006	GWh	PJ	%
Industry (including construction)	116277	419	39.5
Agriculture, silviculture, fishery	3047	11	10
Transport and communications	51253	185	17.4
Other activities	32064	115	10.9
Residential	91749	330	31.2
Total	**294390**	**1060**	**100**

Final energy consumption in industry by source- 2006

Final energy in industry	Coal	Natural Gas	Other fossil fuels	Wood and other RES	Electricity	Other	Total
Total in PJ	63.2	148.7	94.1	11.3	87.5	14.8	418.6
Total, in %	14.8	35.5	22.5	2.7	20.9	3.5	100

Biomass consumption within the energy resources balance

Specification	1997	1998	1999	2000	2001	2002	2003	2004
Primary resource consumptiom (PJ)	2146	1934	1666	1689	1788	1843	1901	1978
Biomass consumptiom (PJ)	141	127	118	116	90	100	123	136
Biomass share	6.57	6.56	7.1	6.87	5.03	5.42	6.47	6.88

2.11.2 Methods and Activities

Assessment of exploitable potential from forestry

The current method used to determine the **allowable cut** is based on a traditional sustained yield approach. The algorithm used to determine the allowable cut takes into account rotation length, average species composition, forest structure according to site indices, and the existing distribution of age classes.

Rotation length is calculated according to the maximum rent principle. This is compatible with the fact that the national forest estate is a state property, with annual expenditures and revenues. Small areas enter and exit this estate. Maximizing the rent is a more reasonable goal than maximizing land value. Rotations have been set according to the average increment of the target dimensional class, and reflect a conservative policy with an environmental dimension.

Long-term goals focus on:

- the maintenance of the integrity and development of the public forest estate; and
- the preservation of private forests.

Ecological objectives aim at:

- the conservation of biodiversity of natural forest types (over 150 000 ha of genetic resource reservations, 350 000 ha of protected areas, special attention for endangered species in forest ecosystems);
- the extension of the present-day forest area (reforestation of 10 000 ha of low production lands and 2 000 ha of low-production farmland is planned for the next five years);
- specific forest and hydro-technical works for flood control (financial resources limit investments in the short term to 600 km);
- technical development of forestry to provide sustainable management of forests (in accordance with current international requirements);
- continuous expansion of the use of natural regeneration (50% by the year 2000 and 60% by 2005) and improved structural complexity of forest stands;
- the ecological and economic reconstruction of degraded forests (50 000 ha/year);
- the intensification of forest protection and safeguarding activities through the establishment of a Center for Biological Methods in Forest Pest Prevention and Control;
- forest health assessment by a European Integrated Monitoring System; and
- the provision of sustainable forests through forest management planning.

Structural adjustment objectives in the forestry sector are to:

- optimize the administrative structure;
- promote the forestry information system;
- improve forest technology;
- promote privatization in forestry for specific forestry activities, such as forest roads, production of planting material, or through the association of private companies and forestry administration units (state-owned forests) to improve the value of forest products;
- improve the financial system through the development of timber extraction from state-owned forests, export of timber and other forest products, and new taxes for various forest benefits in special areas;
- maintain the current administrative organizations for specific research activities, or divide the Institute of Forest Research and Management into a National Institute of Forest Research and an Institute for Forest Management Planning, both under supervision of the Ministry; and create a National Center for Continuous Professional Training for Forestry under Romsilva RA and a new organizational system for mid-level, professional training of forestry personnel.

Study on assessment of the actual energetic potential of renewable energy sources in Romania (solar, wind, biomass, micro hydro, geothermal). Identifying the best sites for development of investments in producing unconventional electricity

The “R&D Plan of the Minister of Economy and Finance in the field of competivity” 2005-2008, funded by Minster for Economy and Finance of Romania – Department of Energy,
performed within the Sectoral Plan for Research and Development of the Minister for Economy and Finance of Romania, was designed to contribute to the implementation of the priorities regarding the evolution of the RDI activities from industry, established by the government politics in this field. This project was meant to supply the basic data to evaluate the potential of RES, and to support the decision making process regarding the implementation of the communitarian aquis in this field.

The specific goals of the project were:

- Terrestrial assessment of current status of RES (including biomass) for Energy use
- Identification of the best sites for development of investments in producing unconventional electricity

Type of methodology used

Statistical data, supported by a technical consideration regarding specific activities performed for a assessment as accurate as possible. The study was focused on the national level.

To assess the agricultural biomass one of the criteria taken into consideration was the type of the agricultural land depending on the land use categories and crop types, but the results of the assessment performed within the project were presented as a total technical biomass potential shared on the considered regions.

Within this study the following categories of biomass were assessed: wood, wood waste, agricultural waste, biogas, and municipal waste. The following types of potential were assessed:

- Theoretical potential
- Technical potential
- Electricity generation potential
- Technical and economic prospective potential

From the point of view of the energy potential, Romania's territory was divided into the following eight regions: Danube Delta, Dobrogea, Moldavia, the Carpathians (eastern, southern, the Apuseni), the Transylvania Plateau, the West Plain, the Subcarpathians and the South Plain. Potential biomass is regionally distributed over Romania. Fuel wood and wood waste is mostly found in the Carpathians and Sub-Carpathians, while agricultural waste is available in the South Plain and Moldavia, biogas in the South and Western plains.

Biomass potential assessment has taken into account limitations foreseen in specific programmatic documents (National strategies in agriculture and forests management), for example:

- Sustainable management of crops and forests
- Soil quality protection and preserving soil fertility
- Protection of forests with natural and quasi-natural structures.
- Protection of the quality of forestry soils
- Enhancement forestry areas, including on the degraded soils; and
- Biodiversity protection

In order to assess the technical and economic prospective potential, the following socio-economic assumptions were taken into account:

- Infrastructure conditions
- Legal status of the area
- Grid connection possibilities
- Availability of potential clients and investors in an area
- Public-private partnership perspectives
- Technical-economic indicators of the investments in the selected area

It was used only a business as usual scenario. The methodology supplied tables showing:

- Biomass potential assessment depending on biomass type and region (thousand t/year)
- Prospective technical and economic energetic biomass potential depending of biomass type
- And two maps:
- Energetic biomass potential distributed on counties and development regions (TJ)
- Vegetable (agricultural and wood) biomass distribution through counties and development regions thousand m^3)

The study was not dedicated exclusively to biomass assessment. The evaluation was a part of a general study concerning all RES potential in Romania, and this led to insufficient depth of analysis. Some of important aspects (as environmental impact) were not taken into account

Accelerated Penetration of Small-Scale Biomass and Solar Technologies (ACCESS)

This methodology was developed and followed by a project within the IEE Programme
Author: a consortium led by Black Sea Regional Energy Centre (BSREC).
The Romanian partner was the Institute for Studies and Power Engineering (ISPE)
The specific goals were:

- To systemize data about the biomass resources that indicate the potential for energy utilization in each country;
- To outline the perspectives to the development of this potential;
- To enable interested stakeholders to identify the optimal scheme for combined utilization of solar thermal and biomass energy;
- To make the interested stakeholders aware of the technology developments, and standards and labels (particularly, Solar Keymark scheme) for the concerned technologies and biomass products in the "old" EU member states;
- To develop a virtual market of these technologies; and
- To propose financing mechanisms that would aid the low-income residents to afford the concerned technologies.

The study used statistical data, supported by a technical consideration regarding specific activities performed for a assessment as accurate as possible. The study was focused on national level (by the Romanian partner of the project). A retrospective analysis was performed, taking into account existing data over eight years in the past, and also a prospective analysis, within the period 2005-2015.
Within this study the following categories of biomass were assessed: wood, wood waste, wheat and rye, maize, sunflower, tobacco, rape, fruit trees, vineyards. The following potentials were assessed:

- Technical potential
- Electricity generation potential.

No environmental or assumptions were made, and no economic availability was assessed. The study only identified the business as usual scenario.

Each biomass type was presented separately in term of biomass quantity (t/year) and energy generated (PJ)

"VIEWLS: Clear Views on Clean Fuels, Data, Potentials, Scenarios, Markets and Trade of Biofuels" (VIEWLS)

The activity was funded by the framework Programme 5, 2003-2005, and it was developed by a consortium lead by SenterNovem Netherlands. Romanian partner: USAMBV, University of Agronomic Sciences and Veterinary Medicine Bucharest. In this study, it was used a unified methodology to estimate the biomass potential assessment for the CEEC.

