Editorial

Special Issue “Renewable Energy, Biomass and Biological Residues”

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Introduction

Biomass is an important contributor to the world economy. Agriculture and forest products industries provide food, feed, fiber, and a wide range of necessary products like shelter, packaging, clothing, and communications. However, biomass is also a source of a large variety of chemicals and materials, and of electricity and fuels. About 60% of the needed process energy in pulp, paper, and forest products is provided by biomass combustion. The biomass industry can produce additional ethanol by fermenting some by-product sugar streams. Lignocellulosic biomass is a potential source for ethanol that is not directly linked to food production. Also, through gasification biomass can lead to methanol, mixed alcohols, and Fischer-Tropsch liquids.

The life science revolution we are witnessing has the potential to radically change the green plants and products we obtain from them. Green plants developed to produce desired products and energy could be possible in the future. Biological systems can already be tailored to produce fuels such as hydrogen. Policy drivers for increased use of biomass for energy and biobased products are reviewed for their potential contributions for a carbon constrained world.

In the future, our energy systems will need to be renewable and sustainable, efficient and cost-effective, convenient and safe. Can the integrated development and use of our nation’s biologically-derived renewable resources contribute significantly to our energy independence, increased energy diversity, and reduced carbon emissions.

There exists a diverse array of conversion mechanisms for biomass feedstock including combustion, gasification, anaerobic digestion, and alcohol fermentation. However, low efficiency conversion of solar energy to these feedstocks may lead to
 unacceptable land requirements if the biomass energy is to make a significant contribution to the current energy system. There are also several direct biological methods for converting sunlight to an energy carrier that may someday rival or exceed the efficiency of other conversion methods, though many technical and economic barriers remain. Future bioenergy technologies have the opportunity to increase the attractiveness of large scale biomass energy by increasing the solar conversion efficiency as well as improving the conversion to viable fuels and energy carriers.

The objectives of this special issue are:

1. To bring together and to present some of the latest research results in the field of biomass and their use.
2. To encourage more research activities in the field on the biomass. With the huge amount of data/information we can use for the next researches and for prepare new projects on the items of the Horizon 2020.

In this Editorial, we begin by reviewing all the several fields of the use of biomasses. we have considered This topic seek to promote and disseminate knowledge the renewable energies and the technologies of renewable (green) energy resources. The coverage of this topics includes the following areas: Energy Sources and System as Wind power, Hydropower, Solar Energy, Biomass, Biofuel, Biological residual, Geothermal, Energy Wave, Hydrogen & Fuel Cells, Energy transformation from thermochemical and biochemical processes, Energy Saving, Computational Methods for renewable energy system, performance analysis of Renewable Energy System, Artificial Intelligence studies in Renewable Energy. We then introduced the papers published in this issue.

Theme of the Special Issue

It is often said that the Biomass offers an unprecedented opportunity for the economic and environmental aspects. in particular there are the follows points:

1. The amount of data/information is huge and still growing rapidly, toward the several energy conversion processes.
2. Keeping up with the changes and monitoring the changes are important issues for many applications.
3. Environmental sustainability and technical on the plants for energy conversion and for create energetic supply chain by biomass residual and energy crops.

Papers in This Special Issue

This special issue of Renewable Energy, Biomass and Biological Residues brings together some of the latest research results in the field of Biomass and use as energy source. It presents eighteen papers, which deal with a wide range of research activities.

All the papers propose some interesting items to using for biomass sectors.
The first paper by Kosuke Hamada, Kozue Yuge, Munehiro Tanaka, Mitsumasa Anan, Yoshiyuki Shinogi studies the evaluation the spatial distribution of methane fermentation digested slurry (i.e., digested slurry) supplied with irrigation water in an irregularly shaped rice paddy field by considering the effects of the wind, evapotranspiration, and infiltration on the surface water and solute movements, and to suggest a method of supplying spatially-uniform digested slurry. A two-dimensional simulation model is introduced to describe the surface water and solute movements in the rice paddy field. To verify the accuracy of the model, a field observation was conducted. The electrical conductivity (EC) and total nitrogen (TN) values for the surface water were measured while the digested slurry with the irrigation water was supplied to the observational field. The EC and TN values showed that the digested slurry accumulated at the vicinity of the inlet and did not reach the outlet region. The trend in the simulated TN values at the inlet and outlet regions was in good agreement with the measurement data, and the accuracy of this model was confirmed. Using this model, an effective method for uniformly supplying digested slurry to irregularly shaped rice paddy fields was considered. The simulation results indicated that this could be achieved by using an additional inlet and by controlling the inflow flux and the TN in each inlet.

