Task 29
Socio-Economic Aspects of Bioenergy Systems

IEA Bioenergy

Proceedings of the Workshop

Socio-economic aspects of bioenergy systems: Issues ahead

19 – 21 September 2002
Cavtat-Dubrovnik, Croatia

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Introduction

It is with great pleasure that we introduce the proceedings of the IEA Bioenergy Task 29 international workshop held in Cavtat, Croatia, 19 – 21 September 2002.

IEA Bioenergy is an international collaborative agreement set up in 1978 by the International Energy Agency (IEA) to improve international cooperation and information exchange between national bioenergy RD&D programmes (www.ieabioenergy.com). As of January 2003, twenty countries or organisations take part in the collaboration: Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Finland, France, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, the USA and the European Commission. The work of IEA Bioenergy is carried out through a series of Tasks, each having a defined work programme and a finite time period, normally three years.

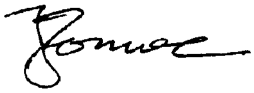
The primary goal of IEA Bioenergy Task 29 ("Socio-Economic Aspects of Bioenergy Systems") is to promote the use of biomass for energy over fossil-based competitor fuels in the participating countries through achieving a better understanding of the social and economic impact of bioenergy systems at the local, regional, national and international level. Participating countries are Austria, Canada, Croatia, Japan, Sweden and United Kingdom.

The workshop at Cavtat represents the culmination of effort for the Task partnership and provided the opportunity for specialists and non-specialists alike to learn and participate in an action focused on understanding the complex social and economic interactions of bioenergy and community. In particular to:

- Compare and contrast approaches taken to the Task in partner countries;
- Learn from Best Practice (including invited papers);
- Hear reports from student and community participants;
- Plan and agree future actions and priorities (next 3 year programme).

During the workshop, 16 papers were presented from 12 different countries on issues varying from bioenergy use in remote northern Canadian communities, to the Mediterranien island of Korčula. These papers or presentations form the basis of these proceedings. Papers are printed as provided by the authors.

It is a pleasant duty to thank our local organisers – the Task 29 Croatian team, all the friendly people at the Hotel Croatia in Cavtat and others involved in the workshop organisation, whose hard work was recognised during and after the event. We would also like to express our appreciation to all those authors and participants for the outstanding, unforgettable event, which we all created together.



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Technical Session

Socio-Economics of the Diffusion of Innovative Bioenergy Technologies. The Case of Small Pellet Heating Systems in Austria[#]

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Abstract

In this paper we study socio-economic aspects and key drivers and barriers that determine the market penetration of modern small-scale bioenergy systems (SSBS) such as pellet-fired burners and stoves. We apply some diffusion of innovation theory and explore the usefulness of standard epidemic diffusion of innovation modelling for making predictions on the rate at which SSBS may penetrate the market. The empirical part contains an illustrative analysis of the historical and expected future market penetration of pellet-fuelled residential central heating systems in Austria from 1997-2001 (by province). For an assumed 35% market share of such systems by the year 2030, we find strongly varying diffusion patterns among the nine Austrian federal provinces, and a total market potential of about 470,000 installed units.

Keywords: small-scale bioenergy technologies, wood pellets, heating systems, diffusion of innovations, modelling;

[#] This paper is a precursor of two forthcoming and more thorough papers that compare and contrast the diffusion of innovative small-scale bioenergy heating systems in Austria and in Sweden.

1 Introduction

Modern bioenergy systems can make a significant contribution to today's heat and electricity requirements and, more generally, a more sustainable development. Also, significant advances in wood heating technologies both at the large and the small scale have been made over the last two decades, leading to significantly higher fuel efficiencies and lower pollutant emissions. For small-scale biomass-fired systems (more than 85% of all dwellings in the EU are being heated by single house systems; CEC [5]) advances in technology have led to considerably increased levels of comfort, mainly through automation and the related use of more sophisticated fuels, such as densified wood pellets, that facilitate delivery (e.g. by road tanker) and storage (e.g. pellets require only a fourth of the space needed for logwood). This has made pellet-fired systems an attractive and innovative renewables-based heating option also for suburban and urban areas, where most people live, while small-scale logwood and wood chips boilers are mainly being used in more rural and agricultural areas (local fuel supply requirement).

Pellet-fired systems for residential use offer a comparable level of comfort relative to oil- and natural-gas-fired fossil fuel systems, but have the additional advantage of allowing for significant reductions in greenhouse gas (GHG) emissions and the use of a domestic (or even local) energy resource that has at least so far exhibited much lower levels of price fluctuation than oil and natural gas. Besides, pellets are an increasingly standardized and therefore internationally tradable commodity.[1] This allows for considerable economies of scale and scope, but also experience curve effects and competition among suppliers and traders, which together can be expected to bring down prices rapidly. Rather unsurprisingly, in recent years the development of the wood pellet market and the diffusion of wood pellet heating systems has attracted an increasing amount of attention among researchers (e.g. Vinterbäck and Roos [36]; Rakos and Hackstock [26]; Umbera [35]; Roos *et al.* ([30]; Rakos [24]; Skaggs *et al.* [33]), industry, industry and consumer associations, policy-makers, and others.

[1] In Austria, for example, pellet standard ÖNORM M 7135 defines parameters such as permissible [natural] raw materials and additives, ash and water content, bulk density, grain size, and abrasion resistance, leading to a high homogeneity of the fuel commodity and thus to easier handling and endurance (e.g. by largely avoiding dust problems) and favourable combustion and hence much lower pollutant emission. In addition, a standard for wood pellet logistics has been introduced recently (ÖNORM M 7136), and another one for storage is currently in preparation (ÖNORM M 7137). In addition, the Austrian Pellet Association (Pelletsverband Austria; www.pelletsverband.at), an important opinion leader in Austria, has defined a separate and in part even more rigorous standard (e.g. regarding heavy metal content and particulate emission during loading and delivery). Other countries have also introduced wood pellet standards, such as Germany (DIN 51731) and Sweden (SS 18 71 20).

Having said all this, wood-based heating systems still suffer from a number of barriers, such as a persistent negative image of being labour-intensive, old-fashioned and outdated; a lack of education, training, know-how and experience among key supply-side actors, such as architects, planners and installers (for a recent survey among Austrian pellet heating system installers see Jauschnegg [12]); and a lack of market and peer-group information among a large share of the population (e.g. Rösch and Kaltschmitt [32]; Fessel-GfK [6]; Rohracher and Suschek-Berger [29]; IFES [11]). Besides, biomass-fired cogeneration plants in (existing) district heating systems and electric heat pumps based on renewable electricity are often less costly and more resource efficient than small-scale wood pellet boilers (Gustavsson and Karlsson [7,8]), although of course economical district heating systems require a sufficiently high energy density (i.e. heat demand per unit of urban area) and heat pumps the availability of a suitable local heat source.

Today, the use of wood pellets for residential heating purposes is most advanced in Austria, Germany, Sweden and in certain parts of the U.S.A. (mainly the Northeast), although it develops rapidly in other countries as well (e.g. Denmark, Finland, France, Italy, Chile and New Zealand, among others). For a quite comprehensive and fairly recent survey of the wood pellet market in a number of European countries, U.S.A., and Canada see Umbera [35]. To get a glimpse of the growth rates involved, in *Austria* the cumulative number of installed residential pellet heating systems has increased from some 400 in 1997 and 3,900 in 1999 to 12,300 in 2001 (Jonas and Haneder [15]). In *Germany* in 1999 about 1,000 and in 2000 about 2,000 pellet heating systems were being sold (Hoffmann [10]). In *Sweden* the total number of installed wood pellet burning appliances was estimated to be around 8,000 in 1997, 15,000 in 1998 and 20,000 in 1999 (Vinterbäck and Roos [36]). In Finland, about 400 pellet systems for single-family-house were installed by early 2001, a number which is also rapidly growing (Alakangas and Paju [1]). In the U.S.A., pellets are used mainly in stoves and delivered in bags (i.e. no bulk delivery); in 1999 34'000 pellet stoves have been sold in the domestic market there (Umbera [35]).

Dedicated policy action is needed especially during the market build-up phase, in order to enable a swift market penetration of these innovative bioenergy systems and to overcome the "chicken-egg" problem. The European Commission, for example, in its 'Campaign for Action' (CEC [5]) to achieve the doubling of the share of renewables aimed for in the 1997 White Paper on renewables (i.e. from 6% to 12% by 2010), has called for 1'000'000 dwellings heated by biomass, which sent an important positive signal to SSBS and biomass fuel suppliers. At the national level, boundary conditions that determine the economics of modern bioenergy systems typically differ considerably among countries. In Sweden, for instance, small-scale pellet burning is essentially economical due to the taxation of fossil fuels (Karlsson and Gustavsson [16]; Brännlund and Kriström [4]), while in Austria investment subsidies have been introduced in all nine federal provinces, with the aim to redress the still significant capital cost imbalance between fossil-based and modern wood-energy-based residential heating systems. These subsidies are capped on average at around 30% of the net SSBS investment costs, and differ quite strongly among the provinces in their levels, eligibility conditions, and year of introduction (cf. Table 1, bottom). Another important success factor are institutions providing independent and high-quality advice on SSBS and platforms for information exchange, such as the German biomass information centre (BIZ) at the University of Stuttgart, or the C.A.R.M.E.N. network in Straubing that has repeatedly published surveys on available pellet heating systems and related market information.

Because numerous factors (e.g. lack of data, incomplete markets) render the construction of standard economic models of bioenergy use complicated (e.g. Roos and Rakos [31]), the use of individual- and aggregate-level innovation diffusion models is a promising and yet largely unexploited avenue for model-supported research on modern bioenergy systems. Here we will briefly introduce and apply some diffusion of innovation theory and aggregate epidemic diffusion modelling in order to improve the understanding of how the further penetration of modern bioenergy technologies may take place, and be described, and how it can be fostered by appropriate policy measures. For the empirical analysis, we have chosen the Austrian residential central heating market for pellet-fired systems, presently one of the most dynamic in the world.

The remainder of the paper is organised as follows: in section 2 we first introduce some theoretical considerations from diffusion of innovation theory. In Section 3 we make a first attempt to apply diffusion of innovation theory to the residential wood-pellet central heating market. Section 4 outlines the basic intuition between diffusion models and their applicability in the present context. Section 5 contains a description of the current situation for residential wood pellet heating systems in Austria. Section 6 contains the empirical results from an econometric diffusion analysis with Austrian data on the federal province level, and section 7 concludes.

2 Theoretical considerations

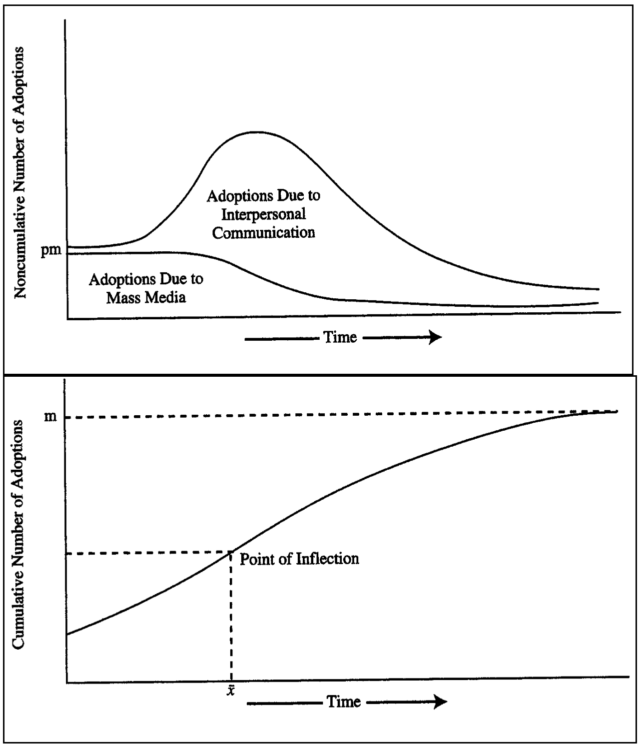
"Diffusion" can be defined as the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers [28]).[2] When new technological ideas are invented and subsequently adopted (or rejected) in the market diffusion process, apart from technical change this also leads to social change, adaptations of the economy, and environmental implications (Kemp [17]).

Empirical research in a number of disciplines has shown that the diffusion of innovations typically follows an S-shaped curve (Rogers [28]), i.e. that the

[2] Note that some diffusion scholars use the term "diffusion" for spontaneous, unplanned spread of new ideas only, and "dissemination" for directed and managed diffusion, while others use "diffusion" both for unplanned and planned diffusion.

cumulative level or share of adoption can be modelled as an increasing function of time, which is initially convex but eventually becomes concave (Figure 1, right). As diffusion occurs within a socio-economic system, many diffusion phenomena cannot be explained solely by individual behaviour. Also, as socio-economic systems often differ widely in their norms, regulatory frameworks, institutional settings, and other boundary conditions, the influence of the system on the individual members and vice versa can be expected to be very heterogeneous, making generalisations on innovation diffusion difficult. One way to explain the diffusion process of an innovation is by means of communication theory, an approach that has been used frequently by diffusion scholars of various disciplines. Closely related are diffusion studies in marketing, a strand of diffusion research which has seen a remarkable growth since the 1970s, partly as a result of the publication of the pioneering and highly influential Bass model (Bass [2]) for the prediction of aggregate market diffusion of a durable product (formally introduced in section 4), and which offers some simple but very plausible explanation on how different communication channels (mass media, interpersonal communication) may influence the diffusion process over time and how contagion and saturation effects form the S-shaped diffusion curve (Figure 1, left).