The methodology is based on the study from Smeets et al. (2004a), which means that land use changes over time are included in the biomass potential assessment based on a scenario analysis. Countries included in the biomass potential assessment were: Estonia, Lithuania, Latvia, Poland, Romania, Bulgaria, Hungary, Czech Republic and Slovakia. An extra methodological aspect of this study is the estimations of costs for biomass production. Final deliverables are the cost-supply curves from different sources (energy crops, residues) and production systems for the CEEC.

This methodology from Smeets et al. (2004a) is applied on a so-called NUTS-3 region level. The total available biomass potential in a NUTS-3 region is the sum of biomass from energy crops, wood from surplus production forest, agricultural and forest residues.

A key question in this study was to answer whether the bio-energy potential in the CEEC is indeed large enough to supply bio-fuels to the European market and under what conditions such potentials can be developed.

The aim of this study is to implement a regional biomass potential assessment for the CEEC, which is based on scenarios so that land use changes over time are included in the analysis.
A retrospective analysis was performed, taking into account existing data over three years in the past, and also a prospective analysis, till 2030. In this study, biomass is defined as the sum of agricultural residues, forest residues and energy crops. Basically, there are three types of results from the biomass potential assessment in the CEEC:

- The availability of land for energy crop production in the CEEC
- The biomass potential in the CEEC
- The cost-supply curves

Regarding the environmental assumptions made, it is noticed that one of the five scenarios used for the regional biomass potential assessment assumes an ecological agricultural production system. The scenario is described as: “V5 scenario: EU has a priority for sustainable development and nature conservation. Biodiversity, protection of rural areas and maintenance of the vitality of forest and grassland areas has a high concern. There is a tendency of greening of agriculture. A certain level of protection (trade barriers) is needed.”

The study has taken into consideration three scenarios to model forest demand, supply and trade for the CEEC on a country level to the year 2030. The scenarios are the base line scenario (status quo), conservation scenario (high environmental awareness) and the “Integration and market Liberalization” scenario. The socio-economic assumption of the five scenarios developed are related to:

- Food consumption;
- Food trade;
- Livestock production system;
- Agricultural production system; and
- Reservation of land in allocation.

Scenarios developed within the methodology:

- V1 scenario: There is a liberalization of trade. There are no market barriers between the EU and the world for agricultural products. EU specializes in products, which are competitive in world market. There is a strong increase in import and export flows.
- V2 scenario: Policies are regionally orientated. There is an uneven economic development in Europe. Trade barriers exist between the Western and Eastern European market. The agriculture in CEEC has difficulties to compete with agriculture in WEC because of struggles as lack of investment, technology and implementation of EU policies and legislation.
- V3 scenario: There are no internal trade barriers in Europe. CEEC has completely adapted the EU legislation and can compete fully with WEC agriculture. Common Agricultural Policy (CAP) regulates agriculture in Europe. Aim of CAP is that farmers can compete with world markets. CAP reforms in Europe are in full implementation.
- V4 scenario: There are no internal trade barriers in Europe. Europe protects its own internal market strongly. EU strives for self-sufficiency in its own food and energy need. Internal trade has increased. External trade of products in world market is limited.
- V5 scenario: EU has a priority for sustainable development and nature conservation. Biodiversity, protection of rural areas and maintenance of the vitality of forest and grassland

areas has a high concern. There is a tendency of greening of agriculture. A certain level of protection (trade barriers) is needed.

The methodology for the cost calculation of biomass production is a bottom up approach that requires a data input for a wide range of cost items. Information about cost calculations is collected from several sources for the selected energy crops.

The following cost categories were taken into account: land rates, wages and inputs of fertilizers Biomass production costs are calculated in € / GJ. First, the total costs for crop production are calculated in € / ha. The next step is to calculate cost levels in € / t dm by dividing the costs in € / ha through the selected yield level. The final step is the estimation of the production costs in € / GJ.

The biomass potential for conventional crops is calculated for the whole crop. This means that the total cost calculation (in € / ha) is divided through the biomass yield for the whole crop to come to the final cost estimation in € / GJ. The cost-supply curves are developed for the eight selected energy crops and calculated for the five different scenarios.

The land suitability for a crop in a region is determined by rainfall, temperature, soil quality and slope. Land suitability for a crop can have a strong variation in a geographical area. The production system is determined by management practices as level of inputs, machinery and technological level. For the regional biomass potential assessment the study has developed an approach that enables to show both the impact of the production system as well as the variation of land suitability classes on agricultural productivity levels in a region.

For each production system, the study developed a database with information about the area of suitable land and the related productivity levels per crop. The land suitability classification per crop is based on the Agro-Ecological Zone (AEZ) methodology from Fischer (2000) and contains five different land suitability classes: Very Suitable land (VS), Suitable land (S), Moderately Suitable land (MS), marginally suitable land (mMs) and Not Suitable land (NS).

The physical outputs are the following:

- Amount of available land (in 1000 ha) on country level for energy crop production for selected scenarios.
- Biomass potential (in EJ) from energy crops, agricultural residues, forest residues and surplus forest for the sum of all Central and Eastern European Countries:
- Cost levels average production costs, based on the % of available potential per individual CEEC country.

No uncertainty analysis was performed.

2.11.3 National data on plant growth and primary production

Data on plant growth and primary production are available from the Romanian Statistical Yearbook, issues by the **National Institute of Statistics**. The type of information collected are as following:

- Subject: Agriculture
- Type of information: total land fund, agricultural branch production, production of the main agricultural products, cultivated area, crop production, average yield
- Subject: Sylviculture
- Type of information: forest land, afforestations, cutting wood area, harvested wood volume, volume of wood exploited by economic operators having forestry activities

Biomass resource type	Total production	Production density
Percent of the total land area covered by		
- Forests	28%	
- Shrublands, savanna, and grasslands	1%	
- Cropland and crop/natural vegetation mosaic	69%	
- Urban and built-up areas	1%	
- Sparse or barren vegetation	0%	
- Wetlands and water bodies	1%	
Primary crop production, tonne		(tonne/1000 ha)
- Total primary crops	53 291 420	2314
- Top 10 primary crops		
• Alfalfa for Forage & Silage	7 846 000	341
• Maize	7 777 600	338
• Leguminous (misc.), Forage & Silage	6 316 667	274
• Wheat	5 364 014	233
• Grasses (misc.), Forage & Silage	4 678 167	203
• Potatoes	3 742 300	162
• Mixed Grasses, Legumes	2 949 367	128
• Clover for Forage & Silage	2 704 367	117
• Vegetables and roots, Fodder	1 244 867	54
• Grapes	1 170 786	51

2.11.4 Feasibility of promoting non food type agricultural production

There is no agricultural overproduction in Romania, but, due to an important share of population (40%) living in rural areas and of uncultivated area (1.2 mil ha), there are good opportunities for biomass for energy crops. Romania has a capacity to produce 500-550 thousands t/year of rape, sunflower and soya oil, which mean a significant quantity of biodiesel.

2.11.5 Conclusion

- There is a good potential for energy crops and for a rational use of uncultivated land areas
- Some studies tried to perform an assessment of biomass potential in Romania
- The is sufficient statistical data to allow the assessment of biomass potential, but there is no “official” or renowned methodology to perform such analysis
- A new and unified methodology used for assessing biomass potential in Europe could be promoted to the policy makers, and there are good chances to be accepted and adopted as a recommended scientific tool in the future.

2.12 Country Report for Slovakia

Author(s)[11]: Pavel Starinsky, Milan Oravec

2.12.1 Overview

Slovakia is fully aware of the 20/20/20 by 2020 objective defined by the European Commission. This objective would raise the share of RES in final energy consumption to 20% by 2020, raise energy efficiency by 20%, and reduce the production of Greenhouse gas emissions by 20%. This commitment applies to the Union as a whole. For national targets, current national situations and future development must be taken into account.

In regard to final energy consumption, Slovak's national target for RES is 6% in 2010. According to the latest data, in 2005 RES represented 4,3% of final energy consumption. The long-term objective is 12-14% in 2020.