The second paper by Andrea Pezzuolo, Bruno Basso, Francesco Marinello, Luigi Sartori, studies the medium and long term yield simulation and energy estimation are carried out for conventional tillage and for no-tillage. Analyses were performed by means of forecasting model SALUS. Such software was fed with several data sets: climatological data summaries (since 1990), climate forecasts (from 2011 to 2025), soil characteristics, crops and management techniques for eight different farms involved in the study. For each farm, simulations provided yield in the case of both conventional and no-tillage. Technical input and yield were converted into energy in order to estimate efficiency. Medium and long term forecasts reveal how no-tillage can provide a better energy efficiency, with enhanced effects in the long term.

The third paper by Fabio Recanatesi, Michela Tolli and Richard Lord, preliminary results of a multi-criteria analysis (MCA) process in GIS environment for the identification of sites suitable for building biomass plants. Today, environmental assessment needs of Decision Support Systems (DSSs) able to consider several aspects in a unique analysis framework. Biomass to energy projects are highly geographically dependent and the plant’s profitability can be strongly influenced by its location. The complexity of interaction among ecological, economic and political variables and a widespread lack of data availability lead to difficulty in bringing together large-scale analysis and local planning systems. This gap can be solved through flexible tools able to relate large scale environmental assessment with medium and small scale DSS, useful for local decisions makers.

The fourth paper by Niccolò Pampuro, Elio Dinuccio, Paolo Balsari, studies, swine solid fraction was composted with the objective to obtain a composted manure with a...
moisture content between 20 and 40% - suitable to pelletize. Three identical SF windrows of approximately 4 m³ and 1800 kg were set up outside, on a concrete pad in an open-sided, roofed facility, and composted for a period of 72 days. An evaluation of the composting process and of the final product was made by monitoring process temperature, ammonia (NH₃) and GHG (carbon dioxide, CO₂; methane, CH₄; nitrous oxide, N₂O) emissions, moisture content, pH, volatile solids (VS), total organic carbon (TOC), total nitrogen (TN) and total ammoniacal nitrogen (TAN). In accordance with the results of the investigation it can be concluded that the composting of swine solid fraction in windrows could be a valuable process to concentrate the nutrients in manure and make it suitable to pelletize. However, appreciable amounts of CO₂, CH₄, N₂O and NH₃ emissions were detected. Total emission of the investigated gases recorded during the experimental period were 273 gCO₂ kgVS⁻¹, 3.50 gCH₄ kgVS⁻¹, 19.3 gN₂O kgTN⁻¹ and 87.4 gNH₃ kgTN⁻¹, respectively. These data can be used to carry out detailed life cycle assessments of GHG emissions from the Italian swine farming.

The fifth paper by Lelia Murgia and Filigheddu Maria Rosaria, Dettori Sandro, Deplano Giovanni with the title A model for the sustainable energy use of forest biomass resources in Sardinia is very interesting and analyses the extent and spatial distribution of the forest resources and their energy potential in the province of Nuoro (Sardinia, Italy). The aim is to create a data base which will help decision makers to make a plan for the sustainable use of the resources of the territory. A GIS-based model was used to assess the energy capacity and suitability of the area. This model used four basic information layers: (1) slope, (2) hydro-geological constraints, (3) protected areas, (4) forest districts under regional forest management. These four criteria are of great importance when attempting to assess the quantity of available sustainable biomass. Based on their potential energy production, 140 basins were identified, which could provide enough forest biomass to fuel all the heating systems currently installed in public buildings of the Provincial administration.