Finally, in most diffusion of innovation studies the diffusion process is categorized according to certain features that characterise adopters' attitude towards innovativeness, and their relative position along the diffusion curve, such as: (a) *Innovators*; (b) *Early Adopters*; (c) *Early Majority*; (d) *Late Majority*; and (e) *Laggards* (cf. Rogers, Ch. 7 [28]). Furthermore, innovations may be characterised by the following five features, which typically have a strong impact on the rate of adoption: (a) *relative advantage*; (b) *compatibility*; (c) *complexity*; (d) *trialability*; and (e) *observability* (ibid., Ch. 6). *Relative advantage* refers to the degree to which an innovation is subjectively perceived by a potential adopter to be better than existing ideas. It may be measured in economic terms, social prestige, convenience, or consumer satisfaction. *Compatibility* refers to the degree to which an innovation is subjectively perceived to be consistent with existing values and social norms, past experiences, and needs of (potential) adopters. *Complexity* refers to the degree to which an innovation is subjectively perceived to be difficult to understand and use. *Trialability* refers to the degree to which an innovation can be experimented with on a limited basis. Finally, *observability* refers to the degree to which the results of an innovation are visible to others. Visibility stimulates peer discussion of an innovation, e.g. through friends, neighbours, or work colleagues, and allows an innovation to achieve status symbol character. One would expect that the higher the perceived relative advantage, compatibility, divisibility and observability of an innovation, and the lower the complexity, the higher the rate of adoption will tend to be.



Source: based on Mahajan, Muller et al. (1990) [20]

Figure 1. Diffusion of an innovative technology or product by adopter category (stylised)

3 Socio-economic aspects of small-scale bioenergy system diffusion

It can be expected that the image of modern SSBS will improve over time, especially as a result of continued techno-economic performance improvements (which improves their attractiveness on ecological and operational comfort grounds), further market development, and the important work that has been done over the last years by energy agencies and other potential opinion leaders in terms of information dissemination. However, the state-of-the-art of the technologies involved is all too often known only to a small percentage of the population, and most of the equipment manufacturing and fuel processing "industries" (typically SMEs) are still in their infancy, making heavily-funded marketing campaigns impossible (an important disadvantage against the well-established competitors, especially the oil and gas industry), and strongly limiting the exploitation of economies of scale, scope, and learning. Besides, it should be remembered that heating systems are long-lived (durable) goods with a product lifetime of typically 20 years, so that the annual replacement rate is rather low.[3] Given the high growth rates experienced in recent years and the expectation that in the future fossil fuel prices for a number of reasons will rather tend to rise than to fall (e.g. increasing internalisation of external costs, rapidly rising energy demand levels in developing countries, and sooner or later the exhaustion of low-cost fossil fuel reserves), the prospects for what presently is only a niche market are quite promising.

In what follows, by using Rogers' classification of innovation features introduced above, and contrasting them with some socio-economic and environmental features of SSBS, we make a brief attempt to study the diffusion of innovation vistas of small-scale wood pellet heating systems. Additionally to the features discussed next, the *lack of information* of actors involved in the purchase (consumers) and installation (architects, planners, installers) of new heating systems is considered a crucial and persistent barrier that needs to be overcome especially in the initial phase of the market diffusion process, in order to make it self-sustaining.

(a) *Relative advantage* – Probably the most important relative advantages of wood pellet heating systems, as compared to fossil-based alternatives, lie in the mitigation of greenhouse gas emissions (substitution for fossil fuels) and the possibility to use a domestic/local energy resource (and maybe even a domestically or locally manufactured heating system, which is an important sales argument in pioneering Austria). Given the current price levels of competing fuels, however, targeted diffusion promotion policies by means of fiscal incentives (such as those provided in Austria, Germany and Sweden) are needed to make wood pellet systems competitive in current markets. Modern automated pellet heating systems virtually offer the same heating comfort as conventional systems, maybe apart from the need to empty the ash compartment from time to time. Recently, dual-fuel boilers have been developed that can use pellets and logs, increasing the flexibility in fuel use, and therefore the consumers' subjective perception of fuel supply security (possibility to switch to logwood in case of pellet supply shortages, a factor that might be relevant especially at the early stages of pellet market development).

(b) *Compatibility* – Technical compatibility is a minor issue in households which already have a central heating system. However, in households with electric heating additional constraints are crucial (e.g. additional space and investments are typically needed for wood storage and the erection of a chimney). A water-based heat distribution system may have to be installed in cases where it does not yet exist, because otherwise only part of the heat demand might be covered by the SSBS. In terms of social compatibility (norms, values, past experiences) it can be expected that pellet-fired systems have particularly good chances where they are

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[3] In Austria about 40,000 old central heating systems are currently being replaced by new ones every year.

considered a clear improvement over existing systems (e.g. transition from logwood and wood chips to pellets), or whether the image of the SSBS is compatible with a potential adopter's needs (e.g. being ecological, being fancy, being cool). Besides, improved standardisation of pellet quality (easier transportation and handling and combustion), automation and control (level of comfort), and education and know-how (in order to help redress actors' misperceptions of modern SSBS and thus influence existing values and social norms with regard to heating systems) can be expected to increase the rate of adoption and the market size.

(c) *Complexity* – In terms of complexity, modern wood boilers are at a certain disadvantage compared to conventional systems. This is problematic because installers, at least initially, tend to stick to traditional systems because of a lack of know-how, training, and experience. However, surveys have shown that at least part of the additional servicing needed by modern SSBS can often be done by the system owners themselves with relatively little effort (e.g. Vinterbäck and Roos [36]).

(d) *Trialability* – Experimentation with modern bioenergy systems on a limited basis is usually not possible. However, it could be thought of that potential adopters get the opportunity from innovative entrepreneurs to lease a system (with or without a purchase option), or that they have the right to have the boiler de-installed in case of complete discontent, in order to improve trialability and reduce the barrier to adoption of a relatively capital-intensive but unfamiliar durable good.

(e) *Observability* – Several surveys (e.g. Vinterbäck and Roos [36]; Rohracher and Suschek-Berger [29]) suggest that trade fairs, exhibitions, and store displays play an important role for establishing a first contact with potential SSBS adaptors and to raise public awareness. In general, a heating system is a rather capital-intensive investment of low visibility to others, and can thus only act to a very limited extent as a status symbol (e.g. in contrast to a Ferrari).

Several additional factors can be thought of to have an influence on the potential use of SSBS. For example, in areas where people apparently put a higher value to actually *own and have control over the operation of the heating system* (such as in the Austrian province of Vorarlberg), SSBS can be expected to have relatively higher market potentials than elsewhere. *Ash recycling schemes* could be beneficial for diffusion off pellet-fired systems especially in urban areas where ash disposal options are often more limited than in rural areas (e.g. lack of interim storage or appropriate disposal facilities). The availability of *comprehensive service contracts for maintenance and repairs*, which are often hard to offer especially for the notoriously under-staffed small- and medium-sized equipment manufacturers and heating system installers, are often considered to be another important precondition for a wider adoption of modern SSBS. Then, especially in densely populated areas, consumers are sometimes obliged by law to get connected to the central district heating system, leaving them no heating system choice (and hence no choice to opt for a SSBS). Finally, some diffusion researchers have argued that additional government action, such as in the form of *regulatory or institutional innovation*, is an important framework condition that needs to be tackled, and that for a successful diffusion process this has to be done *simultaneously with the removal of other barriers* (e.g. Madlener and Jochem [19]). Still others have called for a *system of innovation framework* as the appropriate framework for the analysis of the diffusion of renewable energy technologies (e.g. Jacobsson and Johnson [14]).

4 Diffusion of innovation modelling

Epidemic diffusion models used in the social sciences, in contrast to other growth models such as the logistic, the Gompertz or the Mansfield model [21], aim to explain the adoption of new products, processes or technologies on the basis of explicit behavioural assumptions. Typically, the rate of adoption (*diffusion process dynamics*) and the overall market potential (*ceiling value*) are at the centre of interest in such studies. Only few attempts have been made so far to provide some explicit micro-economic theoretical underpinning to such models (e.g. Jensen [13]), and most often the models that have been used are deterministic and not stochastic.

Based on the theory of Rogers [28], Bass [2] developed an empirically testable diffusion model in which the later adopters of a technology are influenced by earlier adopters. The Bass model and variants of it have been extensively used in many different research disciplines (e.g. sociology, economics, anthropology, marketing and management, geography) for forecasting the diffusion of new technologies and durable products in the market. Mathematically, the Bass model for first-time adoption of an innovative durable good may be expressed as a differential equation of the following form:

$$\frac{dN(t)}{dt} = p\left[m - N(t)\right] + \frac{q}{m} N(t)\left[m - N(t)\right] \quad (1)$$

where $N(t)$ denotes the cumulative number of adopters at time t, m the size of market potential (number of adopters), p is the coefficient of innovation (*external effects*), and q is the coefficient of imitation (*internal effects*).

In contrast, the *Generalized Bass Model* (GBM), introduced by Bass, Krishnan and Jain [3], additionally allows for the inclusion of explanatory variables considered relevant (e.g. relative equipment and fuel prices, marketing expenditures). The ordinary Bass Model is nested within the GBM. The GBM can be specified as follows:

$$\frac{f(t)}{\left[1 - F(t)\right]} = \left[p + qF(t)\right]x(t) \quad \text{with} \quad x(t) = 1 + \beta_1 \frac{\Pr'(t)}{\Pr(t)} + \beta_2 \frac{A'(t)}{A(t)} \qquad (2)$$

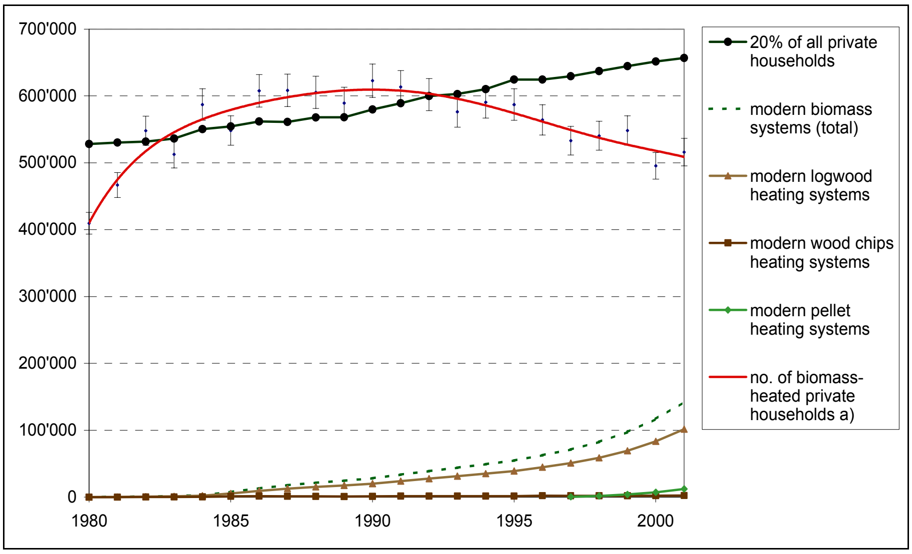
where *x(t)* has been termed the *marketing effort*, *Pr(t)* and *A(t)* denote the *price* and *advertising* and *Pr'(t)* and *A'(t)* the change in price and advertising, respectively, at time *t* (of course other suspects for explanatory variables could also be used). Note that both the Bass Model and the GBM are only appropriate for first time purchases (i.e. not for multiple and/or replacement purchases). Strictly speaking, therefore, in our case where the time horizon of the analysis exceeds the product lifetime of the durable good studied, a repeated purchase diffusion model (Ratchford et al. [27]; Olson and Choi [22]) should be applied in order to reduce the estimation bias.

5 An empirical diffusion study of the Austrian market for residential wood pellet heating systems

5.1 Brief overview of the wood pellet heating market in Austria

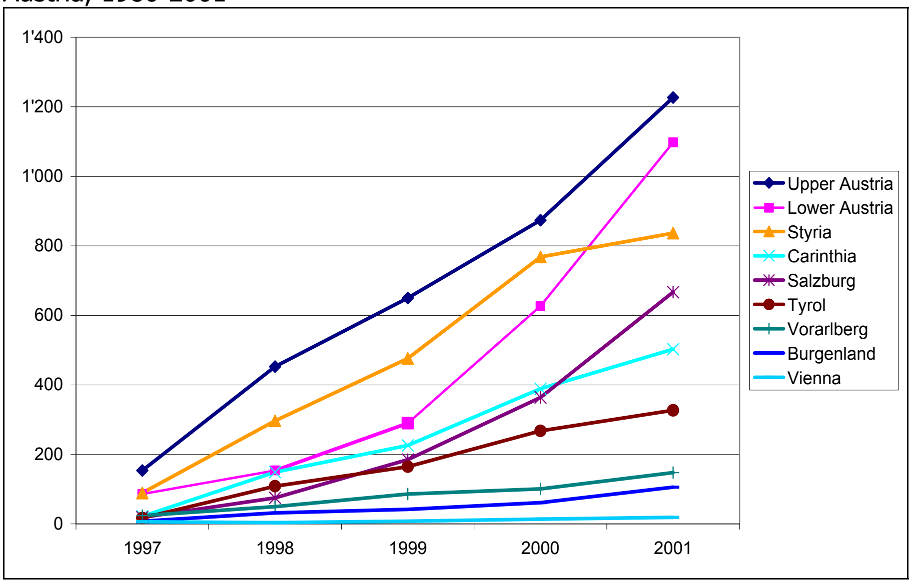
Austria is one of the leading countries with respect to wood pellet manufacturing[4] and the manufacturing and use of pellet heating systems, and it has a long tradition of wood-fuelled heating. Nonetheless, in recent years the share of wood-based heating systems has declined at a staggering rate, despite of a significant growth of modern SSBS (see Figure 2), reflecting a strong substitution of mainly natural-gas- and oil-fired systems for old wood boilers and stoves. It also shows that the sales figures of modern biomass heating systems do not yet fully compensate for the replacement of obsolete wood heating systems.