In regard to the share of RES in electricity production, for Slovakia an indicative target of 31% by 2010 was defined. This was based on EU Directive 2001/77/EC and was adopted during the accession to the EU. As this target is not realistic and not achievable, a new target was set at 19%. The majority of RES electricity originates in large-scale hydro plants (90%) and therefore is influenced by geographical and hydrological conditions. For this reason, the share of the RES in final consumption decreased between 1997 and 2004 from 17.9% to 14.6%.

Currently electricity production from RES in Slovakia is highly dependent on the output form large-scale hydro plants. For this reason a separate target was set for RES electricity production from sources other than large hydro plants. The short-term goal for non-hydro RES in the electricity sector is 4% of the final electricity consumption (1240 GWh) by 2010. A mid-term goal for 2015 is set at 7% (2300 GWh), and a long-term goal of 11% of final electricity consumption has been set for 2030. Currently approximately 1% of electricity comes from non-hydro renewable sources.

In regard to alternative transportation fuels, the target is 5,75% in 2010 and 10% in 2020.

Main documents dealing with the RES and energy security for Slovakia are the Strategy for Higher RES Utilisation, the Action Plan for Biomass Utilization, and the Strategy for Energy Security for the Slovak Republic until 2030. The documents were adopted in 2007 and 2008 respectively and define the targets, measures, implementation, and monitoring.

Currently the biomass is considered as a strategic raw material in Slovakia with the highest technical potential. This was expressed in the above mentioned Action Plan adopted this year. Technical biomass potential is estimated at the level of 147 PJ, which is equivalent to 2, 8 million tonnes of crude oil or 3,36 billion m3 of natural gas annually. This biomass could contribute 15% to the gross energy consumption in Slovakia. The level of actual biomass utilization in Slovakia is not in line with this potential. According to available statistical data, biomass' share of the gross energy consumption in 2005 was only 2% (approximately 21 PJ). Thus there is a very large potential for further use of biomass mostly in district heating and cogeneration as a distributed energy source.

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2.12.2 Methods and Activities

The assessment methodology was based on the analysis "Utilizable forest dendromass potential of the Kosice Self-Governing region area", which was conducted by the National Forest Centre in Zvolen, Slovakia. The methodology was applied to an area of 480 000 hectares which is the area of the forest soils in that region.

The study is aimed in particular at determining the present forest biomass potential. The study assumed that development would occur within the region area, and took into consideration sub-regional areas, indicated according to topography, transport possibilities, and supposed consumption centres.

Results were submitted to the regional development agency in Košice, and then subsequently used for the needs of local authorities and entities in energy, industry, agriculture, etc.

The method used in the study was called "Quantification of potential forest dendromass utilizable for fuel under biological and technological restrictions".

The methodology is based on the average annual planned thick-wood logging without the bark, segmented by particular wood species, their age and site quality. Logging is planned for the period of 10 years, with amount logged per year varying by particular year of the planned period. The total stipulated planned felling for the 10 years horizon may not be exceeded; however total felling may be less than the total planned. Regular logging is planned; there is an assumption of no occurrences of calamities such as wind, snow, ice coating, and biotic pests. About 50 % of the total annual wood logged in Slovakia is due to logging of wood damaged by the calamities – calamity logging. Wood from calamity logging is usually considerably damaged. Consequently, there is an increased proportion of wood suitable for energy utilization. In the methodology used, wood- distribution proportions according to wood species are taken into consideration. Depending on the mentioned parameters, the bark and tree-crown mass is added to the registered logging mass. Conversion of volume to mass units is carried out according to the specific mass components of the tree biomass of the particular wood species, depending on the mass humidity.

The total dendromass potential is reduced by the biological, technical, and transportation restrictions assessment.

Wood biomass from the forest soils in the solid state was assessed as not suitable for industrial processing due to its dimensions and quality. Smallwood was included together with industrially not usable thick-crown tree wood, fuel wood, underground dendromass after soil preparation, waste from assorted wood production and from wood processing by forest entities. In the case of the given study, there were no more development scenarios taken into consideration.

For this study the output data were the following:

- Annual potential forest dendromass usable as fuel, potential quantity within the whole evaluated area in mass units (tons) and the energetic value calculated to the calorific capacity value (TJ),
- Annual usable potential for the territory of the particular sub-regions of the assessed area in mass and energy units.

Following dendromass fuel types were differentiated within the output:

- Forest fuel chips,
- Fuel wood.

2.12.3 National data on plant growth and primary production

There are specialized national databases on plant growth and primary productivity in Slovakia. The official name of the database for forest dendromass is: Overall information of the forests state. This is is financed and prepared by „National forest Centre (address: T. G. Masaryka 22, 960 92 Zvolen www.nlcsk.org e-mail: nlc-lvu@nlcsk.org). Database type: computer-based.
The database provides information on the wood stock for the whole country. This database is one of the bases for the forest dendromass fuel quantification. This database is updated continuously. Data availability is restricted to the Ministry of Agriculture of the Slovak Republic, owners, and forest managers (subject of information: wood without bark thicker than 7 cm. Type of information: wood stocks, wood species, age of wood by species). The database does not include vegetation health indicators.

The official name of the database for agricultural dendromass is: Central database of the Slovakia agriculture production. This database is financed by Ministry of Agriculture of the Slovak Republic. The database is prepared by Research Institute of the Agriculture and Food Economy, Bratislava (address: Dobrovičova 19 Bratislava. www.land.gov.sk). Database type: computer-based.
The database provides information on planting areas and production of particular agriculture plants during the particular year period. This database is updated continuously. Data availability is restricted to the Ministry of Agriculture of the Slovak Republic and bodies of the state government (subject of information: total agriculture production; type of information: real production registered in the last year). The database does not include vegetation health indicators.

2.12.4 Feasibility of promoting non food type agricultural production

The use of wood for energy has become increasingly important. Although wood is the oldest source of energy it has only recently regained recognition. Ever rising prices of fossil fuels, increasing dependency on energy imports from insecure regions, and the effects of climate changes are challenges that our society and politicians cannot ignore.

In regard to supporting utilisation of biomass for energy production, programmes targeting on the overproduction in agricultural sector are not very reasonable because utilisation of this biomass requires quite high initial investment costs.

We hope that this year´s gas crisis will result in greater pressure on politics and policymakers to consider biomass as a very important alternative energy source mainly for heat and power as an alternative to natural gas. Biomass should also be considered as a source energy which improves the security of energy in Slovakia

It is expected that the gas crisis will speed up passage of a bill on Renewable Energy Sources, which have should been accepted last year. Absence of this Act is slowing down broader utilization RES as a whole but particularly biomass which is the most popular renewable source of energy for heating in Slovakia

At present Slovakia covers only 5% per cent of their energy consumption with renewables, of which only 2 per cent comes from biomass. Therefore Ministry of Agricultural was commissioned preparation of the National Biomass Action Plan for 2008–2013. Soaring food consumption is forcing countries worldwide to optimise their use of arable land for food rather than biomass production. Wood biomass is thus seen as a welcome alternative to crop biomass.

2.12.5 Conclusion

At present, potential agricultural biomass utilisable for energy in Slovakia amounts to about 1.8 million tons of straw from grain, corn, sunflower and rape. . This quantity corresponds to an energy equivalent of 25.5 PJ. An additional energy equivalent of 2.7 PJ is available from woody agricultural biomass (orchards, vineyards, etc.). This means that the total energy potential of agricultural biomass suitable for combustion is 28.3 PJ. In view of the sharp reduction in livestock production that occurred at the end of the last century, straw usage for feeding and littering was also reduced, enabling full use of straw for energy production. From the economic point of view, it is very profitable to use straw for heating in enterprises which also produce straw.