The sixth paper by Enrico Maria Mosconi, Stefano Poponi, Maria Azzurra Parsi, assessment of the economic and application-related sustainability of biofuels by a case study. This paper deals with the production of biofuels from the point of view of its economic sustainability and of the effects that the EU directives have had on the Italian productive context. Besides, this paper presents the outcome of an empiric study based on the economic sustainability of the production of rapeseed intended to fuel a new power plant. The study, conducted in the territory of the Viterbo Province (Italy), singles out the various types of rapeseed seeds that best adapt to the climatic-environmental features of the territory and, based on their yield and the production target of the new power plant, ascertains the land area to be reconverted or to be devoted to this type of crop.

The seventh paper by MARRAS Tatiana, PETROSELLI Andrea, Vessella Federico, DAMIANI Giovanni, SCHIRONÉ Bartolomeo, in this work describes a case study located in central Italy, which is characterised by the integration of forest restoration with water-saving management for irrigation purposes, based on the use of effluents from a phytodepuration plant. By joining thematic maps with a map of topographic
wetness index (TWI) a suitable site was selected in the municipality of Tuscania for a cork oak plantation. An irrigation scheme, useful for maximizing the growth rate of cork oak and consequently for maximizing the economic profits retrievable from the plantation, was determined based on the estimated potential evapotranspiration using Thornthwaite’s equation, the soil type and the available wastewater. An economic analysis showed that the total cost of the works might be amortised within the first stripping of gentle cork or even before, for example, if cork oak was cultivated in conjunction with an economically relevant non-food species. In this case study, the advantages of dyeing species were analysed. Results show that an integrated forest restoration and wastewater management system could be implemented to provide an economic income that ensures both cost recovery and a significant profit over time.

The eighth and ninth paper all same authors, the PhD Dario Friso with different titles: Brake Thermal Efficiency and BSFC of Diesel Engines: Mathematical Modeling and Comparison between Diesel Oil and Biodiesel Fueling. In this work was to investigate the brake specific fuel consumption (BSFC) of the engine, installed in an agricultural tractor, fueled before with diesel oil (B0) and then with biodiesel (B100). This was done both vs. the engine speed, which vs. engine load. To understand the influence of the fuel heating value and the brake thermal efficiency (BTE), a mathematical modeling of the BTE vs. engine speed and engine torque was developed. The bench tests on the engine, fueled with the two fuels (B0 and B100), allowed to point out that on average, the BTE of the engine was unchanged in the comparison between the two fuels, while the average BSFC was 19% higher with the B100, consistent with the lower heating value of B100 (-17.2%). However, the power output of the engine with the B100 was not reduced by the same amount, but with an average value of 11%, as there was a partial recovery due to the slight increase in the fuel consumption rate. The fitting of the mathematical model to the engine, fuelled with the two fuels (B0 and B100), allowed to draw the diagrams of the calculated BTE and BSFC contours for both fuels, with a good accuracy represented by a mean relative error of 2.1±2.2% (B0) and 2.0±1.5% (B100). Finally, the comparison of the previous results, allowed to highlight the points of the engine speed-torque plane where the biodiesel BTE was different than that of diesel oil BTE. It emerged that the engine fuelled with B100 had a higher BTE at low load and speed, but lower than that of B0 at high speed due to reduced inclination to evaporate compared to diesel oil, which is critical when the speed increases and the time available for combustion is reduced.

The other paper has title: Energy Saving with Total Energy System for Cold Storage in Italy: Mathematical Modeling and Simulation, Exergetic and Economic Analysis. It was considered for production of cold air, obtained by assembling compression system, absorption system and cogeneration unit (CHP) fuelled with methane-gas, in two different plant solutions: 1) TES consisting of the CHP, mechanically coupled with the compression refrigerating machine and thermically with the absorption system both designed to cool the air in the store rooms; 2) TES* characterized by the CHP, mechanically coupled with the compression refrigerating machine, designed to cool the air in the store rooms, and thermically with the absorption system designed to cool the air in a pre-refrigeration plant. A mathematical modeling and a consequent computer simulation of the behavior of both integrated system (TES and TES*) and both related conventional systems (CES consisting of a compression machine to cool
the air in the store rooms and CES* characterized by two compression machines, the first cooling air in the store rooms, the second cooling air in a pre-refrigeration plant) was carried out. As an overall results, an energy saving of $21\%$ was calculated. Considering the difficulty of comparing the different types of energy involved, an energetic analysis was also carried-out, confirming a better energetic efficiency of TES vs. CES. Finally, an economic evaluation was also conducted with a very attractive profitability index for TES and TES* systems fuelled with natural gas. The economic analysis showed that the use of bio-methane, in the TES system, is profitable up to a bio-methane cost of 0.46 €/m$^3$.