[4] With an annual pellet production of some 120,000 tonnes in 2001 (2000: 60,000 tonnes) Austria ranks third in European pellet production, after Sweden (2001: ca. 714,000 tonnes) and Denmark (2001: ca. 150,000 tonnes). For a detailed overview of the current situation of the wood pellet market in Europe see for example Alakangas and Paju [1], Vinterbäck and Roos [36], the reports made available from the EU-funded research project INDEBIF (www.sh.slu.se/indebif/), and the contributions of the 1st World Pellet Conference held in Stockholm in September 2002 (www.pellets2002.com).



Data sources: Jonas and Haneder [15], Statistics Austria, E.V.A.
Note: [a)] Sixth order polynomial trend with 4% error bars.

Figure 2. Number of wood-heated private households, compared to the number of households (20%) and the number of installed modern wood-fired boilers in Austria, 1980-2001



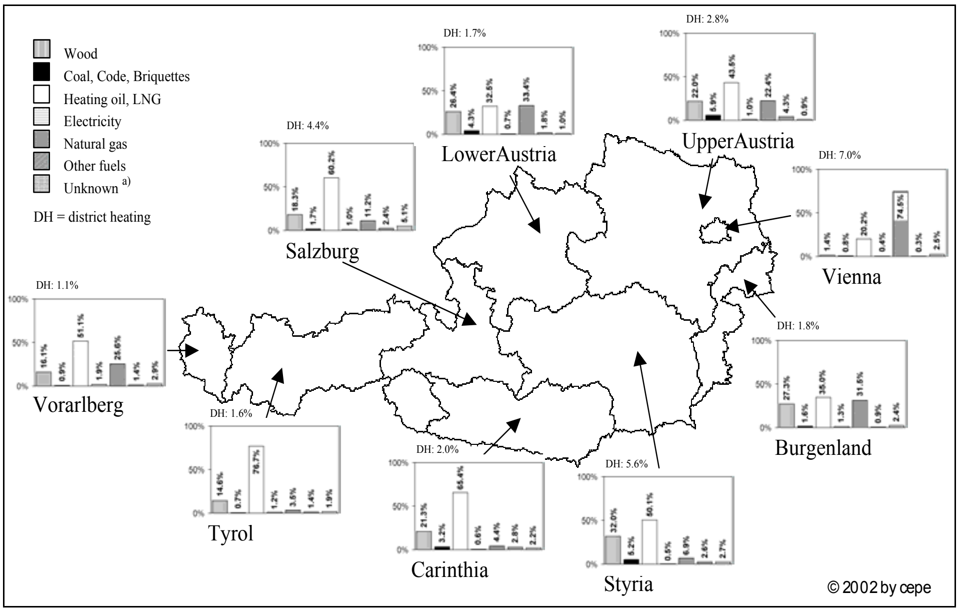
Source: Jonas and Haneder [15]

Figure 3. Number of annually installed small-scale (< 100 kW_{th}) pellet-fired central heating systems in Austria, by province, 1997-2001

In terms of domestic fuel availability, up to now wood pellets in Austria have been manufactured mainly from the cheapest resources available, viz. dry wood shavings and sawdust. For the potential suppliers of raw material, such as sawmill operators, furniture manufacturers, and forest owners, wood pellet business usually constitutes a welcome additional source of income (or avoidance of waste disposal costs). Given the expected continued rapid growth of the pellet heating market in Austria and neighbouring countries, however, the residues from the wood processing industry will be exhausted soon, and the wet sawdust and forestry residues potential will have to be tapped. The role of imported pellets will be determined mainly by the amount of excess pellet demand, their availability (in sufficient quantity and quality), relative prices, and – last but not least – public acceptance (especially if they are going to be imported from distant countries or regions).

In Austria the diffusion of modern wood-fired boilers (logwood, wood chips and pellets) of different size categories has been surveyed systematically and on an annual basis by the Chamber of Agriculture of the Province of Lower Austria since the early 1980s (Jonas and Haneder [15]). Since 1997, when the wider market diffusion became apparent, the number of newly installed wood pellet boilers have been reported separately. In the present empirical analysis we have restricted ourselves to small residential pellet-fired central heating systems, i.e. systems of between 10-100 kW of thermal capacity, the fastest growing market segment for biomass-heated boiler technology in Austria at the moment. Note that so far the pellet heating market in Austria has been confined essentially to small-scale and essentially residential applications. Figure 3 depicts the widely varying market diffusion paths of small-scale pellet-fired central heating systems in the nine Austrian provinces, expressed in terms of the cumulative number of systems that has been sold (installed) per annum. Figure 4 provides an overview of the shares of the fuels used for residential central heating in the nine provinces (1-2 apartment buildings only), and also the district heating shares, for the year 2001.

The attitude of Austrians towards wood-based heating systems has been investigated by the polling institute Fessel-GfK in the late 1990s (Fessel-GfK [6]). According to that survey 17% of the group of respondents that does not use wood as a primary heating source (64%) said they would definitely not switch to a wood heating system. The percentage is considerably higher in the Austrian capital of Vienna (79%), where there is no pronounced tradition of wood-based heating. Interestingly, women and elderly beyond the age of 60 were more against wood heating than others (most likely reflecting the image of wood energy to be labour-intensive). Also, the rejection rate was higher among respondents with lower income/social status, probably indicating a heightened anxiety of expenditure augmentation. Comfort was considered the prime condition for a potential switch to (modern) wood-based heating systems. 40% of the respondents considered investment cost-neutrality (against oil- and gas-based systems) as important, 35% fuel cost neutrality, and 20% of the respondents were concerned about pollutant emissions, and demanded that those must not exceed those of natural-gas-based systems. The two main reasons why the respondents are not using wood-based systems at the moment are comfort and space requirements for fuel storage. Finally, many do not see a possibility because of already existing systems (e.g. a gas connection) and because biomass-based systems (11%) and biomass fuels (14%) are considered too expensive.



Data source: Statistics Austria [34], own illustration

Figure 4. Fuel shares for residential central heating systems in 1-2 apartment buildings in Austria, and district heating share, by province, 2001 (in %)

5.2 Empirical results from the diffusion of innovation modelling

In order to demonstrate the empirical applicability and usefulness of diffusion of innovation models in studies on the predicted market penetration of bioenergy systems, we have used the standard Bass model (BM) for modelling the diffusion of small-scale wood pellet heating systems in the nine federal Austrian provinces (*Upper Austria – OOE, Lower Austria – NOE, Styria – STK, Carinthia – KTN, Salzburg – SBG, Tyrol – TIR, Burgenland – BGD, Vienna – VIE, and Vorarlberg – VBG*) as an illustration.[5] Note that as we do not explicitly allow for replacement purchases, the figures estimated represent the expected number of installed heating systems, rather than sales figures, as the latter can be expected to be

[5] We have considered both cumulative absolute figures (no. of installed systems) and market shares. Due to space constraints, only the former are presented here. The latter can be obtained from the authors upon request.

increasingly underestimated at least for the time after around 2010 (before we do not expect significant numbers of replacement needs, as pellet heating systems only started to penetrate the market in significant numbers after 1996).

Estimates for the long-term market ceiling of the Austrian pellet heating market (i.e. for the next 20-30 years) have not yet been published. What has become available are merely partial estimates for the expected development of the market penetration of pellet heating systems over the next decade (e.g. Rakos [25] aggregated for Austria; Leitgeb, p.55 [18] for Vorarlberg). Because the outcome of long-term diffusion models tends to be very sensitive in case of a lack of data beyond the point of inflection of the S-curve (in the current case we only have five observations from 1997-2001 at our disposal), we have decided to estimate the market ceiling values exogenously for each province for the year 2030 on the basis of some first crude assumptions only (cf. Table 1). Particularly, we assume that by the year 2030 a 35% share of all existing residential central heating systems will be pellet-fuelled. In other words, we estimate the cumulative market diffusion curve for installed systems, acknowledging at the same time that the sales figures will be higher over time due to the necessary replacement purchases, plus of course the high degree of uncertainty inherent in such long-term projections. The resulting ceiling estimate is then implemented as an exogenous variable into the BM. Note also that the application of the GBM does not seem to be advisable in the current case due to the non-availability of data prior to 1997 and the resulting lack of degrees of freedom for statistical inference.

Figure 5 depicts the S-curves that derive from the extrapolation of the (deterministic) statistical estimations of the standard Bass Model with an exogenously determined ceiling.[6] It can be seen that on the basis of the actual data available, the predicted rate of adoption for small pellet-fired central heating systems varies widely among the provinces, and that by 2010 a large share of the assumed total market potential is exploited only in Lower Austria and Salzburg, while in most others a substantial remaining potential exists. For 2010 the models predict a total of 146’000 installed units, and for 2020 344’800 units. At a first glance the level and timing of the investment subsidies granted is mirrored to a considerable extent in the diffusion paths, although in future research the influence of other factors, such as the existence of local pellet producers or pellet heating system manufacturers, should also be looked at more closely.

[6] The small pictures inserted show a magnified view of the actual, fitted and projected curves. Due to a lack of space, the results from the non-linear least squares (NLS) estimations are not reported, but can also be obtained from the authors upon request. All statistical inferences have been undertaken with the econometrics software package EViews 4.0 (QMS - Quantitative Micro Software, Irvine, Cal./U.S.A.).

Table 1. Ceiling estimation and investment subsidies for the Austrian residential wood pellet central heating market (buildings with 1-2 apartments only) [a)], by province

Province	*OOE*	*NOE*	*STK*	*KTN*	*SBG*	*TIR*	*VBG*	*BGD*	*VIE*	*AUT*
A. Number of private households, buildings with max. 1-2 apartments only (in thousands)										
1988	258.6	336.9	218.2	118.6	81.8	106.3	61.6	78.4	45.9	1,306.3
1998	308.1	400.7	249.8	131.6	97.3	123.1	73.5	88.6	56.8	1,529.6
2000	310.6	411.5	253.4	133.1	97.0	126.5	72.7	88.6	61.5	1,554.9
2001	313.5	406.0	252.0	132.9	99.1	125.9	74.2	89.1	59.9	1,552.4
2030 (est.) [b)]	337	441	268	139	105.5	135	79	94	66	1,662
B. Number of domestic central heating systems, buildings with max. 1-2 apartments only (in thousands, for 2000-01 also in %)										
1998	249.4 (80.9%)	308.2 (76.9%)	195.6 (78.3%)	90.6 (68.8%)	69.8 (71.7%)	90.7 (73.7%)	57.7 (78.5%)	64.4 (72.7%)	40.9 (72.0%)	1,167.4 (76.3%)
2000	258.8 (83.3%)	322.6 (78.4%)	206.4 (81.5%)	96.4 (72.4%)	71.8 (74.0%)	93.3 (73.8%)	61.3 (84.3%)	63.8 (72.0%)	48.2 (78.4%)	1,222.6 (78.6%)
2001	262.6 (83.8%)	329.2 (81.1%)	205.2 (81.4%)	95.4 (71.8%)	75.1 (75.8%)	95.8 (76.1%)	62.3 (84.0%)	67.6 (75.9%)	48.5 (81.0%)	1,241.5 (80.0%)
2030 (est.) [b)]	282 (83.7%)	359 (81.4%)	223 (83.2%)	105 (75.5%)	81 (76.8%)	102 (75.6%)	69 (87.3%)	69 (73.4%)	61 (92.4%)	1,350 (81.2%)
C. Estimated long-term market ceiling for central pellet heating systems, buildings with max 1-2 apartments only (expressed as no. of installed units, in thousands), based on the assumption that by 2030 35% of the resid. central heating capital stock will be pellet-fuelled)										
Ceiling for 2030 (est.)	98.6	125.7	78.1	36.8	28.4	35.7	24.2	24.2	21.4	473
D. Subsidies granted (in Euros and % of max. eligible investment cost) [c)] and year of introduction										
Stoves:										
- single	-	-	€ 800	€ 727 [g)]	€ 1,962.2	-	€ 800	-	-	-
- central	-	-	€ 1,100	same	same	-	€ 1,800	-	€ 3,564 [l)]	-
Boilers:	€ 1,500 / € 440 [f)]	€ 2,950 + € 370 p. add'l apartm.	€ 1,400	€ 1,800 [h)] (plus € 1,100[i)])	same	€ 3,700	€ 2,200 [k)]	€ 2,500	same	-
Eligible net investment cost (max.)	25% / 10% [e)]	30%	25%	30%	30%	15%	35%[j)]	30%	-	-
Introduction	1992, 1/1998	9/1998	5/2001	1991	10/1999	1/1999	1993	1993	6/2002	N/A

Notes: [a)] We have restricted our analysis to buildings with 1-2 apartments, as this is considered to be the key future market for the diffusion of pellet-fired heating systems in Austria. [b)] est. = estimate; as a first approximation, the estimated number of apartments and number of central heating systems in 2030 have been obtained by fitting a logarithmic trend. [c)] A number of special conditions apply to the granting of the subsidies mentioned which cannot be described in greater detail here due to a lack of space; for an overview see www.eva.ac.at/esf. [d)] Granted only if the stove is the only heating system used (STK: granted only if no more than 25% of the heat demand is provided by non-renewable fuels). [e)] Subsidies for installation of a new heating system and for the substitution of a boiler, respectively. [f)] Changed on 1 Jan 2000 from € 872 to € 654 and on 1 Jan 2001 to € 440; since 1 Jan 2002: € 1,000 if the oil or gas tank is disposed of properly. [g)] For the period of 1 Jan 2000 – 31 Dec 2001 only. [h)] € 1,163 until 31 Dec 1999. [i)] For substitution of a fossil-fuel-based or electrical heating system only; introduced on 17 March 1998 with € 1,599, changed to € 1,100 as of 1 Jan. 2000. j) Until 30 June 2000 max. 30%, € 1,090 for central stoves, € 2,180 for boilers (plus € 727 per additional apartment). [k)] Amount stated is for single-family houses; for multi-family houses it is € 1,500 (or € 600 per apartment); € 150/kW are additionally granted for switching from single stoves or electrical heating systems, or if previously no heat distribution system existed. [l)] Corresponds to the maximum available for a state-of-the-art system of € 220 (+ 5% of spending, max. € 550) * 6.08 (= applicable pollution emission factor; zero-emission factor = 8.18).