The forest sector has traditionally been the largest supplier of chip wood and firewood in Slovakia. In 2007 the biggest state-owned forest company produced about 150.000 tonnes of chip wood. Smaller chip wood companies produced an additional 40.000 tonnes. Annual volume of forest dendromass for energy production has been rising, especially in the three last years. (See table bellow)

Year	Chipwood		Fuelwood and other[1]		Total	
	1000 tonnes	TJ	1000 tonnes	TJ	1000 tonnes	TJ
1990	2	19	368	3496	370	3515
2000	5	48	471	4475	476	4523
2005	120	1140	640	6080	760	7220
2006	150	1425	660	6270	810	7695
2007	190	1805	670	6365	860	8170

Table 1. Yearly volumes of forest dendromass for energy production (source: NFC-FRI, 2008; Prepared by: NCF-FRI Zvolen;
Note: [1]fuelwood and waste wood, post-harvest debris and snags, [2]chipwood and wood for chips production)

2.13 Country report for Slovenia

Author(s)*: Dr. Andrej F. Gubina, Borut Kozan, Iztok Zlatar

2.13.1 Overview

In the past years, Slovenia has started with procedures which aim to determine the national biomass potential for energy use and establish the baseline, against which further policies can be developed. Primary statistical data has been collected for years. With the accession of Slovenia to the European Union, the database methodology has been harmonized with EUROSTAT methodology. The specific methodology includes collection of national data on the regional level. This leads to very accurate results because Slovenia is a relatively small country.

Methodology for determination of energy potential of biomass based on these primary data wasn't developed until 2007. At that time, a meta-study was undertaken for establishing the energy potential which can be produced from renewable energy sources was carried out by University of Ljubljana, Faculty of Electrical Engineering. The results of this study and the methodology established will most probably serve as the template for future detailed studies.

2.13.2 Methods and Activities

As mentioned before, the use of biomass for electricity production in Slovenia was not systematic or widespread in recent history. Therefore, the first study to attempt to classify and analyze biomass potential as electrical energy source was undertaken only in 2007. The key information on the study and the results are described in the matrix that is supplied in the attachment. There we describe which inputs and methodology were taken into account in this study. The study covers all applicable renewable energy sources and meta-analyses data, available in a range of partial reports on different renewable energy sources. For biomass, the main information sources for raw data were taken from Statistical Office of the Republic of Slovenia and Slovenian Forest Service. These two offices are financed by the Slovenian government for the activities which are necessary in the national interest. An analysis was made for an annual snapshot, based on the latest available information (2006). The model can be used for any type of data time series. Retrospective analysis was used on existing data. Prospective analysis was using industry models to predict the future development of the biomass potential in Slovenia.

In the study, theoretical, technical, economical, realizable and prospective potential were taken into account**.** The following definitions were employed:

- **Theoretical potential**: General physical parameters have to be taken into account. This potential represents the upper limit of what can be produced from a certain energy resource from a theoretical point of view, based on current scientific knowledge;
- **Technical potential**: If technical boundary conditions (i.e. efficiencies of conversion technologies, overall technical limitations as e.g. the available land area to install wind turbines) are considered, the technical potential can be derived.

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- **Economically available potential**: covers all biomass one can collect up to a specified cost level (taking into account the (elastic) price band of competitors on the market).
- **Realizable potential**: The realizable potential represents the maximal achievable potential assuming that all existing barriers can be overcome and all driving forces are active. Thereby, general parameters as e.g. market growth rates and planning constraints are taken into account.
- **Electricity generation potential:** All the potential that might be used for electricity generation.
- **Prospective potential**: Equal to the realizable potential in some future year (typical 2015, 2020, 2030, 2050…)

Considerations on the environmental impact of crop changes have not been included. We therefore recommend to include these analyses in the subsequent studies.

2.13.3 National data on plant growth and primary production

The main national statistical database is operated by the Slovenian Statistical Office. For some sectors, raw data for the statistical office are acquired from other national sector services (forest, agricultural, energy). The methodology for analysis of the biomass potential in Slovenia in the study consisted of two parts: calculation of forest biomass and of agricultural biomass. In the part for calculation of forest biomass potential, data were obtained from the Slovenian Forest Service. The following data were used:

- forestation and variety of forests,
- growing stock,
- increment,
- cut and
- forest ownership.

In the agricultural part of the methodology, data were obtained from the Ministry of agriculture, forestry and food, which are used for determination of EU agricultural subsidy level determination. The biomass was classified into more than 120 different categories.

Input data which were classified in the categories shown below:

BIOGAS
Agricultural biogas: covering the following primary fuels:

- Farm slurries,
- Agricultural residues,
- Residues from pasture land,
- Separately collected biodegradable fractions of municipal waste.

Landfill gas: The primary resource for this energy carrier is the biodegradable fraction of landfill waste.

Sewage gas: As the primary resource, waste water or sewage, respectively, processed and refined in sewage purification plant was used.

SOLID BIOMASS
Forestry products: covers all forms of wood (e.g. firewood and wood chips) directly harvested from forests. The additional potential is derived from the unused net annual increment of forests which are marked as available for wood supply.

Forestry residues: wood residues which occur in the forests in the process of harvesting.

Solid industrial by-products: include bark and waste from sawmill- , wood- and paper industry production.

Agricultural products: fast growing woody plants (Poplar, Willow and Eucalypt).

Agricultural residues: The most prominent representative of this category is straw.

BIOWASTE
The biodegradable part of waste is treated as a renewable energy source. Among countries, differences occur between definitions of potential for municipal waste, country-specific current waste treatment (incineration vs. recovery operations vs. landfilling) as well as the implemented policy regulations.

2.13.4 Feasibility of promoting non food type agricultural production

Due to the small size of the arable land, Slovenia is a net-importer of agricultural products. This is also the main reason that there is no mentionable overproduction of agricultural biomass. In the forestry sector, although percentage-wise a lot of the surface is covered by forests, the absolute surface area is again relatively small. At the same time, a great part of the forests are either protected under Natura 2000 decree, or are located in hilly and hard-to-reach areas where the costs of exploitation for electricity production are prohibitively high.

Slovenia is just starting to introduce the first energy projects for use of biomass for production of electricity. Mostly, for this purpose, residues in biomass production are considered. Because of that, Slovenia is not planning to grow biomass only for energy use because of the limited natural sources and area available for this purpose. Future plans for using biomass in energy sector are therefore limited to as efficient as possible use of biomass residues.

2.14 Country report for Serbia

Author(s)*: Dr. Andrej F. Gubina, Borut Kozan, Iztok Zlatar

2.14.1 Overview

Research on the potential of biomass for energy use in Serbia is just beginning. Some academic papers and smaller studies have been made in the last couple of years. The National Office for Energy Efficiency has the initiative in this field and is driving the projects and studies. Due to the economic circumstances, that limits the relative expensive investment in technology for conversion of biomass into electricity and the predominant reliance on the fossil fuels in the past, the country has yet to experience the first wave of biomass-fuelled electricity generators.

Biomass has been used a lot for heating during the years when Serbia was under economic sanctions of international community. During those years electricity was considered as social category, so due to the low end-price of electricity and non-existent subsidies for biomass-to-electricity installations, projects utilizing biomass and other renewable sources weren't able to develop. Research on biomass potential was made only recently, and it incorporates only theoretical potentials without any boundary conditions. On the positive side, the study has been performed by governmental body so there are good possibilities that the study will become an ongoing project with more details each year. The results can also be used for stimulation of the biomass use for energy purposes.

2.14.2 Methods and Activities

Most of the information contained in this report is taken from a study by Dr. Mladen Ilic of Energy Efficiency Agency of Republic of Serbia entitled "Biomass for energy, The Conditions for and Status of Energy Use of Biomass in Republic of Serbia". The main source of raw information in the study was taken from the Statistical Office of Serbia. The study analyzed the past studies and other information which were made in the past by other governmental bodies. The data are collected on the regional level and can be evaluated as good input. The Analysis was made in 2005 on the latest available data. The analytical model, that was developed, can be used for any type of time series of data.

On the other hand, in the study only theoretical potentials were analyzed. There were no assumptions on the technical or economical factors influencing the potential. For this purpose, only general physical parameters were taken into account, so the study represents only the upper limit of what can be produced from a certain energy resource from a theoretical point-of-view. Considerations on the environmental impact of crop changes weren't included, which is another drawback of the theoretical potential-only study.

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2.14.3 National data on plant growth and primary production

To establish theoretical potential of biomass for energy use two main sources of raw data were taken into account. All input data were taken from Statistical office and Ministry of Science and Technological Development. In the analysis of the forest potential, data were obtained from Serbian statistical office. The data used in the methodology included information on forestation, forest ownership and 7 types of trees which are used for different purposes. In agricultural part of the study data from Ministry of Science and Technological Development and Statistical office were used. The analyzed categories in agricultural part were: 7 crop types (wheat, barley, rice, corn, sunflower, soya and rape) and 8 tree species in fruit gardens. As well, manure management systems for cattle and pigs (slurries, sewage gas) were take in to account.