The tenth paper by Alessio Facello, Niccolò Pampuro, Marco Manzone, paolo Balsari and Eugenio Cavallo with the title: Wood chips compaction: first energetic analysis. To increase the efficiency of the entire wood fuel supply chain, it is necessary to reduce the cost of harvesting, processing and transportation. One possible way to cut the handling costs is the densification of the chips. This paper reports the results of a study conducted on the densification process of chips, with particular focus on the demand of energy required by the process and on the density achieved. The investigation has been carried out on chips from hybrid poplar (PC) chestnut (CC), and a mixture of spruce and eastern white pine (MC) at different pressures (20, 30, 50, 80 and 110 MPa). The study pointed out that average values for density ranges between 546-898, 559-1082 and 543-913 kg m$^{-3}$ for PC, CC and MC respectively. Specific energy demand ranges between 22.5-58.1, 18.8-43.3 and 19.4-50.2 kJ kg$^{-1}$ for PC, CC and MC respectively.

The eleventh paper by Simone Di Giacinto, Longo Leonardo, Menghini Giuseppina, Delfanti Lavinia, Egidi Gianluca, Licia De Benedictis, Simone Riccioni with the title: A model for estimating pruned biomass obtained from Corylus avellana L. In this work the amount of biomass available by the hazelnuts pruning in the province of Viterbo was investigated. At present, the pruning’s residues are destroyed by farmers directly in the field, at the end of the pruning; in this way a large quantity of biomass, represented by hazelnut’s prunings, is lost; the residues obtained from the hazelnut’s pruning, are an important source of biomass that could be used for thermal energy production. The aim of this work is to realize a map with the estimated energy potential from hazelnut pruning biomass, in the province of Viterbo. In the first phase the amount of biomass obtained from a hectare of hazelnut’s cultivation was estimated: sampling were carried out in some municipalities of Viterbo while hazelnut pruning was taking place, from January to March.

The twelfth paper by Daniele Dell’Antonia, Sirio Cividino, Olga Malev, Gianfranco Pergher, Rino Gubiani. The study showed technical and economic aspects of forest combined heat and power (CHP) biomass system with two different types of gasification plants: (i) gasification with combustion engine and (ii) gasification with a Stirling engine. The technical and economic characteristics of small-scale gasification technology was determined using the methodology of Net Present Value (NPV) in order to identify the best technological solution for the construction of a gas plant in a company that processes timber: From the technical point of view the gasification plant with Stirling engines is a more reliable energy system which is not subjected to strains due to the use of synthesized gas during its normal activity. However, the investment costs are significantly higher (€ 7,429/kWe) when compared to the costs necessary for
a gasifier with internal combustion engine (€ 4,040/kWe). The techno-economic feasibility assessment has shown no substantial difference in the remuneration time for both type of gasification plant being in the range of 4-5 year period. Additional studies are necessary to elucidate both technical and economic aspects and to suggest which type of technology is more suitable on small-scale forest biomass gasification at a regional level.

The thirteenth paper by Lavinia M.P. Delfanti, Roberto Bedini, Manuela Romagnoli, Fabio Recanatesi, Francesca Meacci, Luciano Caruso, Alberto Manzo, Luca Salvati with the title: Estimation of agroforestry biomasses available for energy purposes in a Municipality in central Italy as instrument for energy planning. The aim of this work is to give and indicative estimation of agroforestry biomasses (as volumetric mass and energy content), relative to the forest and agricultural sectors (tree and grass cultures) for the Municipality of Bracciano, in central Italy, that can be used as a basis for support for the new territorial politics. This work shows that the total energetic content could cover the thermal consumption of the ‘economy’ sector of the Bracciano territory, that includes the agricultural, industrial and tertiary sectors.