Data source: ÖSTAT [23] / Statistics Austria [34] (no. of households and heating systems), own calculations (ceiling estimation) and research (subsidy survey).

7 Conclusions

In this paper we have focused on the current situation of and prospects for modern small-scale biomass heating systems. The emphasis was on socio-economic aspects, diffusion, and the actual and expected future development of the market for small-scale pellet-fired heating systems in Austria. In particular, we discussed how diffusion of innovation theory and modelling can be used to predict and analyse the future penetration of modern bioenergy systems. With the availability of time series data with more observations, it will be feasible to estimate both the ceiling and the diffusion trajectory more accurately, and to apply more sophisticated model specifications. Nevertheless, apart from political and supply-side factors, certain demand-side boundary conditions, such as the socio-technical innovativeness, and the systems that compete with innovative SSBS are often quite heterogeneous among countries and regions, so that generalisations should only be made with great care. Overall, diffusion of innovation research from various disciplines' perspectives, joined with energy system analysis, seems to be a promising avenue for the assessment of the future role of modern biomass for energy systems.

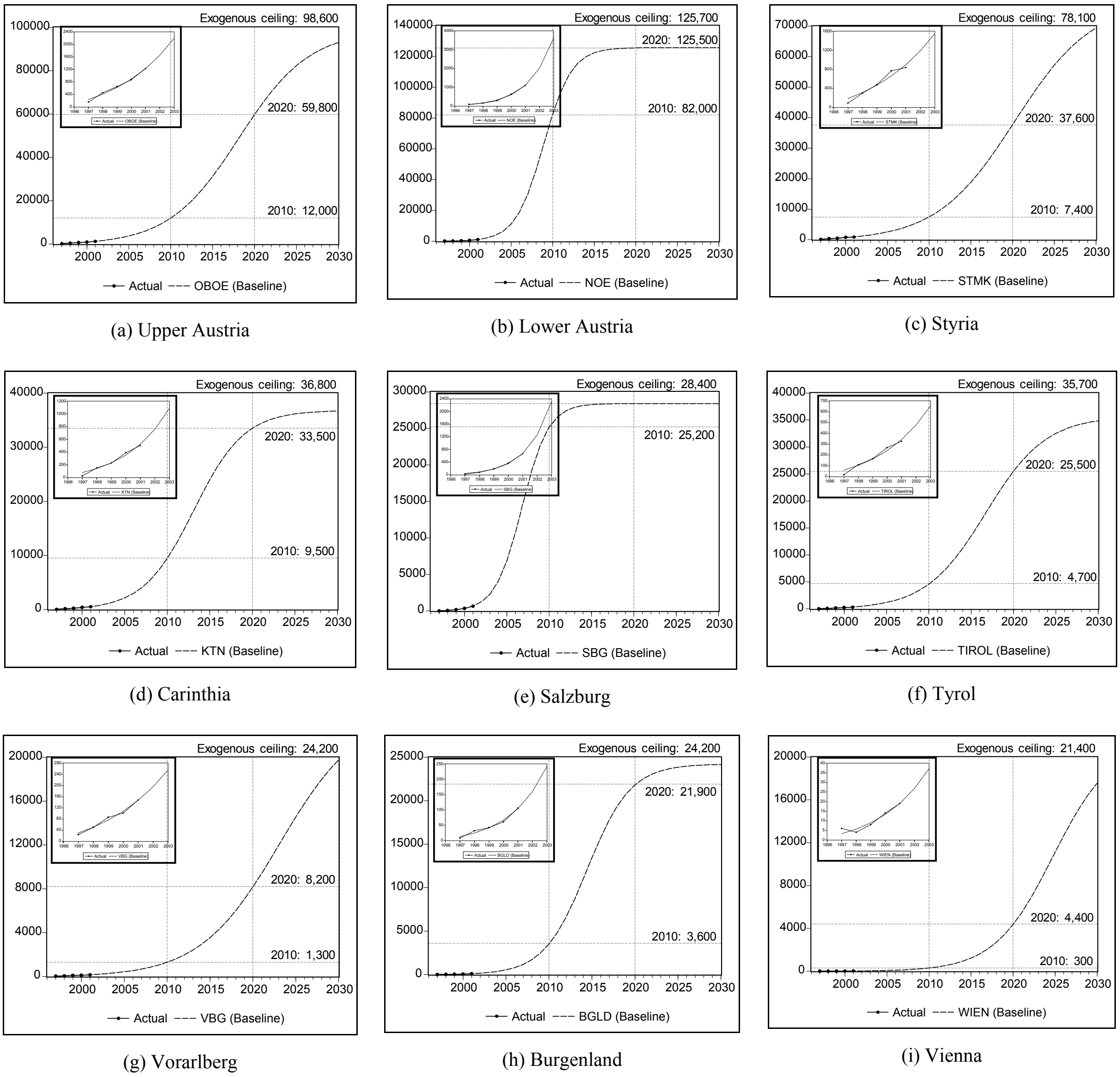


Figure 5. Extrapolation of the non-linear least squares estimation results from the ordinary Bass Model (market diffusion in levels), by province

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Carbon Tax, Energy Security, and Biomass Energy Production in the United States

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Abstract

Comparative economic analysis of biomass and fossil fuels was conducted to assess their relative competitiveness under assumed carbon tax and energy security scenarios. Changes in energy prices resulting from carbon emission taxes imposed on fossil energy and increases in U.S. oil self-sufficiency were simulated using a computable general equilibrium (CGE) model. The production costs of feedstock, electricity, and ethanol from energy crops (hybrid poplar, hybrid willow, and switchgrass) and logging residues were estimated and compared to those of fossil fuels derived from the simulation results. A $25/Mg carbon emission tax imposed on coal and oil would increase their market prices by 51% and 11%, respectively. U.S. domestic oil price would rise by some 22% for a 10% increase in the oil self-sufficiency rate. With current average production costs and yields, biomass from energy plantations would become competitive with coal if the carbon tax is within $75-125/Mg. It would be able to compete with coal in electricity generation using the gasification combined cycle system if carbon emissions are taxed at $100-150/Mg. Ethanol produced from the energy crops would not be cost effective if carbon is taxed at below $175/Mg even with elevated oil self-sufficiency. Compared to energy plantations, logging residues would be a more economical source for bioenergy if effective integrated harvesting systems are employed. Although the inclusion of carbon benefits and energy security premiums strengthens its competitiveness, the economic feasibility of bioenergy still depends on improvements in biomass productivity and energy conversion technology.

Keywords: Bioenergy; Competitive status; Computable general equilibrium.

1 Introduction

Environmental advantages as well as economic disadvantages of bioenergy over traditional fossil fuels are well known. The higher production cost of bioenergy than fossil fuels has long impeded its market expansion, particularly in developed countries. Increasing concerns about atmospheric CO_2 concentration and economic and energy security, however, have recently further drawn our attention to bioenergy. This paper attempts to conduct a comparative economic analysis of biomass and fossil energy by incorporating carbon credits and national energy security.

The consumption of fossil energy has led to tremendous environmental concerns including greenhouse gas emissions. One means to mitigate CO_2 emissions is to impose taxes on carbon emitted from energy consumption. Though no carbon tax has been used or proposed in the U.S., CO_2 emissions represent a sort of social/environmental cost associated with fossil energy uses. Carbon taxes reflect these social/environmental costs. On the other hand, bioenergy produced from herbaceous and woody plants offers the prospect of reduced CO_2 emissions to the atmosphere due to the carbon capture and sequestration capacity of biomass [14, 21]. Moreover, reliance on imported energy particularly oil poses risks to energy and economic security. Renewable bioenergy produced from agricultural and forest lands can play an important role in reducing foreign oil dependency, while creating an alternative land use option and viable economic opportunities. The U.S., the world's largest energy user and importer, imports more than half of the oil it consumes. On the other hand, the U.S is also endowed with rich land resources suitable for biomass energy production [9]. A significant amount of forestry residues (logging, thinning, and mill residues) also could be used as a source of energy if their production costs can be justified. Both carbon taxes and reductions in oil imports are likely to increase U.S. domestic prices of fossil fuels. This would enhance the competitiveness of biomass energy. How would the energy prices be affected by the imposition of carbon taxes and reductions in oil imports? To what extent, would it influence the economic potential and competitive status of biomass energy? These are the foci of this study.

Economic analysis of biomass energy production in the U.S. has been extensive [25]. Many existing studies are primarily based on research trial plantations [4, 18, 19, 23]. The estimated biomass production costs vary across regions and crops and are affected by yield. Generalization of these empirical studies has also led to the development of models to estimate biomass production costs under different circumstances. One of these models is the ORNL (Oak Ridge National Laboratory) model capable of estimating the full economic cost of biomass production in eight U.S. regions [26]. In addition to intensively managed energy plantations, technical and economic feasibility of producing energy wood from logging and thinning residues has also been explored [1, 2, 13]. Various integrated harvesting systems, which simultaneously harvest conventional wood products and biomass for energy, have been developed, tested, and used in several countries [7, 11, 22]. The estimated marginal costs of recovering energy wood using the integrated harvesting systems show great potential for utilizing logging residues in energy production [20].

Economic analysis beyond biomass feedstock production, though limited, has also gained momentum recently. Biomass co firing with coal in electricity production has been demonstrated to be technically feasible and, in some cases, cost effective as well [17]. In general, generating electricity using biomass is still in its infant stage, and the economics remain the major barrier [12]. The economic and technical feasibility of producing ethanol from biomass has also been investigated. Some ethanol conversion technologies have shown potential to substantially reduce ethanol production costs [3, 5, 16]. However, most of the existing studies focus on only traditional internal (private) production costs. Externalities in energy production and consumption are obvious and different from one type of energy to another. These externalities represent additional costs/benefits to society. To incorporate social costs/benefits like environmental benefits and energy security into the economic evaluation will enrich the existing body of knowledge and present a more comprehensive picture about the competitiveness of biomass energy.

2 Methods

2.1 The model for predicting energy price changes

Changes in energy prices resulting from carbon taxes and reductions in oil imports were projected using a computable general equilibrium (CGE) model. Compared to other approaches, CGE models have an advantage in combining both intersectoral and intrasectoral effects of a policy change. Because energy is virtually an input factor for all economic sectors, a change in energy price is the result of interactions among many sectors. This makes the CGE approach an effective and appropriate tool for analyzing the effect of carbon taxes and increases in oil self-sufficiency on energy prices.

The CGE model used in this study is based on the Global Trade Analysis Project (GTAP) model, which was initially constructed to analyze the economic effect of global trade at Purdue University [10]. The standard GTAP model is a comparative static, multisector, and multiregion model. It assumes constant returns to scale in all production sectors and perfect competition in all markets. Products are differentiated by country of origin using a traditional Armington structure. For each region in the model, expenditures by private households and the government and savings are determined by maximizing an aggregate Cobb-Douglas utility function within a budget constraint. On the production side, the households sell endowment commodities to firms. Then, the profit-maximizing firms use these endowment commodities along with intermediate goods to produce final goods and services. The government finances its expenditures by imposing taxes on the private households, firms, imports, and exports. The private households, firms, and governments in different regions interact through trade.

In the model there is a global component consisting of global transportation and banking. The global transportation sector redeems its service with the difference between the f.o.b. (free on board) and c.i.f. (cost, insurance, and freight) values for a particular commodity shipped along a specific route. The global bank allocates the investment good to all firms according to global savings and rate of returns to capital.

The GTAP database version 4 was used with a base year of 1995. The database constructed primarily from regional I/O tables and trade and protection datasets contained 45 regions/countries and 50 sectors or commodity groups. Hertel provided detailed explanations of the GTAP model and database [10].

The standard GTAP model was modified for the purpose of this study. The regions/countries were further aggregated into five regions: the U.S., the rest of developed countries, oil exporting countries, the Former Soviet Union, and the rest of the world (ROW). Each region's economy was divided into ten sectors: agriculture, forestry, wood and paper products, coal, oil, natural gas, electricity, the rest of secondary energy, manufacturing, and services. These sectors were aggregated according to Standard Industrial Classification (SIC) codes. The regional and sectoral aggregations reflected our study emphasis on the energy (fossil and biomass) sectors and the U.S. economy.

Three input factors--land, labor, and capital were considered. Land supply was fixed although it could be allocated to different uses/sectors. Labor was assumed to be perfectly mobile between sectors in each region, but completely immobile among regions. Capital was considered to be perfectly mobile across sectors and regions.

Running a CGE model usually involves model calibration using a base year data and projection of changes in endogenous variables against their benchmark levels in the base year after introducing a policy shock. The shock variables used in this analysis were carbon emission taxes on fossil fuels and import tariffs on oil (equivalent to energy security premiums).

