

Conference Topic: Agricultural Information Systems including data banks and data mining

An assessment of the available Biomass Resources in the EU27 and India for synergistic development of Bio-based economy

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ABSTRACT

On the basis of research being carried out to investigate the potential of biomass and bio-waste for energy production in Europe and in India, more technical, economic and financial information has become available to experts in recent years; however, up-to-date information on biomass and bio-waste is still not accessible to end-users. In the frame of the EU-SAHYOG Project, we collected the most up-to-date data on biomass production and availability from three major sectors: forestry, agriculture and wastes in Europe and India. Analysis of availability of the potential biomass and bio-waste feedstock for sustainable conversion to bio-energy and bio-materials was performed at state level through an intensive consultation of existing databases and reports in both countries. The paper will provide a general overview on the biomass resources present at state level in the European Union and in India. An accurate analysis of the results SAHYOG inventories, will finally outline the EU and Indian priorities in biomass utilization and technology implementation.

Keywords: Biomass, Resources, Biobased economy, Potential biomass, Sustainable production, Biowaste, Biotechnology

1. INTRODUCTION

The excessive use of fossil fuels has resulted in a number of environmental and socioeconomic problems worldwide, including ecosystem degradation, pollution, and global climate change (Holdren, 2007). Sustainable bioenergy production can reduce energy poverty, contribute to rural development and avoid the negative environmental impact of increasing greenhouse gases emissions (Wicke et al., 2011). The European Union and Indian government have partnered for a research and development initiative that will focus on finding solutions for existing challenges and needs in biotechnological research activities involving energy production from biomass and bio-waste conversion. Initial work has focussed on developing comprehensive inventories of available biomasses and research activities in both the European Union and India, in order to identify common areas of interest as well as knowledge gaps and cooperation opportunities. The main objective of the project SAHYOG (Strengthening Networking on Biomass Research and Bio-waste Conversion – Biotechnology for Europe India Integration) is, in fact, to actively and effectively link research activities implemented within EU and Indian research programs. The activities of the SAHYOG project include, beside the setup of inventories of biomass and bio-waste resources and of research projects and programs, also project twinning, short-term exchanges of researchers, summer schools, stakeholder workshops, and the development of roadmaps defining key RTD

priorities and a Strategic Research Agenda (SRA) to facilitate concerted planning of future EU-India research initiatives in the area of biomass and bio-waste (www.sahyog-europa-india.eu).

The first step towards a more effective collaboration between Europe and India in the field of bioenergy is, indeed, the setup of a common database of available biomasses (biomass potential) that would allow, on one side, a better evaluation of common future collaborations in applied and basic biomass research projects, on the other side it will also be very useful for business-oriented stakeholders both in Europe and in India. Biomass inventories represent an important step toward a sustainable energy policy since information on type and geographic distribution of biomass is critical for feasibility analysis and project prioritization. However, the different existing databases and reports on type and quantity of available biomass for energy and materials production seldom show overlapping data, especially in Europe. In many cases two- or even ten-fold different values for the same biomass are shown by different sources. So great divergences are due to various factors, among which the following ones are the most common: (i) biomass categories of two different databases do not always have exactly the same meaning; (ii) as biomass quantity values are almost always estimated ones, it is very likely that calculations in each database rely on different assumptions. The latter question is strictly related with the still relative confusion concerning the different types of biomass potential used in the various databases and their precise definition. Unfortunately there is not an accepted consensus among experts on both the definition and on the way to calculate sustainable, economic, technological and theoretical biomass potentials.

In this paper we report the setup of an updated inventory of biomass resources available in Europe and India based on existing databases and reports in both regions. We will present the structure of the inventory and discuss differences and similarities in biomass potential between Europe and India; furthermore, we will briefly describe how we tackled the above-mentioned problems related to the definition and calculation of biomass potential.

2. BIOMASS DATABASES AND REPORTS

2.1 In Europe

To prepare the SAHYOG biomass inventory the following main resources were used in Europe:

1. The NREAPs (National Renewable Energy Action Plans) reports (www.buildup.eu/publications) were published by all [Member States of the European Union](#) as required by Article 4 of the renewable energy Directive (2009/28/EC). In these plans each Member State completed a set of tables on the availability of biomass and bio-waste resources and on how it expects to meet its 2020 target, including the technology mix and the trajectory to reach it. The first reports, published in the year 2010, contain data referring to the year 2006. Afterwards, they were updated, although only partially, to the years 2009-2010.
2. The EUBIONET (European Bioenergy Network) project (www.eubionet.org) provided market parties, policy makers and scientists alike with relevant information on European biomass markets and related topics. Data on biomass resources refer to the years 2005-2009.
3. The European Biomass Association, funded by the European Commission (EC) under the Intelligent Energy Europe (IEE) program, brings together 30 national associations from all over Europe thus representing a network of more than 4000 companies, research centres and individuals. AEBIOM gathers statistical data from various sources (Eurostat, EurObservEr, EEA, FAO, AEBIOM members, etc.) including its own calculations. Some important tables

publically available on the AEBIOM homepage are regularly updated. The latest report (www.aebiom.org) on Biomass Annual Statistics on the Contribution of Biomass to the Energy System in the EU27, published in June 2011 provides data for the year 2010.