2.14.4 Feasibility of promoting non food type agricultural production

Due to the circumstances outlined in the introduction, the field of biomass use for electrical energy production in Serbia is underdeveloped. Only recently studies have been undertaken to analyze the theoretical potentials of biomass for energy use, although agriculture and forestry have significant share in national economy. In the existing considerations agricultural and forestry residues are considered for energy use of biomass. Due to various reasons, including economic instability and undeveloped regulatory and support framework, the future plans for production of biomass for energy use hasn’t been made yet.

2.15 Country Report for Ukraine

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2.15.1 Overview

Historically Ukraine is well known as an agricultural country, and traditionally it has used various kinds of renewable energy, primarily biomass, as a result of 'business in nature' activities, and total usage is huge. Mega analysis of biosphere-related properties of Ukraine's agro-ecosystem show: solar radiation of 3,500–5,200 MJ/m^2/a; biomass accumulation of 60–200 million tons of fodder; agricultural land productivity of 1.5–5.0 tons of fodder units /ha; crop energy content of 400–1200 million GJ/a [1].

Consumption of 'primary energy sources' in 2005 was 200 million toe (tons of oil equivalent), while consumption of renewables, i.e. 'other fuels' (coal methane, biomass, biogas, peat etc.) and 'energy of the environment' was near 11.02 million toe or 5.5% of the total [2]. Ukraine utilizes biomass mainly as firewood (about 0.7 million toe/yr) for heating private houses and as wood wastes and residues in more than 1,000 burners operating at forestry and wood processing enterprises.

In 2008 the reported contribution of biomass to Ukraine's energy supply was about 0.5 percent. In practice, the contribution is almost certainly larger as considerable quantities of biomass in the domestic and small industry sector may go unrecorded. Some studies have suggested that biomass sources could provide at least six times more energy [3]. The power intensity of Ukraine's GDP was about 0.89 toe/US$ in terms of purchasing power.

A set of references to official materials on a governmental Internet data base [4] refers to documents which contain key worlds in their text. The key words searched and number of documents containing these key words are: (parentheses show approximate number of documents useful for this report): 'energy': 341 (>10); 'bioenergy': 2(2); 'biomass': 11(~2); 'biogas': 48(~8); 'biofuel': 10 (~3); 'renewables' or 'alternative sources of energy': 10 (~2); 'wood combustion': 51 (~2); 'straw combustion': 24(~2).

The above mentioned database provides a general overview of available documents. Legislative packages on utilization of biomass for energy production provide additional documents, for example:

- Law of Ukraine "About Development of Production and Use of Biofuels" (under consideration);
- Decree of Cabinet of Ministers of Ukraine of 01.10.2008 № 1290-p "Concerning Approval of the Action Plan on Acceleration of Awareness of the Society on Effective Energy Usage, Q4 2008 and 2009";
- Law of Ukraine of 25.09.2008 № 601-VI "Changes of Some Laws Concerning Green Tariff Implementation";
- Decree of Cabinet of Ministers of Ukraine №145-p "Concerning Acceptance of Energy Strategy of Ukraine for the Period up to 2030" (March 15, 2006);
- Decree of Cabinet of Ministers of Ukraine "Concerning Acceptance of the Program of Production Development of Diesel Biofuel" (2006);
- Law of Ukraine of 05.04.2005 № 2509-IV "On Combined Production of Heating and Electric Energy (co-generation) and Usage of Residual/Waste Energy Potential";
- Decree of Cabinet of Ministers of Ukraine "Concerning Approval Procedure for Certificate

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for Conversion to Alternative Fuel" (2004);
- Law of Ukraine of 20.02.2003 № 555-IV "On Alternative Energy Sources";
- Decree of the President of Ukraine "Concerning Actions for Development of Fuel Production from Raw Biomaterial" (2003);
- Decree of Cabinet of Ministers of Ukraine "Concerning Development of Production of Biodiesel at 2003 Year" (2003);
- Law of Ukraine "Concerning Alternative Types of Liquid and Gas Fuel" (2000);
- Decree of the President of Ukraine of 26.09.2003 № 1094/2003 "Concerning Measures for Development of Fuel Production from Biological Sources";
- Law of Ukraine of 01.07.1994 № 74/94-BP "On Energy-Saving".

The following programs concerning biomass production or usage for energy purposes have been approved by the government:
- The Program for Production Development of Diesel Biofuel;
- The Program for Development of Production of Diesel Fuel;
- The Ethanol Program;
- The Program for State Support of Development of Untraditional and Renewable Sources of Energy and Small Hydro- and Heat-and-Power Engineering;
- National Energy Program for the Period up to 2010.

In addition there are supportive measures to improve data collection and reporting formats for energy sector promotion of RES, including biomass – i.e 'directions' and statistical 'forms' (examples):
- Directions for Procedure on Forest Cadastre Completing and Primary Registration of Forests;
- Form#1 Location of Forest Fund Lands by Its Categories in the Context of Groups and Owner Categories;
- Form#2 Location of Forested Vegetated Lands in the Context of Dominated Type and Age Groups;
- Form #3 Common Data About Forest Fund Lands;

2.15.2 Methods and activities

Kind of potential assessed (theoretical, economical etc.)

In accordance with information from the above mentioned institutions it can be stated that the contribution of biomass to Ukraine's energy supply is lower then possible. Only about 0.7 million toe are currently used, primarily firewood for domestic purposes and for fuel in forestry and wood processing enterprises. Available potential of wood, straw and peat is adequate to provide usage for following technologies (size of units):

- heating wood fired boilers (1...10 MWth): 1,000 units
- industrial wood fired boilers (0.1...5 MWth): 500 units
- domestic wood fired boilers (10...50 kWth): 53,000 units
- farm straw fired boilers (0.1...1 MWth): 16,000 units
- heating straw fired boilers (1...10 MWth): 1,400 units
- heating peat fired boilers (0.5...1 MWth): 1,000 units

The most promising strategy for the development of bioenergy technologies in Ukraine, at least initially, seems to be production of licensed European equipment by industrial enterprises in Ukraine, thus bringing a variety of Ukrainian companies into the market. In this way, Ukrainian organizations develop technologies and equipment that have already been introduced in foreign countries. If current plans are realized (expected to be realized by 2030) the total installed capacity will reach 9000 - 1200 MW_{th} and 400 - 1200 MW_e. The replacement of fossil fuels will be 4 - 8 mtoe and reduction of CO_2 emission will amount to 34 million t/year.

Expected investment (millions €) is (EU TACIS Project Support and Development of Renewable Sources of Energy (Biomass):

Wood-based biomass	50-100
Agricultural residues (sunflower residues, straw etc.)	200-400
Biogas, landfill gas	150-300.

2.15.3 National data on plant growth and primary production

National-level data is based on information from governmental sources (committees, ministries, agencies); international programs and project offices; public institutions; scientific publications; and via Internet, mainly from the State Statistics Committee, Forestry Committee of the Ministry of Natural Resources of Ukraine, and National Academy of Sciences of Ukraine (Institute of Engineering Thermophysics). Many results are publicly available in hard copy reports, presentations and/or on web-pages. Examples of references are included in this report.