2.2 Carbon tax

Imposing taxes on carbon emitted from fossil energy consumption has been a policy instrument proposed to curtail greenhouse gas emissions. Taxes on carbon emissions are likely to increase the prices of fossil fuels. A range of carbon tax rates in $25/Mg increments was simulated in our model. Taxes on coal, oil, and natural gas were derived based on their carbon equivalents emitted from combustion (Table 1). No tax was imposed on bioenergy produced from woody and herbaceous crops and logging residues because the net carbon emissions from bioenergy are negligible compared to fossil fuels [15]. To be consistent with the unit used in the CGE model, the carbon tax rates were converted to percentages of the energy value as follows:

$$\text{Carbon tax rate (\%)} = CE \div P \times CT \times 100\%$$

where
CE = the carbon equivalent of CO_2 emissions from combustion (Mg/GJ);
P = the price of the fossil fuel ($/GJ);
CT = carbon emission tax ($/Mg).

To avoid inflation effects and the inconsistency of the base years used in different data sources, all values reported here were measured in 1995 dollars unless otherwise specified.

Table 1. Carbon coefficients for selected fossil energy.

Energy Type	CO_2 Emission from Combustion (CO_2 Mg/GJ)	Carbon Equivalent from Combustion (C kg/GJ)
Coal	0.085	24.32
Oil	0.066	19.29
Natural Gas	0.047	13.71

Source: US Environmental Protection Agency [24].

2.3 Energy security premium

Too much reliance on foreign energy supply would affect national energy and economic security. However, national security is a public good. The energy price in a competitive market does not reflect national security cost because individual importers have no incentive to consider our collective national security interests when deciding on how much to import. The effect of national security on oil supply, import, and price is illustrated in Figure 1. Adding a national security premium (τ) to imported oil will shift the foreign oil supply curve upwards from S_f to $S_f{'}$. With the domestic supply curve (S_d) unchanged, the total supply curve will then shift from S_t to $S_t{'}$. Given the demand (D) for oil, the domestic market price will increase from P to P´, domestic production (demand for domestic oil) will go up from Q_d to $Q_d{'}$, but the quantity of imports will drop from Q_f to $Q_f{'}$. As a result, the oil self-sufficiency rate measured by the proportion of the domestic production (Q_d) to the total quantity demanded (Q_t) will increase. In other words, to ease the dependence on foreign oil by reducing imports will cause domestic oil price to rise. The increase in oil price reflects the national security premium shared by energy consumers.

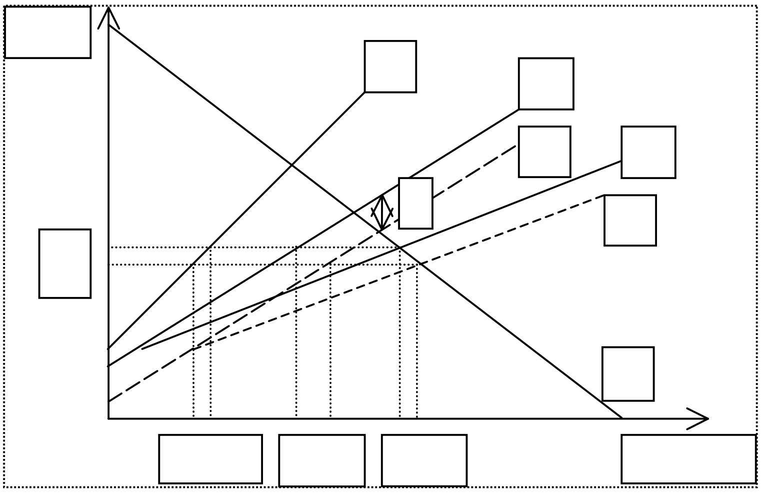

Figure 1. Effect of national security premium on oil price, import, and domestic production.

Notes: τ is the national security premium for oil import. D is the demand curve for oil. S_d, S_f, and S_t are respectively the domestic, foreign, and total oil supply without consideration of the national security premium. S_f' and S_t' are respectively the foreign and total oil supply after adding the national security premium. P and P´ are respectively the domestic market prices of oil without and with the inclusion of the national security premium. Q_d and Q_d' are respectively the quantity demanded for domestic oil before and after adding the national security premium. Q_f and Q_f' are respectively the quantity of oil imported before and after adding the national security premium. Q and Q´ are respectively the total amount of oil demanded by domestic consumers before and after adding the national security premium.

In this analysis, using the GTAP data we first estimated the oil self-sufficiency rate in the base year, which was 0.51. Then, various oil-sufficiency rates including 0.6, 0.7, 0.8, 0.9, and 1.0 were simulated. By altering the security premium (τ) to reach a targeted self-sufficiency rate, we simulated the effects of the increases in oil self-sufficiency on energy prices. In addition to their separate effects, the combined effects of both carbon taxes and energy security were also analyzed. For each level of the carbon tax, we simulated energy price changes under different oil-sufficiency rates.

2.4 Comparisons of fossil and biomass energy production

The comparative analysis was based on three forms of energy production: feedstock production, electricity generation, and ethanol conversion. Three major energy crops--hybrid poplar, hybrid willow, and switchgrass were considered. The lifetime, the time span from initial establishment (planting) to final harvest, was presumed to be 7 years for poplar, 22 years for willow, and 10 years for switchgrass. For poplar, its rotation length was also 7 years. Willow was harvested first at the end of the fourth growing season and every three years thereafter.

Switchgrass was harvested annually with the first harvest occurring at the end of the second year. After each rotation, they were reestablished.

Biomass yields and production costs were derived primarily from the Oak Ridge Energy Crop County Level Database (ORECCL) [8]. The production costs included those of establishment, annual maintenance and management, harvest, and land rent. Both fixed and variable costs were incorporated. Land rent was assumed to be $123.5/ha/yr, reflecting the national average Conservation Reserve Program (CRP) rent for the land used for energy crop production. Because this study was intended to assess the general competitive status of biomass energy, national average production costs and biomass yields were used. To estimate the national average production cost for each energy crop, we first identified the median production cost in each biomass producing county listed in the ORECCL database. The mode of the counties' median costs was then determined and used as the national average production cost. The same approach was used to estimate the national average biomass yield, which was 11.21 dry Mg/ha/yr (5 dry tons/ac/yr) for poplar and 13.45 dry Mg/ha/yr (6 dry tons/ac/yr) for willow and switchgrass. Two other yield scenarios including 50% and 100% increases from the base yields were also considered for sensitivity analysis. The production costs were adjusted for yield differences based on the average marginal effect of biomass yield on production costs estimated using the ORECCL data. All costs incurred during the rotation period were annualized using a 6.5% real discount rate.

In addition to energy plantations, recovering biomass for energy from logging residues was also analyzed. The procurement costs of logging residues from conventional forests were derived mainly from Puttock [20]. An integrated harvesting system was used to harvest both conventional wood products and fuel wood from logging residues. The system involved a feller-buncher/grapple to skid whole trees to landing, flail processing at landing, and a tub-grinder for residue comminution. The costs were estimated in two approaches: the joint cost and the marginal cost. In the joint cost approach, the total production costs were distributed between the conventional wood product (pulpwood) and fuel wood. On the other hand, in the marginal cost approach only additional costs from the conventional operation were counted for fuel wood production costs. No stumpage values were allocated to fuel wood in both approaches.

The energy contents were assumed to be 19.19 GJ/dry Mg (16.5 million Btus per dry ton) for the woody biomass and 16.86 GJ/dry Mg for switchgrass (14.5 million Btus per dry ton), respectively. The production costs were calculated based on per unit energy produced, which were then compared to the national average wellhead price of coal in the base year and under various carbon tax and energy security scenarios.

Three electricity generation systems were analyzed: biomass gasification combined cycle, conventional pulverized coal, and integrated coal gasification combined cycle. The costs and performance characteristics of these systems, adopted from Energy Information Administration (EIA) [6], are presented in Table 2. All three systems were assumed to operate at commercial scales for 20 years. The costs included the initial capital investment and those for operation and maintenance. The fuel cost was determined based on the price of delivered biomass and coal to power plants. The delivery cost for woody and grass crops was estimated at $8.27/dry Mg ($7.5 per dry ton) with an average transportation distance of 120 km. It was assumed that 6% of the biomass was lost during storage and transport. The national average price of coal received by power plants was derived from EIA. Using these data, the costs of per unit electricity generated from each system were estimated. The electricity production costs of the biomass gasification combined cycle system were then compared with those of the conventional pulverized coal system and the integrated coal gasification combined cycle system.

For ethanol production, we attempted to estimate the costs of ethanol conversion from woody biomass and switchgrass using the lignocellulose-to-ethanol process. Because the commercial operation of ethanol conversion from woody biomass has virtually not emerged, our analysis was based on existing published research findings and assumptions about advances in ethanol production technologies. McAloon and others predicted the ethanol conversion costs from corn stover based on a process and economic model of the conceptual lignocellulose-to-ethanol process developed by the National Renewable Energy Laboratory (NREL) [16]. Our assessment was an analogy to their cellulose-to-ethanol process analysis. The production facility was assumed to be designed solely for ethanol production, produce 94.6 million liters (25 million gallons) of ethanol annually, and operate for 10 years. The conversion technology to be used was the enzymatic hydrolysis process. It was also assumed that the initial capital investments and overhead costs of ethanol production using switchgrass and woody biomass were similar to those using corn stover because no other better estimate was available. The variable operating costs were adjusted based on the delivered price and ethanol conversion rate of feedstocks. The delivered prices of switchgrass and woody biomass calculated previously in electricity production were used. The estimated ethanol conversion rate was 417 liters per dry metric ton (100 gl/dry ton) for poplar, willow, and logging residues and 300 liters per dry Mg (72 gl/dry ton) for switchgrass. No by-product credit was included in the economic analysis. The estimated ethanol conversion costs were compared with the gasoline production cost derived from EIA to evaluate the cost effectiveness of ethanol production.

Table 2. Cost and performance characteristics of electricity generating systems.

Cost and Characteristics	Conventional Pulverized Coal	Integrated Coal Gasification Combined Cycle	Biomass Gasification Combined Cycle
Size (mW)	400	428	100
Total overnight cost ($/kW)	1,119	1,338	1,725
Variable operation and maintenance (O&M) cost ($ mills/MJ)	0.94	0.22	0.81
Fixed O&M cost ($ mills/MJ)	6.50	9.08	12.49
Heat rate (MJ/kWh)	9,903	8,302	9,402

Source: Energy Information Administration [6].

3 Results

3.1 Impact of carbon taxes and oil import reductions on energy prices

According to our simulation results, imposing carbon taxes would increase the prices of coal, oil, and natural gas. Reductions in oil imports would cause oil prices to rise while generating relatively small impacts on coal and natural gas prices. Given our emphasis on ethanol conversion and electricity production where coal is the dominant fuel, only coal and oil prices are reported here. The coal price in the U.S. market would go up by about 51% for each $25/Mg carbon emission tax imposed (Figure 2). Increases in oil self-sufficiency would have a negligible impact on coal price, meaning that substitution between coal and oil in U.S. current energy consumption is limited. U.S. oil price would go up with increases in the carbon tax and reductions in oil imports. Without a carbon tax, for each 10% increase in the oil self-sufficiency rate, U.S. domestic oil price would rise by some 22%. The effect of oil self-sufficiency on oil price would reduce gradually with increases in the carbon tax. At the current oil self-sufficiency rate, oil price would rise by almost 11% for a $25/Mg carbon tax. The marginal impact of the carbon tax on oil price would diminish slightly as the oil self-sufficiency rate increases (Figure 3).

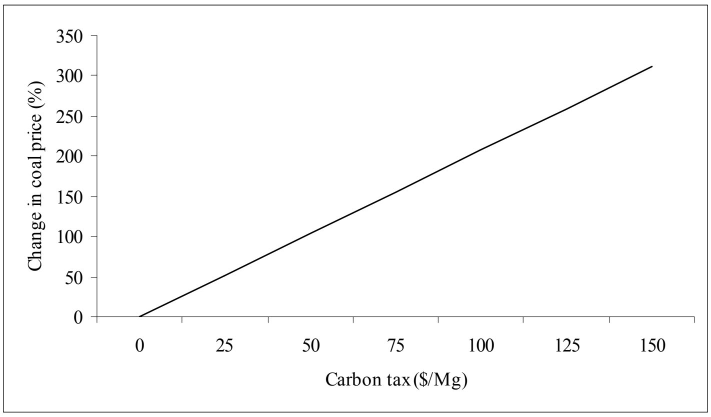

Figure 2. Effect of carbon tax on coal price.

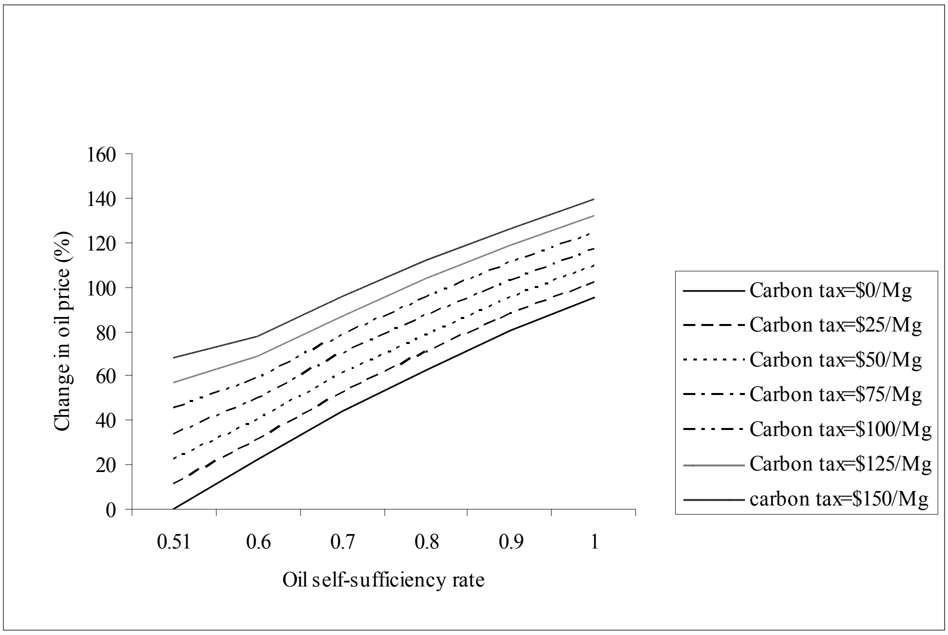

Figure 3. Effect of carbon tax and oil import reductions on oil price.