4. The BIOMASS FUTURES project (Biomass role in achieving Climate Change & Renewables EU policy targets, funded by the EU Intelligent Energy Program). The aim of this EU Project was to assess the role that biomass can play in meeting EU energy policy targets, and to define the key factors likely to influence biomass supply, demand and uptake over the next twenty years. Most data on biomass and bio-waste resources available at www.biomassfuture.eu refers to the years 2008-2010.

2.2 In India

The study for India has been carried out in two approaches based on the availability of the existing data sources. Initially based on the available data source for the entire country, an inventory on pan India basis was developed. Further based on the availability of few data sources that categorised the information from various Indian states, an attempt was made to prepare an inventory for 23 states. Considering the limitations, the inventory had to be prepared by considering certain extrapolations on the available data from the sources mentioned below.

1. Biomass Resource Atlas of India, Indian Institute of Science, India 2004
2. Annual report of Indian States of Forest 2011
3. Statistical Year Book, Government of India, 2012
4. Directorate of Economics and Statistics, Government of India (<http://eands.dacnet.nic.in>), 2012
5. Reserve Bank of India, Data base, Ministry of Agriculture, Government of India, 2012
6. TIFAC Biomass resources Report (Technology Information, Forecasting and Assessment Council), 2009
7. the annual reports published in India by authenticated Government sources, in most recent year 2010-2012.
8. Central Pollution Control Board report (CPCB,2012)
9. Report on Sustainable Solid Waste Management in India by Ranjith Kharvel Annepu, Columbia University in the City of New York, 2012.

3. STRUCTURE OF THE INVENTORY

Forestry, agriculture and fishery, and wastes are the main sources of biomass for energy, materials and chemical production and are the fundamental categories used in the NREAPs reports. The same main categories are also used in the SAHYOG biomass inventory, as well. Also at subcategory level the SAHYOG inventory structure almost overlaps that of the NREAPs. However, in SAHYOG inventory few modifications are introduced as described below.

3.1 Biomass from Forestry

This section is divided into two categories: Direct supply of wood biomass from forests and other wooded land, where primary residues are also included, and Indirect supply of wood biomass for energy, materials and chemicals production, where all the secondary and tertiary wood residues are included.

3.2 Biomass from Agriculture and Fishery

This section has also been divided into two sub-categories: Agricultural crops and fishery products directly provided for energy, materials and chemical production and Agricultural by-products / processed residues and fishery by-products for energy, materials and chemicals production. As for forestry, primary products were included in the first section, whereas secondary and tertiary residues were included in the second section. In the first category, the additional information provided was as follows: the different arable crops were reported separately to gain more insight. In the second category, the two more subcategories, waste oils and crop residues, were also added.

3.3 Biomass from Waste

In this section, the same categories and subcategories as in NREAP were maintained. However, these were re-arranged into four categories: (i) Biowaste, that includes as major subcategory the biodegradable fraction of municipal solid wastes, (ii) Biodegradable fraction of industrial wastes, (iii) Sewage sludge and (iv) Landfill gas.

4. INFORMATION PROVIDED BY THE SAHYOG INVENTORY FOR EACH BIOMASS CATEGORY

Technological, economic and sustainable potential are the main biomass potentials used to measure the availability of biomass for energy (Chum et al., 2011). Among them both economic and sustainable potentials are very difficult to measure because of the many political, economic, environmental factors that influence them. It is relatively easier to measure the technological potential, which is defined as the theoretical potential which is available under the regarded techno-structural framework conditions with the current technological possibilities such as harvesting techniques, infrastructure and accessibility, processing techniques. Most biomass databases and related reports use mainly the technological potential. For the SAHYOG biomass inventory we tried to gather exclusively data referring to the technological biomass potential.

1. Total available biomass (it corresponds to the technological biomass potential, ie. the fraction of the theoretical potential which is available under the regarded techno-structural framework conditions with the current technological possibilities such as harvesting techniques, infrastructure and accessibility, processing techniques (Chum *et al.*, 2011).
2. Used biomass (biomass utilized for energy, chemical, and material production)
3. Net biomass potential (total available biomass – used biomass)
4. Energy content of total available biomass
5. Conversion processes (processes used for biomass transformation)
6. Geographical location (main geographical locations where biomass was produced/collected)
7. Source/link (data source)
8. Reference year (year of biomass production/collection)
9. Notes (additional information)

Database has been set up using MS Excel program.

Most recent data referring to the years 2006-2009 were presented in this report. However, in some of the cases, data referring to the year 2010 were also presented.

The energy content of each biomass category was calculated by using the low heating value of a specific biomass (LHV expressed in MJ/Kg) reported in Phyllis database (www.ecn.nl/phyllis/). The calculations were made by multiplying the LHV with the total amount of biomass (DW). The energy content was expressed in terajoule (TJ) or kilotons oil equivalents (k toe).