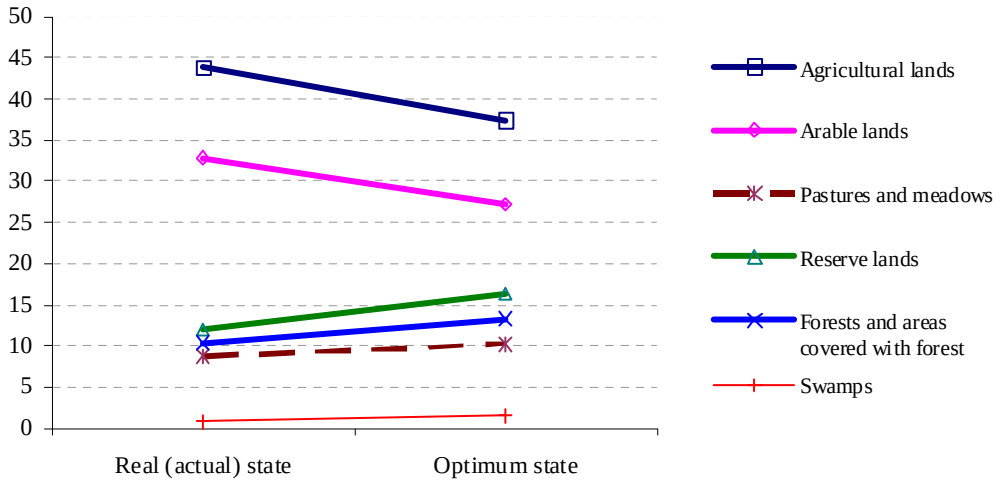
National or regional assessment

The national level assessment is based on information from governmental sources (committees, ministries, agencies); international programs and project offices; NGOs and firms; public institutions such as the Ministry of Fuel and Energy of Ukraine, the Ministry of Industrial Policy of Ukraine, the Ministry of Agrarian Policy of Ukraine, the Ministry of Housing and Communal Services of Ukraine, the National Agency of Ukraine for Effective Energy Use, the Forestry Committee of the Ministry of Natural Resources of Ukraine, the State Statistics Committee of Ukraine, the Committee of Verkhovna Rada of Ukraine for Ecology Policy, Nature Management and Elimination of Chernobyl Accident, the National Academy of Sciences of Ukraine (Institute of Engineering Thermophysics, the Institute of Botany, etc.); national universities; the Scientific Engineering Centre “BIOMASS”; and source traders and bioenergy producers (see above).

Development of data bases

National data on plant growth and primary productivity is based on compound annual statistics reflecting, in particular economic interests of business in agriculture. In the 2000s an expanded scope to include ‘land use optimization’ needs and progressive, environmentally sound activity was proposed for the first time – Figure 1. Traditionally national data showed well-known key data, e.g.: ‘As of January 1st, 2003, the total area of the land of the country amounted to 60,354.8 thousand ha; the area of inner waters – 2,421 thousand ha; the area of agricultural lands – 41,800.4 thousand ha; and the area of cultivated agricultural lands was 72.2% of total land. Several years later new approaches to land-use optimization were strengthen by use of information technologies (RS, GIS), and modern indicators and indices [7,8]. For example, the calculated fraction of agro-landscape surface based on RS and GIS constituted 64% of the total surface of Ukraine, while the traditional data reported a higher percentage. In 2005 a list of useful indicators and indices included not only the traditional ‘Types and areas of agricultural lands’ or ‘Arable land per capita’, but also ‘Net loss of agricultural land’; ‘CIA - Composite Agro biodiversity Index’; Anthropogenic pressure’ as measured by the Red Data Book species response to anthropogenic pressure (or RDB-response index);, Conservation of land as indicated by protected afforestation and forest shelterbelts; ‘Areas of high diversity with threatened species’; ‘Consumption of food production per capita’; ‘Agricultural lands best-suited for migratory species’; ‘Lands planned for conversion to a natural state’; ‘Fragmentation of natural landscapes (remnants inventory)’; and ‘Species diversity used for food’.

Figure 1 Scientifir Recommendations on Agricultural Land-use Optimization in Ukraine in the Nearest Future, ml ha
Source: Natural-resource aspect of developent of Ukraine, 2001



2.15.4 Feasibility of promoting non food type agricultural production

Three scenarios have been published for the Ukraine (basic, optimistic and pessimistic) based on GDP projections to 2030, starting from February 2006 [2]. Nevertheless, due to the global financial crisis of 2008, all scenarios must be updated. Recalculations could be undertaken as of early 2009, after approval by Verkhovna Rada of a revised Ukrainian budget for 2009. As of the end of 2008, analysts proposed a mosaic of scenarios for development of renewables [2,3].

Ukraine has a huge potential of renewal energy resources of almost all types (solar, wind, biomass, biofuel, geothermal and micro hydropower). Tapping this resource promises great potential in line with the global trend to use renewal energy, including in consideration of the Kyoto Protocol. The current national program envisions achieving use of renewal energy sources at the level of 10 billion kWh of electricity by 2010, which is comparable to targets set by some European countries.

Biomass: The Institute of Engineering Thermodynamics of the National Academy of Sciences of Ukraine (NASU) has suggested that biomass in Ukraine could satisfy as much as nine percent of the country's primary energy use. Consumption of 'primary-energy-sources' in 2005 was 200 million toe, while consumption of renewables, i.e, 'other fuels' (coal methane, biomass, biogas, peat etc.) and 'energy of the environment' was near 11.02 million toe or 5.5% of the total [2]. In accordance with a basic scenario, in 2030 consumption of 'primary-energy-sources' will reach about 302.7 million toe, or which 39.5 million toes or 13% will be from renewables (other fuels)[2].

Bio-fuel. Experts say that as much as 30 percent of automotive fuel could consist of additives to traditional gasoline. Analysts singled out rapeseed, a crop with high oil content, as one of the best prospects for biofuels in Ukraine. Agricultural conditions for harvesting rapeseed in Ukraine are nearly ideal. Accordingly, earlier this year, Ukrainian government officials outlined preliminary plans to produce up to two million tons of rapeseed by 2008.

Considerations for the environmental impact of included crop changes
Different data and examples show that RES use can result in 'neutral', 'positive' and/or 'possibly negative' impacts to the environment i.e. to urban, rural or natural ecosystems. The main effect in Ukraine is 'neutral' or 'positive' because of the use of 'biomass' instead of 'gas' or 'coal' or 'oil'. In

any case, there are no adequate published calculations of influences of many RES methods on terrestrial (forest, agriculture) or internal fresh-water or coastal ecosystems, and assessments on biodiversity impacts are particularly lacking. Without doubt, crop and wood remnants provide habitats or food for many species. Further, the presence of wood remnants wood in natural forests is an indicator of wild forest status for inclusion in the certified forest list. Possibly the Chernobyl 30-km Exclusive Zone is only the example in Ukraine where calculations by scientists have been presented to society to demonstrate a positive role for oil plant production (rape specially) of radionuclides for improvement of environmental conditions. Utilization of algae for RES purposes could also improve the condition of coastal ecosystems.

2.15.5 Conclusion

In 2006 the EU TACIS PROJECT ’Support and Development of Renewable Sources of Energy (Biomass)’ concluded that the prospects for increasing biomass utilization in Ukraine are excellent because of the high existing biomass potential. However, a significant fraction of the existing energy-production capacity needs up-dating. There is an opportunity to use carbon trading (ETS) for financing investments in renewable energy production. The European biomass markets are growing rapidly. Based on this there is an opportunity to increase Ukraine’s self-sufficiency in energy supply.

Ukraine’s objective of integration into Europe provides an additional argument for active development of RES, primarily bioenergy. It is expected that because of the ‘gas crisis of early 2009’ RES activity in Ukraine will intensify.

The end of 2008 and early 2009 showed that natural gas costs in/for Ukraine constantly increase. As a result, number branches of the national economy were brought close to the point of no longer being viability. Ukraine has a pressing need to look at all possibilities t for introducing alternative energy sources and energy saving technologies.

The methods for potential assessment (in terms of CEUBIOM’s questionnaire terminology) in Ukraine include: ‘wood from forestry and scrublands’, ‘biogas from agriculture’, ‘biogas and energy from domestic wastes’, ‘biogas from industrial domestic wastes’, ‘enterprises waste’, and ‘renewables’ (sunlight, wind, hydro). Dominating partitions of many information sources are ‘forest’ and ‘agriculture’, a problem which modern IT-methods for monitoring of dynamics by remote sensing can be used to overcome. The national project (to apply current methodologies to terrestrial activities for biomass potential assessment in SEEC) has been accomplished. All biomass sources have been included, as well as boundary conditions.
An initiative is underway to recommend national focus points for several key international agreements on environment conservation. Focus points would include such terms as ‘biomass’, ‘renewables’ and respective related subjects, including a list of biodiversity indicators. Recommendations are expected to be available in 2010.

Policy measures [6]. The Government should pass a resolution that sets clear targets for energy production from domestic fuels. The following contribution of domestic fuels seems to be realistic: in 2008 (present state) - about 0.7 million toe (0.5 % of the total primary energy consumption in Ukraine), in 2010 – 1.4 million toe (1 %), in 2015 – 3.5 million toe (2.5 %), in 2020 - 7 million toe (5 %), in 2025 – 10.5 million toe (7.5 %), 2030 - 14 million toe (10 %).