3.2 Biomass production

To assess the economic efficiency of the biomass energy production systems identified in the previous section, we compared the biomass production costs (annualized farm gate costs) with the wellhead price of coal. At current yields, the estimated biomass production costs range from $2.69/GJ for hybrid poplar, to $2.05/GJ for hybrid willow, and to $1.74/GJ for switchgrass. Obviously, all three energy crops have no cost advantage over coal under the current market conditions. Given the current price of undelivered coal at around $0.80/GJ, the biomass production costs have to be reduced by 55-70% in order to be able to compete with coal. Without significant reductions in biomass production costs, yields should substantially increase. The yields at which biomass produced from energy plantations would be comparable with coal should be at least 38 dry Mg/ha/yr for poplar, 36 dry Mg/ha/yr for willow, and 30 dry Mg/ha/yr for switchgrass, respectively (Figure 4).

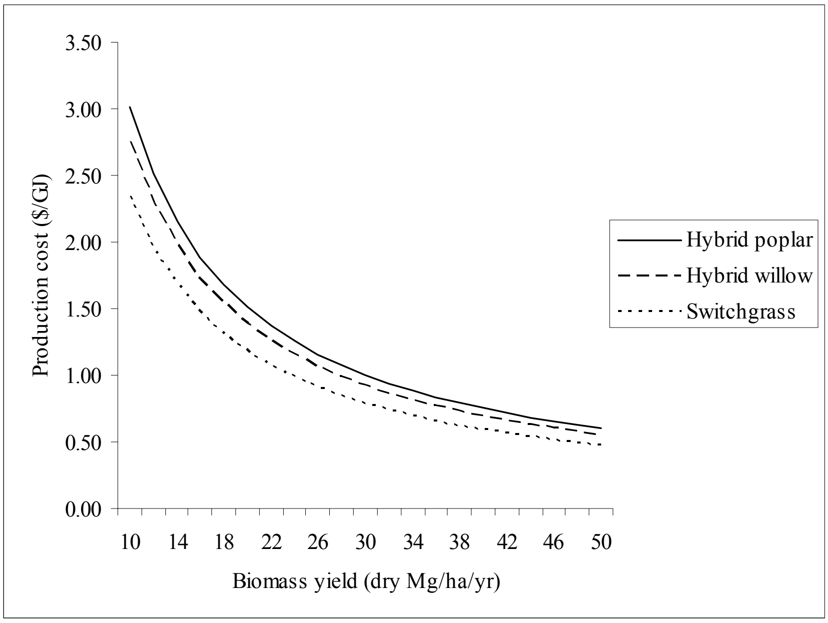

Figure 4. Biomass production costs at different yields.

Imposing a carbon tax would enhance the competitiveness of biomass energy production. At current yields and production costs, switchgrass and willow would become competitive with coal if the carbon tax rate is about $75 per metric ton of carbon emitted. Coal would be more cost effective than hybrid poplar unless the carbon tax is close to $125/Mg (Figure 5).

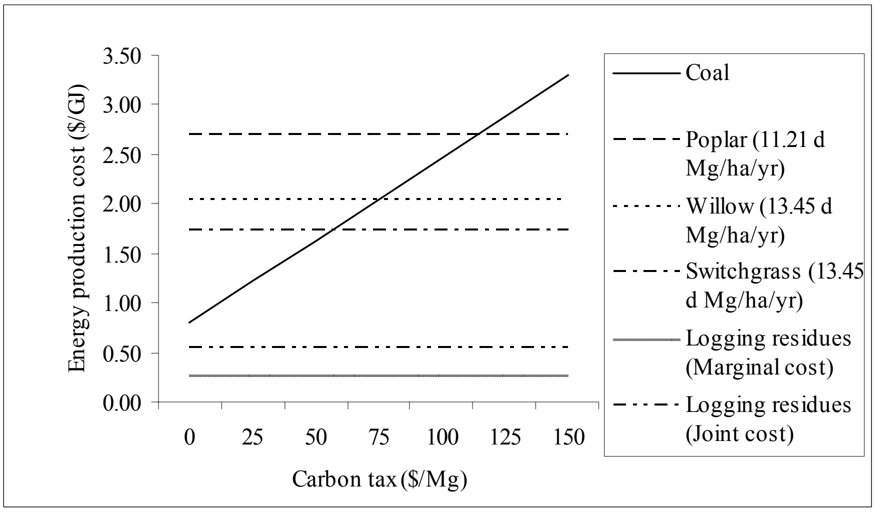

Figure 5. Production costs of undelivered biomass and coal at different carbon tax rates.

An increase in biomass yield would improve the cost effectiveness of biomass energy production. Switchgrass and hybrid willow would be able to compete with coal at a carbon tax of less than $50/Mg if yields rise to about 20 dry Mg/ha/yr. A further increase in yield to near 27 dry Mg/ha/yr would make them competitive at a carbon tax of around $25/Mg. Similarly, the energy production costs of hybrid poplar and coal would be comparable at a $75 carbon tax when poplar yield increases to 16.81 Mg/ha/yr, and at about $50/Mg when it reaches 22.42 Mg/ha/yr.

The production of biomass for energy from logging residues using the integrated harvesting system seemed more economical. The estimated marginal costs of procuring fuel wood from logging residues were $0.26/GJ, and the full costs (excluding the stumpage values) were about $0.54/GJ (Figure 5). Even though these costs were relatively low, the transportation costs of biomass would be much higher than coal on a per unit energy basis. The economic comparison of delivered biomass and fossil fuels in secondary energy production will be discussed later. Other benefits and costs may also arise from the removal of logging residues. These benefits include, among others, reductions in site preparation and planting costs, and fire and disease risks. The potential adverse effect is the concern about the loss of soil productivity. Due to data limitations, these benefits and costs were not incorporated in this analysis.

3.3 Electricity generation

The electricity generation costs using the conventional pulverized coal system and the integrated coal gasification combined cycle system were estimated to be \$0.0084/MJ and \$0.0083/MJ, respectively. The biomass gasification combined cycle system fueled by poplar biomass would produce electricity that was almost twice as expensive as the coal conventional or gasification system. Compared to the integrated coal gasification system, the biomass gasification system would cost more in all categories, particularly in the initial capital expenditure and fuel. The fuel cost made up almost half the total electricity cost in the biomass gasification system while it was only about one-third of the total cost in the coal conventional or gasification system (Table 3). Therefore, to reduce the fuel cost through increasing the productivity and efficiency of the biomass production and transport systems would have significant implications for enhancing the competitiveness of the electricity generated from biomass. The effect of biomass price on the electricity production costs is shown in Figure 6. For a \$10/Mg reduction in biomass price, the electricity production costs would fall by 0.136 cents/MJ.

The non-fuel costs (capital and maintenance and operation costs) of electricity generation fired by biomass were almost the same as the total costs in the coal conventional and gasification systems. Therefore, without improvements in electricity generation technology or/and inclusion of social costs, it would be impossible for biomass to compete with coal in electricity production. Excluding social/environmental benefits, if the non-fuel costs are reduced by 25% biomass would be able to compete with coal at a delivered price of \$15/dry Mg or lower. This is achievable with logging residues if only the marginal costs are counted.

Table 3. Electricity generation costs (\$/MJ).

System	Capital Cost	Variable O&M	Fixed O&M	Fuel Cost	Total Cost
Coal					
Conventional pulverized coal	0.0037	0.0009	0.0009	0.0029	0.0084
Integrated gasification combined cycle	0.0045	0.0002	0.0012	0.0024	0.0083
Biomass gasification combined cycle					
Hybrid poplar (Yield = 11.21 Mg/ha/yr)	0.0057	0.0007	0.0017	0.0081	0.0162
Hybrid willow (Yield = 13.45 Mg/ha/yr)	0.0057	0.0007	0.0017	0.0065	0.0146
Switchgrass (Yield = 13.45 Mg/ha/yr)	0.0057	0.0007	0.0017	0.0058	0.0139
Logging residues (Marginal cost)	0.0057	0.0007	0.0017	0.0018	0.0099
Logging residues (Joint cost)	0.0057	0.0007	0.0017	0.0026	0.0107

Note: All costs except the biomass fuel cost are derived from Energy Information Administration [6].

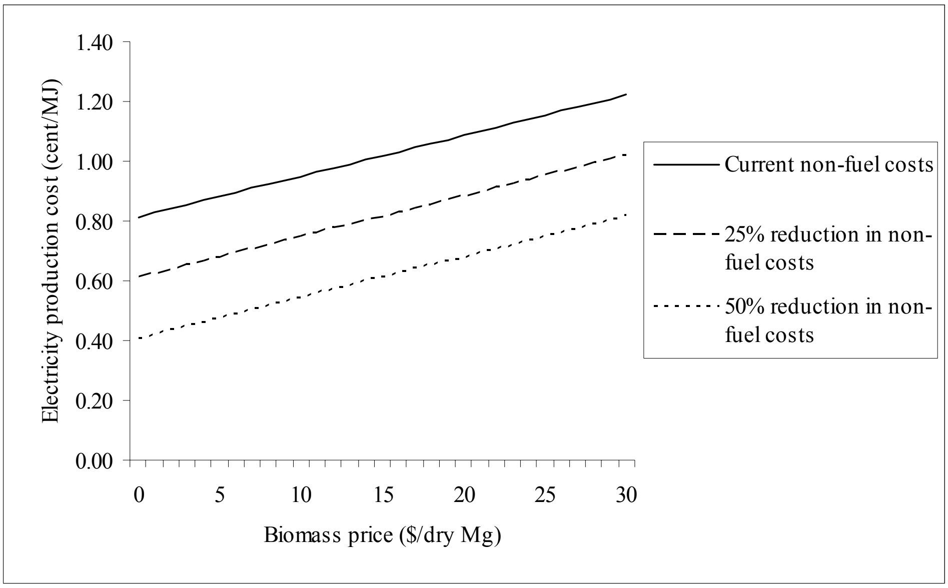

Figure 6. Effect of biomass price on electricity production costs.

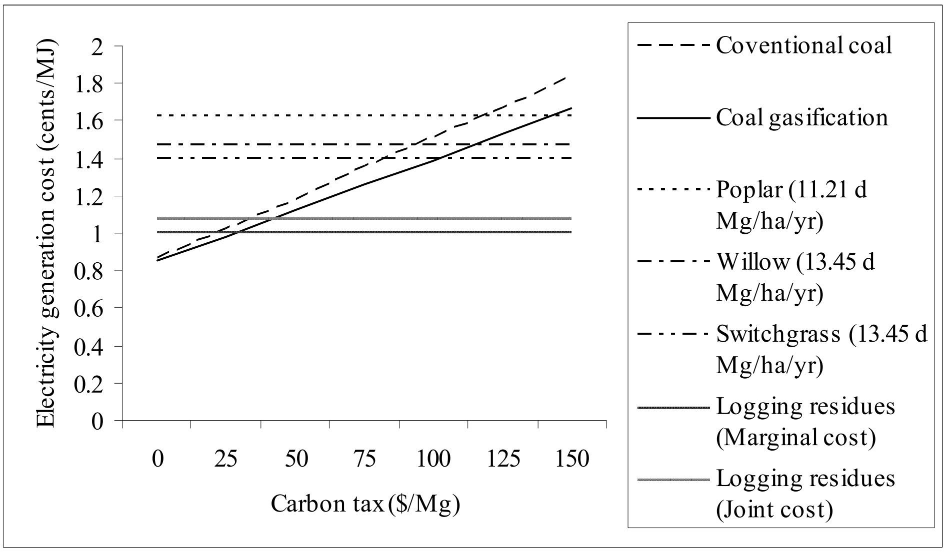

Figure 7. Electricity generation costs using coal and biomass at different carbon tax rates.

Biomass procured from logging residues appeared to be more cost effective than energy plantations. Imposition of a carbon tax between $25-50/Mg would enable logging residues to be comparable with coal. With current average biomass yields and electricity generation technology, for energy plantations to become competitive with coal in electricity production, at least $100/Mg carbon tax would be required for switchgrass, $125/Mg for hybrid willow, and $150/Mg for hybrid poplar. If the current average yield doubles, i.e. it reaches 26.90 Mg/ha/yr for hybrid willow and switchgrass, they would be able to compete with coal at a $75/Mg carbon tax. So would be hybrid poplar at a $100/Mg carbon tax if its yield increases to 22.42 Mg/ha/yr (Figure 7).

Biomass would become quite a promising fuel for electricity generation with improved technology and the consideration of social/environmental costs of CO_2 emissions from fossil fuels. If the non-fuel costs are reduced by 25% and if carbon emissions are taxed at $25/Mg, a biomass price of $30/Mg would make it competitive with coal. This price exceeds the estimated full costs of delivered logging residues and is very close to the costs of delivered hybrid poplar and willow if their yields double.