Some additional information for the interpretation of the database is given below:

1. The surface area (hectares) dedicated to energy crop cultivation, when possible, is reported in the column “Notes” of the database.
2. Dry weight biomass value has been reported, unless specified.

5. BIOMASS POTENTIAL IN EUROPE AND INDIA

Based on all the possible available information reported in the existing databases and reports in Europe and India, at the regional and local level, the setup of a comprehensive SAHYOG biomass inventory was accomplished.

Nevertheless the wealth of information was provided by the single sources, many shortcomings and gaps were found while collecting the biomass data. Main problems encountered during data collection are listed below:

1. There is a lack of consensus among the different consulted databases as far as the meaning and use of different biomass and bio-waste potentials is concerned.
2. It is not always clear which type of biomass potential is used for the single biomass categories. Apparently, in some cases, availability of different biomasses has been calculated taking into account different types of biomass potential.
3. Measure units are not homogenous throughout the databases.
4. All datasets and reports consulted for SAHYOG inventories show incomplete data.
5. A lot of discrepancies in the available data and only few estimates exist regarding the biomass database in India as compared to Europe.

In order to ensure as high accuracy as possible in our inventory, all the data included in the above-mentioned databases have been screened carefully and, whenever possible and/or necessary, biomass availability using first-hand data from national statistical databases was calculated. An evaluation of the data collection for SAHYOG inventories demonstrates that only 40% of 27 EU Member State inventories are complete as far as total available aggregate data (tons/m³) is concerned. Furthermore, as can be seen in Fig. 1, all the data under the biomass resource category “Forestry” is complete, whereas in case of “Agriculture and Biowaste”, only around 50% data is found to be completed in case of EU countries, as far as total aggregate data are concerned.

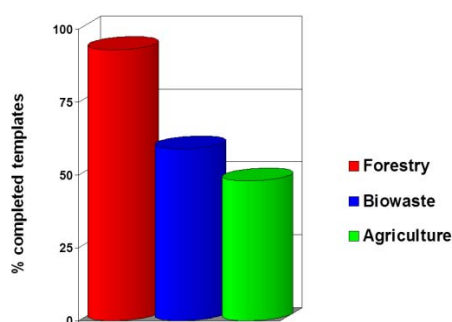


Fig. 1 Percentage of EU countries with complete aggregate data in the three main biomass categories of the database.

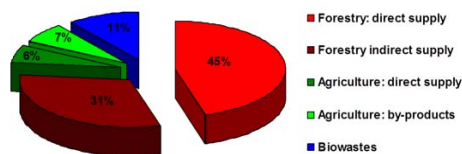


Fig. 2 Availability of different types of biomass in Europe (k toe)

The percentage based on the availability of different types of biomass resources under the main categories as reported in SAHYOG inventories, have been calculated and shown in the figure 2. The SAHYOG biomass inventory contains very little information on the really “used biomass” and its “conversion processes”, so the “net biomass information”, which is strictly related to the “used biomass”. This is because of the fact that in most of the public databases, information concerning these items is missing. Recently, a report containing information on use of biomass for chemicals and materials in Germany, referring to the year 2008, was published by the Nova-Institute GmbH (Germany). However, it was not possible to use the information because biomass categories mentioned, were different from the ones adopted in SAHYOG database. Moreover, biomass import values were also included therein.

6. CONCLUSIONS

SAHYOG biomass inventories contain the updated information on the availability of biomass in Europe and India. However, setting up both EU and Indian inventories revealed that because of lack of relevant data in various databases consulted for this purpose, it is really a challenging task to achieve a complete and reliable picture of biomass availability. Indeed, datasets in official statistical reports are not always complete or contain mainly highly aggregated data. For example, in the case of biomass from forestry in India, the information is very limited due to the fact that forests come under resource security policies and are considered as conserved. An analysis of the EU and Indian inventories demonstrates similarities as well as differences in the availability and usage of renewable biomass for energy, chemicals and materials. Being an agriculture-based country, India derives most part of its potential biomass from agriculture by-products, whereas in the EU huge quantities of biomass originates from forestry. A common feature is that in both EU and India, a great part of the available biomass from forestry, agriculture, and biowastes remains unexploited. In addition, due to data heterogeneity, it is not always possible to directly compare biomass availability in EU and in India for specific subcategories. However, under the framework of SAHYOG project, the work on the on-going research for new data will be continued to fill in the gaps in the inventories. An accurate analysis of the results for both SAHYOG inventories, will finally outline the EU and Indian priorities in biomass utilization and technology implementation.

Based on the results of inventories, specific research cooperation activities between stakeholders from EU and India will be implemented. The information provided in the SAHYOG biomass inventories will help to define common fields of interest to maximize EU-India collaboration and will constitute an important instrument to develop the joint Strategic Research agenda and the future R & D Roadmap to facilitate concerted planning in the field of biomass and biowaste.

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