Economy measures [6]. Provide effective support for purchasers (or users) of bioenergy equipment. The support must be introduced at an earlier stage in the development of the bioenergy sector (the next 5-10 years). It should include: a 20 % subsidy for purchasers (or users) of bioenergy equipment, which should be paid from the State energy conservation fund under control of the National Agency of Ukraine for Effective Energy Use. The level of support may be: from 334

million UAH in 2008-2009 falling to 228 million UAH in 2014-2015. Biomass which is sold and used as a fuel should be VAT-free. Import of bioenergy equipment to Ukraine should also be free of tax and custom duties. The state should encourage realization of bioenergy projects via the JI mechanism of the Kyoto Protocol.

Administrative measures [6]. Assign a governmental body to be responsible for the development of energy production from biomass. Elaborate a state program for bioenergy development. Target support for R&D projects directed at the creation of bioenergy equipment for manufacture in Ukraine.

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3. Methodology for terrestrial biomass potential assessment

In this section the various types of information needed for terrestrial biomass potential assessment (chapter 3.1) and the work flow (chapter 3.2) of these assessments is discussed on basis of the contributions reflecting the practice in the various European countries (in chapter 2). In chapter 3.3 some concluding remarks on various methodological issues are extracted.

3.1 Information basis

For establishing a biomass potential assessment information on various subjects is needed:

- Boundary conditions
- Information on biomass production and use
- Information on land use
- Expertise in forestry and/or agriculture

Remarks on information on these subjects are given in chapters 3.1.1 to 3.1.4.

3.1.1 Boundary conditions

A bioenergy potential assessment is typically targeted to answer a specific question. The question reflects the specific interest of the assessment. From the question, restrictions for the assessment can be deduced and interpreted as boundary conditions. These boundary conditions have to be stated in the introduction to the assessment in order to clarify the applicability of the results. Usually no assessment is made for total biomass potential (theoretical potential with no restrictions) because of the limited utility of such an assessment.

The technical restrictions for biomass production and harvesting can be seen as inherent boundary conditions for the present time. Such restrictions include topographic conditions, available machinery, lack of expertise in growing specific plants etc.

Other boundary conditions restrict the use of the technical biomass potential in order to achieve a more realistic result. Typical examples of such restrictions are:

- The food supply should not be affected by the use of biomass for bioenergy purposes
- The supply of biomass as feedstock for the industry should not be affected by the use of biomass for bioenergy
- The production of fuel wood for residential heating should not be affected by the use of biofuels for other purposes.
- The sustainability or the future operability of forestry and agriculture should not be affected by extracting biomass for biofuels
- Import and exports of biomass should not be affected (this can be important, if exports make a considerable contribution to the national income, or imports are used for food or industry feedstock)

There can also be imposed specific restrictions, e.g.

- Restrictions on the area considered (e.g. natural reservations, areas with restricted agriculture, tourism areas etc.)
- Restrictions concerning specific forms of cultivation (e.g. no energy plantations)

- Only biomass up to a specific production cost limit is considered
- Only specific crops or specific biofuels are to be considered (e.g. only lignocellulosic biomass, or only liquid automotive fuels)

In some cases boundary conditions widen the scope of biomass potential assessment, e.g. by including waste products from wood processing and food processing industries (important energy sources in some countries as Austria, Finland, Sweden etc.).

Other typical boundary conditions refer to the year and the scenarios of future developments.
Typical possibilities are:

- Actual snapshot analysis (What would have been the potential in the last year, if unused land would have been used for energy production and/or forestry would have been intensified to the limits of sustainability?).
- Outlook on biomass potential in the future (x years) under consideration of specific (or expected) developments (in land use, fertility, cultivation intensity, etc.)

3.1.2 Information on biomass production and use

Information on biomass production and use usually is given as production figures collected in national statistical data. In some very few cases no statistics are available for specific issues. In such cases estimates of production have to be used instead of statistics.

Typical statistical sources on biomass production and use are:

- Agricultural production statistics (region, crops, quantity produced, quantity used
- Forestry production (region, species, quality, quantity, quantity used
- Industry statistics (feedstock used, quantity, by-products produced,)
- Import/export statistics (crops, quantity)

3.1.3 Information on land use

Statistical information on land use gives the areas used for agricultural production of crops, in meadows etc., as well as information on soil quality and productivity. Information is also provided on areas and quality of unused land. In some very few cases in Europe detailed information is not available as statistics and published information is based on estimations.

In the case of forestry, land use statistics are replaced in some countries by forest inventories giving spatial information on forest areas, stock quantities (standing trees in forests), volume ready for harvesting, productivity etc. Forest inventories are completed in cycles of 5 to ten years and give an excellent basis for assessing the amount of wood that can be removed and used as fuel (wood chips and firewood) and as round wood (not for use as fuel).

3.1.4 Expertise on forestry and agriculture

Expertise on forestry and agriculture is needed for interpreting production and land use statistics and other information, for respecting the boundary conditions in the assessment, and for evaluating neglected possibilities for biomass production in the assessment (e.g. production on unused land). In the case of forecasts of biomass potentials, expertise is necessary to include expected developments in productivity and markets.

In any assessment of forestry and agricultural biomass potential, expertise of forestry and agricultural specialists is indispensable for making sure that the sustainability and the future operability of production is respected.

A special form of expertise is needed in the case of economic boundary conditions. The specific supply costs (production cost plus logistic cost) of biomass production have to be assessed in this case. This can be done only by experts with deep knowledge of regional situations and by taking into consideration soil fertility, viability issues, experience of producers and logistic companies etc.

3.2 Work flow of terrestrial biomass potential assessments

Concluding the consideration of methodology, some general remarks on the work flow and on the possibility of doing national and international assessments are given in this chapter.

The methodology for establishing terrestrial biomass potential assessments is highly dependent from the specification of the task to be done, i.e. from the specific information request and subsequently from the boundary conditions imposed. A simplified typical work flow is shown in Figure 1.

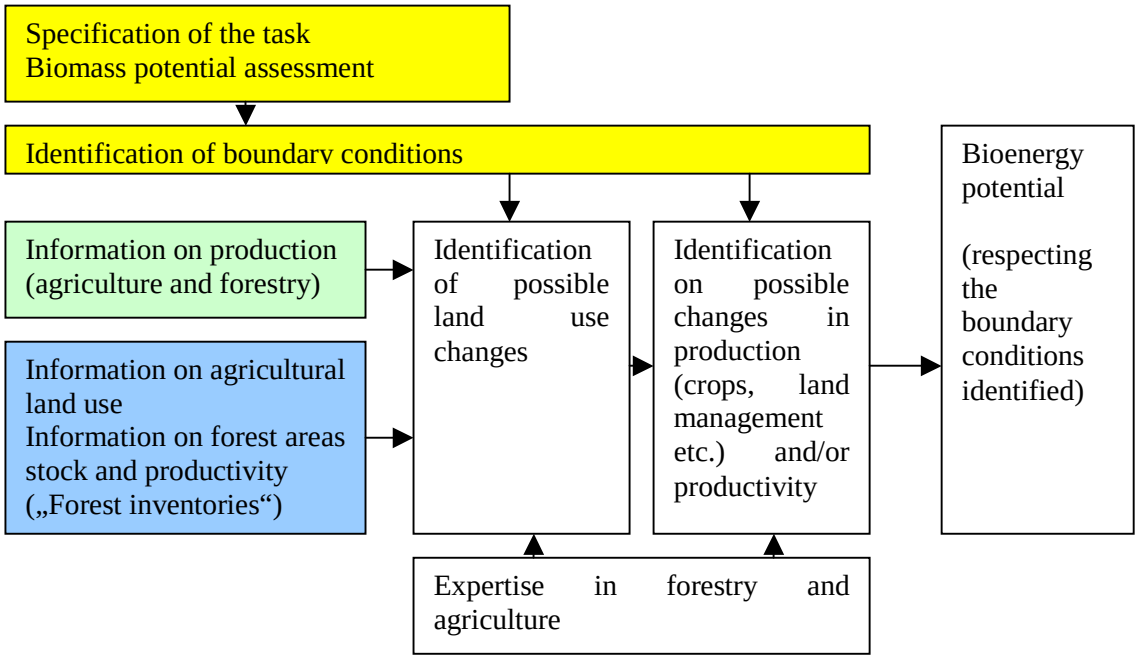

Figure 3-1: Flow chart of realising biomass potential assessments with terrestrial methods

Terrestrial biomass potential assessments are usually done for a region or a country. The work flow has to be adapted to the specific characteristics of the national statistics used.
Transnational assessments are only possible if statistics with uniform characteristics are available for all regions/nations considered in the assessment and if expertise with intimate knowledge of all regions/nations is involved.