3.4 Ethanol production

The estimated costs of producing ethanol from different energy crops under current biomass productivity and conversion technology were quite similar. They would all be above $0.35/L, almost twice as high as the gasoline production cost. Even the production costs using logging residues were close to $0.30/L (Table 4). Although the biomass feedstocks cost less than crude oil, ethanol conversion costs under existing technology far surpass gasoline refining costs. Reductions in biomass feedstock costs would have very limited effects on total ethanol production costs. For a reduction of $10/Mg in biomass price, ethanol production costs would drop by only 2.25 cent/L (Figure 8). Ethanol produced from biomass would be hard to compete with gasoline without a breakthrough in ethanol conversion technology or a significant increase in crude oil price. The required biomass price at which ethanol could be comparable with gasoline would be about $25/Mg if the ethanol conversion costs can be slashed by a half.

Table 4. Costs of ethanol conversion from biomass using the cellulose-to-ethanol process ($/L).

Biomass and Yield	Feedstock Cost	Conversion Cost	Total Cost
Hybrid poplar @11.21 Mg/ha/yr	0.130	0.251	0.381
Hybrid poplar @16.81 Mg/ha/yr	0.105	0.251	0.356
Hybrid poplar @22.42 Mg/ha/yr	0.093	0.251	0.344
Hybrid willow @13.45 Mg/ha/yr	0.103	0.251	0.354
Hybrid willow @20.17 Mg/ha/yr	0.080	0.251	0.331
Hybrid willow @26.90 Mg/ha/yr	0.068	0.251	0.319
Switchgrass @13.45 Mg/ha/yr	0.126	0.251	0.377
Switchgrass @20.17 Mg/ha/yr	0.109	0.251	0.360
Switchgrass @26.90 Mg/ha/yr	0.100	0.251	0.351
Logging residues (Marginal cost)	0.030	0.251	0.281
Logging residues (Joint cost)	0.042	0.251	0.293

Note: The conversion costs are derived from DiPardo [3] and McAloon et al. [16].

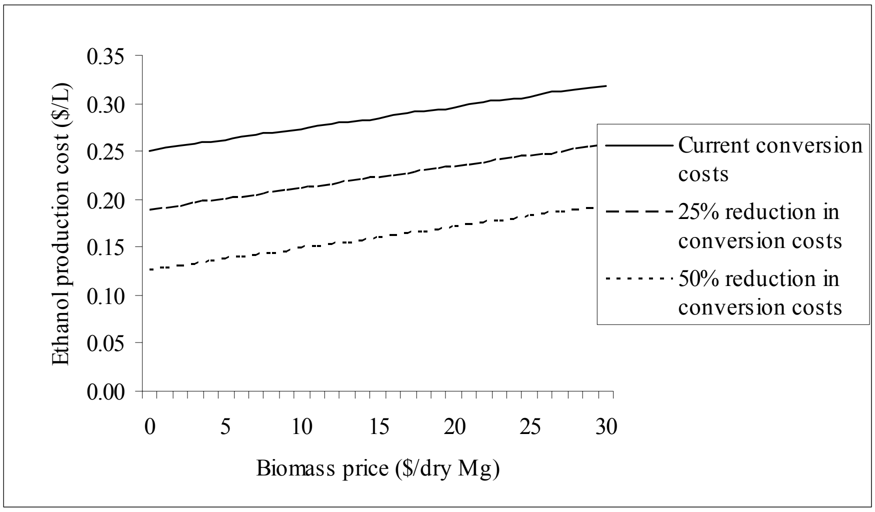

Figure 8. Effect of biomass price on ethanol production costs.

Incorporation of carbon benefits and energy security would enhance the competitiveness of ethanol (Figure 9). Under the current oil self-sufficiency rate, ethanol production using biomass from energy plantations would be competitive with gasoline only if carbon emissions are taxed at $300/Mg or higher. If the proportion of domestic oil in the total oil consumption reaches 70%, the production costs of ethanol and gasoline would be equivalent at a carbon tax of $250/Mg. When the oil self-sufficiency rate reaches 90%, ethanol would be competitive with gasoline at a $175/Mg carbon tax.

Increases in biomass yield would help elevate the competitiveness of ethanol modestly. If the current biomass yield doubles, a carbon tax of $275/Mg would make ethanol production from biomass as cost-effective as gasoline even under the current oil self-sufficiency rate. The carbon tax rate that would enable ethanol to compete with gasoline would drop to around $200/Mg with a 70% oil self-sufficiency rate and to $125/Mg with a 90% oil self-sufficiency rate.

Biomass recovered from logging residues showed better potential in ethanol production than energy crops due to the relatively low feedstock cost. Even without carbon taxes, ethanol produced from logging residues could compete with gasoline if the oil self-sufficiency rate approaches 90%. At an oil self-sufficiency rate between 60% and 70%, a carbon tax of $100/Mg would enable ethanol converted from logging residues to compete with gasoline.

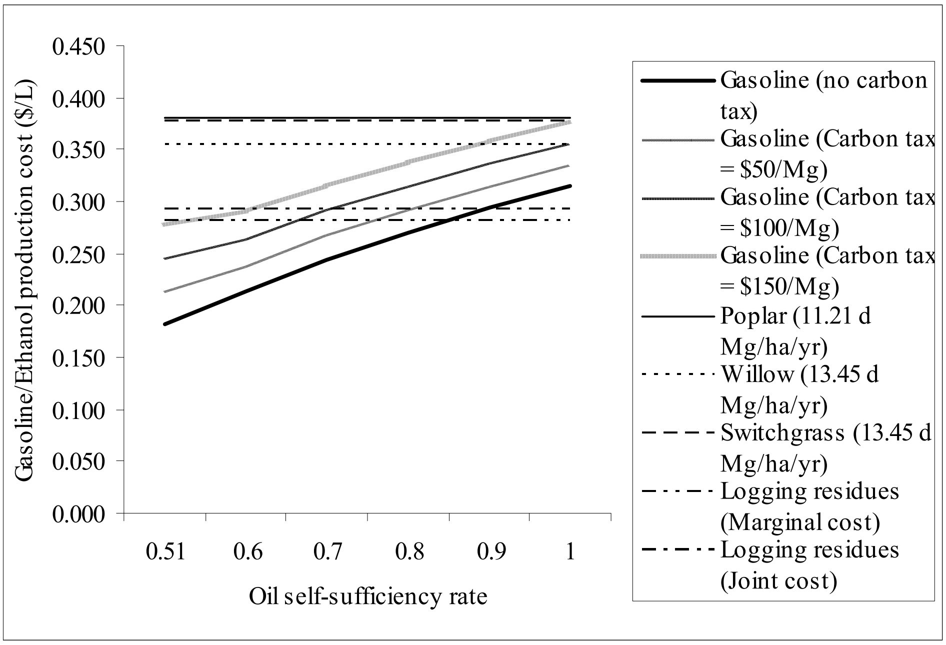

Figure 9. Ethanol and gasoline production costs at different carbon tax and oil self-sufficiency rates.

If carbon tax, energy security, and technology advance are all considered, ethanol would have much better potential to compete with gasoline. For instance, with a carbon tax of $25/Mg, a 70% oil self-sufficiency rate, and a 25% reduction in ethanol conversion costs, a biomass price of $30/Mg would enable ethanol to become competitive with gasoline. Again, this is feasible for logging residues as well as energy plantations if yields can be significantly increased.

4 Concluding Remarks

Increasing concerns about atmospheric CO_2 concentration and energy security have further aroused our interest in biomass energy. Biomass energy produced from woody and herbaceous plants is thought to be nearly CO_2 neutral. Being able to capture and sequestrate carbon in the atmosphere, biomass is emerging as a means to mitigate CO_2 emissions from fossil fuels. Meanwhile, there is a significant amount of idle and marginal agricultural land suitable for biomass production in the U.S. In addition to environmental benefits, using these lands for biomass energy production would benefit rural communities by creating jobs and income. Ethanol produced from biomass may substitute for gasoline, reducing oil imports and ultimately the nation's economic and energy vulnerability caused by heavy dependence on foreign oil.

This study focused on the comparative analysis of biomass and fossil energy in the U.S. under several scenarios of carbon taxes and reductions in oil imports. Imposing a carbon tax would significantly increase U.S. market prices of coal and oil. Reductions in oil imports would boost oil price, but would have a relatively small impact on coal price. The comparison of the annualized farm gate cost of biomass with the wellhead price of coal indicated that biomass from energy plantations, even at current average yields, would become competitive if carbon emissions are taxed at a rate ranging from $75/Mg to $125/Mg. For a 50% increase in yield, the carbon tax at which biomass could compete with coal would reduce by approximate $25/Mg. Similarly, coal is more cost effective than biomass for electricity generation under current technology and market conditions. For a carbon tax between $100/Mg and $150/Mg, biomass would be able to compete with coal. Ethanol produced from biomass would be even less competitive with gasoline due to the relatively low oil price and immature ethanol conversion technology. At the current oil self-sufficiency rate (about 51%) and market and technology conditions, ethanol converted from biomass harvested from energy plantations would be unable to compete with gasoline unless carbon emissions are taxed at $300/Mg or higher. The carbon tax at which ethanol would become competitive with gasoline would decrease at a progressive rate as the oil self-sufficiency rate increases.

Compared to energy plantations, biomass recovered from logging residues using integrated harvesting systems showed better potential for energy production. The electricity generation costs using coal and logging residues would be comparable at a carbon tax between $25/Mg and $50/Mg. Using logging residues to produce ethanol would be economically feasible at a carbon tax of around $150/Mg. Lower carbon taxes would be required if higher oil self-sufficiency is desired.

Though carbon taxes and reductions in oil imports would strengthen the competitiveness of biomass energy, costs would still be the major impediment for biomass energy to substitute for fossil fuels. Advances in power generation and ethanol conversion technologies and improvements in the productivity of biomass production, harvesting, and transport systems are clearly the key to enhancing the bioenergy share in U.S. energy markets. With improved technologies and inclusion of more social benefits/costs in energy production and consumption decision-making, biomass energy would promise to be an alternative, cost-effective energy source. The competitive status of biomass energy under different technological progress, carbon emission tax, and oil self-sufficiency scenarios is presented in the Appendix (Tables 5-16).

This analysis incorporated existing findings on the economics of biomass energy production in the U.S. and was in general based on conservative biomass production costs and energy prices. Due to the unavailability of data on commercial operations of electricity and ethanol production using biomass, our analysis was based on the best estimates from the existing published works. Because the averages of the county-level data were used in the analysis, our results represented national average production costs, but might not reflect regional variations or special cases. Local, niche markets may be sufficiently different from the national average results. Indeed, bioenergy is already competitive in some local markets or under certain circumstances. Furthermore, many factors influence energy prices. Energy prices do fluctuate from time to time due to economic and non-economic reasons. In fact, energy prices have climbed significantly since 1995, the base year used in this analysis. This further indicates that our results are conservative estimates. Hopefully, this study has provided a general picture about the competitive status of biomass energy in the U.S. under the consideration of potential carbon taxes and reductions in oil imports. Further studies are suggested to incorporate other relevant economic, institutional, and technical factors into the analysis and to periodically update the economic evaluation as technologies for biomass production and energy conversion advance.

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Appendix - Competitive status of biomass energy relative to coal and gasoline.

Table 5. Competitive status of biomass relative to coal in electricity generation (gasification combined-cycle) at current delivered feedstock costs.

Carbon emission tax ($/Mg)	Percentage reduction in non-fuel costs			
	0	10	25	50
0			Logging residues (Marginal cost)	Logging residues (Marginal or joint cost)
25	Logging residues (Marginal cost) [a]	Logging residues (Marginal cost)	Logging residues (Joint cost)	
50	Logging residues (Joint cost)	Logging residues (Joint cost)		Willow/Switchgrass
75			Willow/Switchgrass	Poplar
100		Willow/Switchgrass	Poplar	
125	Willow/Switchgrass	Poplar		
150	Poplar			

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.

Table 6. Competitive status of biomass relative to coal in electricity generation (gasification combined-cycle) with a 10% reduction in delivered feedstock costs.

Carbon emission tax ($/Mg)	Percentage reduction in non-fuel costs			
	0	10	25	50
0			Logging residues (Marginal or *joint* cost)	Logging residues (Marginal or joint cost)
25	Logging residues (Marginal cost) [a]	Logging residues (Marginal or *joint* cost)		*Willow/Switchgrass*
50	Logging residues (Joint cost)			*Poplar*
75			Willow/Switchgrass	
100	*Willow/Switchgrass*[b]	Willow/Switchgrass	Poplar	
125	*Poplar*	Poplar		
150				

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.
[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 5.

Table 7. Competitive status of biomass relative to coal in electricity generation (gasification combined-cycle) with a 25% reduction in delivered feedstock costs.

Carbon emission tax ($/Mg)	Percentage reduction in non-fuel costs			
	0	10	25	50
0			Logging residues (Marginal or joint cost)	Logging residues (Marginal or joint cost)
25	Logging residues (Marginal cost) [a]	Logging residues (Marginal or joint cost)		Willow/Switch grass
50	Logging residues (Joint cost)		*Willow/Switch grass*	Poplar
75		*Willow/Switch grass*[b]	*Poplar*	
100	Willow/Switch grass	*Poplar*		
125	Poplar			

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.
[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 6.

Table 8. Competitive status of ethanol relative to gasoline at current delivered feedstock costs and oil self-sufficiency rate (51%).

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0				Logging residues (Marginal or joint cost)
25				
50				
75			Logging residues (Marginal cost)	Willow/Switchgrass
100			Logging residues (Joint cost)	
125		Logging residues (Marginal cost)[a]		Poplar
150		Logging residues (Joint cost)		

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.

Table 9. Competitive status of ethanol relative to gasoline with a 10% reduction in delivered feedstock costs and at current oil self-sufficiency rate (51%).

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0				Logging residues (Marginal or joint cost)
25				
50				
75			Logging residues (Marginal or *joint* cost)	Willow/Switchgrass
100				*Poplar*
125		Logging residues (Marginal or *joint* cost)[a, b]		
150				

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.
[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 8.