The fourteenth paper by Roberto Deboli, Massimiliano Ruggeri, Angela Calvo, evaluated the a Short Supply Chain To Guarantee Wood-Chip Quality. In this work the entire chain is controlled by means of a novel electronic architecture onboard the machine, interfaced with a communication system connected to a central server acting as a supervisor. All the machines are equipped with a GPS receiver, a data communication module and a CAN (SAE J1939) interface: machines data are sent to a central server, through an internet connection, and collected in a database ready for web services. A communication protocol has been designed to optimize data transfer and to minimize the cost. To increase the product value, an automated integral sensor (capacitive type) for wood chip humidity determination was implemented. With the fleet management system installed on the machine, cruise controls data (using a GPS system) are acquired, other than all the machine states (through CAN line inside the machine) and wood humidity. The data base (MySQL standard) permits, moreover, to the system administrator and to the user to manage all these information. Another important result is the web access that permits to monitor the fleet situation (route, engine status, time of journey, climatic conditions) at any moment with a screenshot. The capacitive sensor for humidity measurements gives good results, especially in the case of chips with dimensions comprised between 34 and 64 mm and an initial humidity (on wet basis) of 45%.

The fifteenth paper with the title: BiogasAgriAtex, new methods of risk assessment explosion on biogas plants, by Sirio Rossano Secondo Cividino, Olga Malev, Michele Lacovig, Gianfranco Pergher, Rino Gubiani, Michela Vello. The aim of this study was to discuss explosion prevention during biogas production and to determine if inside agricultural biogas plants are present areas in which explosive atmospheres may occur. These risk areas should be classified determining several parameters such as the volume of explosive atmosphere (Vz), the risk distance (dz) and the dispersion time (t). For these evaluation was designed a software named BiogasAgriAtex developed in Microsoft Excel program following the CEI 31-35 2007 regulation (third edition).
which applies the CEI EN 60079-10 (CEI 31-30) regulation. The main result of this study is a comprehensible program for agricultural companies that defines and manages critical points within biogas production plants.

The sixteenth paper is Energy Characterization of Residual Biomass in Mediterranean area for small biomass gasifiers in accordance to the European Standards by Sonia Castellucci, Silvia Cocchi, Clara Benavent Celma. In this work some typical biomass of Mediterranean Area, with specific regard to residual ones, are analyzed according to the European Standards, in order to determinate the following properties: C/N ratio, calorific value, ash content and moisture. The aim of this paper is to classify biomass in order to evaluate either of biomass, or a mixture of them, using gasification processes. Among the studied biomass hazelnut shells are the most suitable to gasification process: C/N ratio is 121.76, moisture on wet basis is 6.04%, ash content is 1.72%, and Low Calorific Value (LCV) is 18.83 MJ/kg.

The seventeenth paper is a GIS-based territorial model for energy balance evaluation of corn-to-ethanol process: an Italian case study by Roberta Martelli, Claudio Caprara. An energy analysis was carried out on a territorial base to highlight the energy expense due to corn production, transportation and processing into ethanol. Energy balances were calculated for each single supply area as the ratio of output/input, considering coproducts energy credit as part of the energy output. Energy balances vary in a small range of 1.15443 - 1.16576 according to supply areas and corn yields.

The eighteenth paper by Andrea Cappuccini, Andrea Petroselli, Ettore Arcangeletti with the title: Mathematical modeling and GIS applications for greenhouse energy planning in Italy. In this work were determined the annual requirements of artificial energy to heat a greenhouse (MJ m\(^{-2}\) year\(^{-1}\)) covered with polyethylene film for the whole Italian territory at a predetermined internal thermal threshold. The results show that through the analysis of energy requirements has been possible to obtain a classification of the Italian territory by identifying areas that are most appropriate to the greenhouse activity for the high availability of natural energy.

**Summary**

In summary, the papers of the special issue represent some of the latest and most promising research results in this new and exciting field, which continues to make significant impact on real-world applications. We are confident that this special issue will stimulate further research in this area.

**Received:** June 1, 2014