International assessments can be done by combining several national assessments even if the same workflow can not be used in all assessments. In this case, however, only assessments based on exactly the same boundary conditions can be considered.

3.3 Concluding remarks on methodologies of terrestrial biomass potential assessment

The review of national use of biomass potential assessments in Europe shows that the assessments are based on national information on production of biomass and on national information on land use (including forest inventories, if available). Only very specific assessments (for specific species or specific uses (biogas) are done based mainly on primary data for small regions.

The productivity assessment used is mainly based on national statistics. If the intention of the assessment work is a forecast, future developments in productivity in cultivation or achieved by land use changes are assessed by including agricultural and forestry expertise and by taking into account environmental conditions, soil fertility, etc.

Bioenergy potential assessments linked to changes in agricultural intensity of biomaterials production and to population through land and water use are usually also forecasts, where again expertise in agricultural and forestry issues is needed.

In the case of forest inventories (as a special form of land use information) various indicators are used for assessing the capability of forests for future biomass production. These indicators include special information on soil fertility and condition of forest (plant density, crown condition), and stock of living biomass. Forest inventories were not available for all countries investigated.

A comparative assessment of terrestrial methods is not possible, because all national reports show the same principal approach, but are differentiated by the quality of data sources available and the intention of the assessment (technical, economic etc.) together with the resultant boundary conditions.

The assessment methods all over Europe are very similar and follow a rather simple scheme. Beginning with the question driving the assessment, boundary conditions (economics, social demands, socioeconomic demands) are specified, which can be very different depending on the specific question. Typically the biomass potential is generated based on national statistical information using agricultural and forestry expertise. Depending on the question behind the assessment the assessments are snapshot analyses or forecasts.

Current practice reflects very different information requests resulting in different boundary conditions. This procedure gives specific answers to the questions posed by the information request. As the information requests are different from case to case, the results are not comparable. As a result, a common methodology can not be identified.

A specific methodology for common practice could easily be established if an agreement on an information request and further on a specific set of boundary conditions can be achieved. With such agreements, comparable biomass potential assessments would be possible.

4. Conclusions on current terrestrial methods and activities for biomass potential assessment in European countries

In this section an overview on the results of the country survey on terrestrial potential assessment is given in chapter 4.1. Specific concluding remarks on the methodologies and possibilities for establishing a generally applicable methodology for terrestrial biomass assessment are given in chapter 4.2

4.1 Outcome of the country survey

In all countries considered, some activities on assessing biomass for energy potential have been reported. In four countries, one or more assessments reported were conducted in the framework of an international project.

For all the countries considered, some information on total energy consumption/use and on the share of biomass in the energy use is stated. Only in two countries was information not based on national statistical data but on assessments done by international organisations.

The methods for assessing biomass-for-energy potential described in the questionnaires are mostly based on statistical data supplemented by agricultural and forestry expertise. Some are related only to a few plant species or to selected biomass sources (e.g. only forests). The kinds of potentials, as a result of the assessments, are very different. Most methods try to assess the realizable potential, and some aim at theoretical, technical, and economic potentials. No common method for establishing the potentials of biomass for energy can be identified.

National data on plant growth and primary productivity are established in the national statistics of most of the countries. Only in one country (BIH) is the existing data considered to be of poor quality. These national data are in general agricultural and forestry production statistics and statistics on the use of the products. Data on plant growth for non-food plants and non-forest plants seem to be non-existent with some exceptions: short rotation coppice, triticale, and other vey specific species.

The assessment of the feasibility of promoting non-food agricultural production as a measure against overproduction and shifting towards sustainable farming and energy utilisation resulted in a “not feasible” determination in the European countries investigated because no overproduction was reported for any country. Only in Romania and the Ukraine were substantial opportunities for dedicated farming for bioenergy reported. However as intensity of production/management is likely to increase in both forestry and agriculture, some opportunities for dedicated farming of energy crops is expected in most of the countries.

In table 4-1 a compilation of results of the country reports and the questionnaires are collected in order to allow a quick overview.

Most of the country representatives have expressed interest in standardized biomass energy potential assessment procedures and also report a national interest in such assessments. Activities for designing a standardized procedure could be encouraged by the outcomes of the report in hand and other CEUBIOM results as well as with the co-operation with the BEE project.

Table 4-1: Overview on the results of the "report on current terrestrial methods and activities for biomass potential assessment in South East European countries"

	AUT	BIH	BUL	CRO	CZ	GER	GRE	ITA	MAK	ROM	SK	SLO	SRB	UKR
Biomass use for energy known?	y	y	y	y	y	y	y	y	y	y	y	y	y	y
Methods for potential assessment in questionnaire	1[5]	1 (2)[3]	1	1	2	2[3]	1	1	1	3	1	1	1	1
National scope?	y	y	y	y		y	y	y	y	y		y	y	y
Regional scope?					y				y		y			
all biomass sources included?	y	y	y	y	y	no[1]	no[1]	y	y	y/ no	n[1]	y	y	y
boundary conditions included?	y	no	y	y	y	y	no	y	y	y	y	y	no	y
kind of potential [4])	R	E	R	R	E	T/R	Te	R	T/R	R/E	T	R, El	T	R
snapshot analysis?	y	no	no	y	y	no	y	y	y	y	y	y	y	
scenario analysis?	y	y	y	y		y	no		no	y	n	y	no	y
Activities reported in questionnaire	1[5]	1	1	1	2	4	--	1	4 (5)[2]	3	2	1	1	sev
Done in the framework of international projects	no	y	no	no	no	2	no	n	y	y	n	no	no	no
National Database on plant growth existing	y	poor	y	y	y	y	no	y	y	y	y	y	y	y
Free areas available for biomass fuel farming?	no	no	?	?	y	y	?	y	?	y	?	no	?	y

[1]) only wood from forestry and scrublands
[2]) one activity reported is the national agricultural production statistic, so it cannot be seen as a biomass potential assessment activity
[3]) one method reported is a forest inventory, this is seen not as a potential assessment but as a basis for establishing one.
[4]) kind of potential: T theoretical
Te technical
E economic
R realizable
El electricity generation
[5]) several assessments using similar methodologies discussed

4.2 Specific concluding remarks on methodologies of terrestrial biomass potential assessment

The review of national use of biomass potential assessment in Europe shows that the assessments are based on national information on production of biomass and on national information on land use (including forest inventories, if available). Only very specific assessments (for specific species or specific uses (biogas) are done based mainly on primary data for small regions.

The assessment methods all over Europe are very similar and follow a rather uniform scheme. Beginning with the question driving the assessment, boundary conditions (economic, social demands, socioeconomic demands) are specified that can be very different depending on the specific question. Typically, based on national statistical information the biomass potential is generated using agricultural and forestry expertise. Depending on the question behind the assessment the assessments are snapshot analyses or forecasts.

The involvement of agricultural and forestry expertise is essential for assessing the results of productivity development and/or land use changes (soil fertility environmental effects etc.) and for consideration of restrictions induced by specific boundary conditions (e.g. economic, socioeconomic, environmental and social)
In the case of forest inventories (as a special form of land use information) various indicators are used for assessing the capability of forests for future biomass production. These indicators include special information on soil fertility, condition of the forest (plant density, crown condition), and stock of living biomass. Forest inventories are not available for all countries.

At the moment, the different biomass potential assessments done in the different countries are not comparable. Reasons are the different information requests (questions) behind the assessments, resulting in different boundary conditions which give different results.

A specific principal methodology for common practice could easily be established, if an agreement on the information request (question to be answered by the assessment) can be achieved. In this case the biomass potential assessments for different countries would use identical boundary conditions and so would be comparable to each other and could be summed up. Due to different statistics available in the countries the methodologies would differ in details, but not in the principal approach.

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