Table 10. Competitive status of ethanol relative to gasoline with a 25% reduction in delivered feedstock costs and at current oil self-sufficiency rate (51%).

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0				Logging residues (Marginal or joint cost)
25				
50			*Logging residues (Marginal cost)*	*Willow/Switchgrass*
75			Logging residues (Joint cost)	*Poplar*
100				
125		Logging residues (Marginal or *joint* cost)[a, b]		
150			*Willow/Switchgrass*	

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.

[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 9.

Table 11. Competitive status of ethanol relative to gasoline at current delivered feedstock costs and a 60% oil self-sufficiency rate.

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0				Logging residues (Marginal or joint cost)
25			Logging residues (Marginal cost)	
50			Logging residues (Joint cost)	Willow/Switchgrass
75				
100		Logging residues (Marginal cost)		Poplar
125		Logging residues (Joint cost)		
150	Logging residues (Marginal cost)[a]			

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.

Table 12. Competitive status of ethanol relative to gasoline with a 10% reduction in delivered feedstock costs and at a 60% oil self-sufficiency rate.

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0				Logging residues (Marginal or joint cost)
25			Logging residues (Marginal cost)	*Willow/Switchgrass*
50			Logging residues (Joint cost)	
75				*Poplar*
100		Logging residues (Marginal cost)		
125		Logging residues (Joint cost)		
150	Logging residues (Marginal or *joint* cost)[a, b]		*Willow/Switchgrass*	

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.
[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 11.

Table 13. Competitive status of ethanol relative to gasoline with a 25% reduction in delivered feedstock costs and at a 60% oil self-sufficiency rate.

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0			*Logging residues (Marginal cost)*	Logging residues (Marginal or joint cost) and *willow/switchgrass*
25			*Logging residues (Joint cost)*	*Poplar*
50				
75		*Logging residues (Marginal cost)*		
100		*Logging residues (Joint cost)*		
125	*Logging residues (Marginal cost)*[a, b]		*Willow/Switchgrass*	
150	Logging residues (Joint cost)		*Poplar*	

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.
[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 12.

Table 14. Competitive status of ethanol relative to gasoline at current delivered feedstock costs and a 70% oil self-sufficiency rate.

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0			Logging residues (Marginal or joint cost)	Logging residues (Marginal or joint cost) and willow/switchgrass
25				
50		Logging residues (Marginal cost)		Poplar
75		Logging residues (Joint cost)		
100	Logging residues (Marginal cost)[a]		Willow/Switchgrass	
125	Logging residues (Joint cost)			
150				

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.

Table 15. Competitive status of ethanol relative to gasoline with a 10% reduction in delivered feedstock costs and at a 70% oil self-sufficiency rate.

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0			Logging residues (Marginal or joint cost)	Logging residues (Marginal or joint cost), willow/switchgrass, and *poplar*
25		*Logging residues (Marginal cost)*		
50		*Logging residues (Joint cost)*		
75	*Logging residues (Marginal cost)*[a, b]			
100	*Logging residues (Joint cost)*		Willow/Switchgrass	
125				
150			*Poplar*	

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.
[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 14.

Table 16. Competitive status of ethanol relative to gasoline with a 25% reduction in delivered feedstock costs and at a 70% oil self-sufficiency rate.

Carbon emission tax ($/Mg)	Percentage reduction in ethanol conversion costs			
	0	10	25	50
0			Logging residues (Marginal or joint cost)	Logging residues (Marginal or joint cost), willow/switchgrass, and poplar
25		Logging residues (Marginal cost)		
50		Logging residues (Joint cost)	*Willow/Switchgrass*	
75	Logging residues (Marginal cost)[a]			
100	Logging residues (Joint cost)		*Poplar*	
125				
150		*Willow/Switchgrass*[b]		

[a] "Marginal cost" indicates that only additional costs from the conventional timber (pulpwood) harvest were counted for fuel wood production, and "joint cost" means that the total production costs were distributed between the conventional wood product and fuel wood. No stumpage values were included.

[b] Biomass in italics indicates that its competitive status has been improved from the scenario specified in Table 15.

Establishing Community Based Wood Heat Supply Clusters in the Thames Valley

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Abstract

As yet, little renewable energy is currently used in the Thames Valley even though the technology is fairly well established. The difficulty lies with misinformation, lack of understanding and the complexities involved in the implementation of wood fuel systems in a competitive market dominated by other energy forms, rather than acceptance of wood fuel as a viable heating system. For the most part, people register concern over environmental issues, but this is not enough to engage them into readily accepting new technologies.

The regional dimension

The energy and environmental context in which communities and organisations can work and operate locally is important. To a large extent this context is set regionally and nationally. TV Energy has been working closely with the regional arm of government that is responsible for the Thames Valley area, the South East of England Regional Government Office, Assembly and Development Agency, to establish:

- The extent of the technical renewable energy resource (including biomass as the most important one) in the South East
- The potential credible exploitable resource
- Setting targets for 2010, 2016 and beyond
- Looking at partnerships and methods to gain local acceptance and draw in local groups

The regional strategy has now been published and can be seen via the TV Energy website at *www.tvenergy.org*. TV Energy is seen as a 'delivery vehicle' for change and is presented as a case study.

Building clusters

TV Energy has identified a series of organisations keen to become more sustainable and wanting to use biomass for heat and sometimes also for electricity generation. These 'end-users' range from local municipalities redeveloping large urban centres to eco-centres and local community buildings.

One such 'cluster' of eco-centres is being lead by developments at the 'Living Rainforest', an educational research Trust caring for a range of tropical flora and fauna in a purpose built environment close to Newbury, Berkshire. The Trust is working with TV Energy to redesign the site on energy efficiency principles coupled with renewables energy supply. In particular, using biomass heating (300kW boiler) to supply the entire heating needs of the establishment.

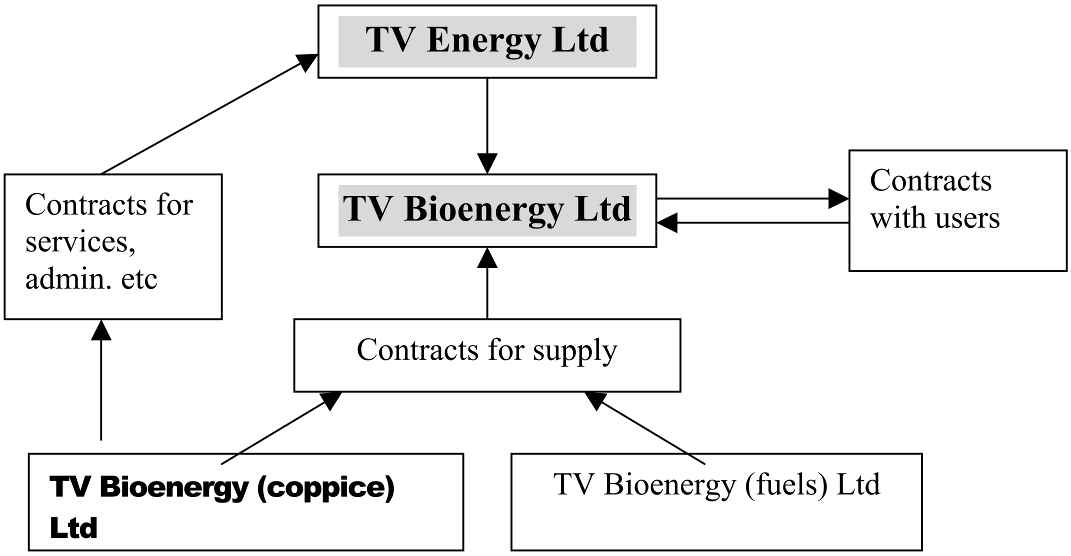
The intention is to link the upkeep of a tropical environment with the use and management of local woodlands. Very much on the 'think global, act local' idea. TV Energy and the Trust will develop joint educational activities for the area.

Such thinking will be applied to the other three sites that TV Energy has 'clustered'. This method of operation should also give the eco-centres an opportunity to network on other matters too – hopefully enhancing their operations and effectiveness.

Of course, clustering also allows us to more effectively develop a wood fuel supply infrastructure without which no projects can become a reality.

TV Energy is in the process of establishing a 'vertically integrated wood fuel supply infrastructure' for the region. This will allow woodland owners, operators, tree surgeons and others to join in and be a part of this new diversification opportunity. Companies based on the cooperative principal are being established for wood residues and for short rotation coppice. All will be linked contractually through 'TV Bioenergy'.

In exploring the *modus operandii* for us in this area it has become apparent that we will need to establish the following hierarchy of organisation:



Organisation to enable a wood fuel supply infrastructure to be developed for clustered projects in the Thames Valley and Surrey region

Empowering local communities

Overcoming 'non-technical' barriers will necessitate a structured framework identifying the stumbling blocks for the development of a wood fuel market. To address this issue, wood fuel projects will benefit from well managed consultations to build confidence and avoid scepticism in local communities. Consultation is important and beneficial to projects relating to wood fuel for energy production as it will improve the quality of the product by ensuring that expert advice and local knowledge are incorporated into the design, development and management of the scheme. By identifying, anticipating conflicts at a preliminary stage, major problems can be reduced, thus creating a positive image for the project as well as building public support.

The consultation process can be viewed as a three-pronged approach; through information dissemination, discussion and debate and decision-making. Information dissemination is vital in helping people to understand and accept the need for renewable technology. This can be carried out, using a wide range of communication methods such as leafleting, web-based material, exhibitions, public meetings and workshops to stimulate local dialogue as well as sociological analysis in the form of surveys, focus groups and in-depth interviews. Other possibilities that will help to inform the public are site visits, involvement of local schools and regular progress reports for public scrutiny.

Through discussion and debate, the criteria affecting people's decision of whether they want to pursue a community renewable energy project will emerge. History of past failures could have a decisive impact towards acceptance or rejection of any new initiative. Therefore to prepare for this possibility, an analysis should be made of all key groups and information collected on relevant social issues. Wood fuel as an industry may be a new concept for the local community to adjust to, therefore it is important that its visual appearance, likely impact and positive benefits are explained, highlighting the potential for increased local employment both in obtaining the fuel and in energy production. People need to have reassurance on the scale of the proposed industry, that it is regulated with minimum visual and environmental impact on the countryside, including the collection, drying, chipping, storage and transportation processes.

Using this approach encourages local communities to participate in the decision making process and has the advantage of gaining their longer term commitment to a project by developing a sense of ownership for both the resource and the sustainable energy product. With this relationship, there is likely to be a greater willingness from local people to protect and conserve the resource as well as promoting the energy produced. In some instances it may be possible for a formal partnership between the project developer, the community and other parties to be set up as a trust, to jointly manage the resource and energy generation plant.

Moreover, the opportunities of wood fuel should be placed in the broader context of energy policy, in order to gain widespread public understand and support for growing short rotation coppice or using forestry residue. It is therefore important that a clear link between global warming and renewable energy is given, in order to increase public acceptance. Individuals should be made to believe that they are key stakeholders in the development of renewable energy and through their actions as local champions they are contributing to Local Agenda 21 objectives as well as helping to meet national and international targets.

Conclusion

Recognising this method as the way forward, TV Energy has initiated community consultations in the Thames Valley through a series of workshops in the four counties of Berkshire, Buckinghamshire, Oxfordshire and Surrey. These were aimed at educating local communities about the potential for renewable energy projects in their respective areas. The workshops involved presentations on different renewable technologies and breakout groups to discuss the potential and obstacles posed for local renewable energy schemes. From the workshop groups and all other TVE events all feedback is being followed up to maintain continued community interest and to portray a sense of action. TV Energy believes that communities represent the potential catalysts for social change which can inject momentum and commitment into the wider acceptance of renewable energy across the UK. If green technology is to be deployed successfully to the extent required to meet government targets, community involvement will have a vital contribution to make.

For more information on how the TV Energy initiative is progressing please visit the TV Energy website at www.tvenergy.org. TV Energy is a 'not-for-profit' public-private sector partnership working in the interests of local people and communities in the Thames Valley and Surrey region of the SE of England.

Towards Sustainability: Four Models for Implementing Sustainable Strategies in the Swedish Energy Sector

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The Social Context of Energy Systems

When compared to many other western countries the development of the Swedish energy system has been characterized by a strong interrelation between the development and organization of the public sector and the development and organization of the energy sector. Since the social goods that the energy system has contributed with have been of great importance for the development of society, this interrelation has also been characterized by ideological interpretations about the desired direction and content of this societal development. (Kaijser, 1994:21). Because of changed economic circumstances and an increased environmental awareness during recent years these interpretations have been characterized by a market orientation as well as a discourse concerning sustainable development in society.

The orientation towards a *market-oriented public sector* began within the Swedish state and then diffused to the municipalities. This reinterpretation has expressed itself through a transition from a production orientation, bureaucracy and monopolies to a customer orientation, privatization and competition. The path has been via decentralization, customer-choice models, better planning routines and development of entrepreneurship (Hansson & Lind, 1998:16f). The drive towards a market-oriented public sector has resulted in great changes in the development of the energy system and, in turn, a massive reformulation of the institutional structures of the system.

The debate about a sustainable development first entered Swedish energy policy/politics during the spring of 1997 when the Swedish Parliament decided on new guidelines. Energy issues were linked to the government's overarching program of environmental policies. The goal of energy policies and the role of the public sector in the energy sector was reformulated (Lindquist, 2000:11). This can be seen in the efforts being expended to change existing patterns of production and consumption through the use of investment support, energy advisory

programs and support to research. The Swedish government also takes upon a different role: from direct control to the establishment of "the rules of the game". The public sector's influence over the development of the energy system has been divided between additional groups of which the municipalities and the newly established Swedish National Energy Administration are important actors.
To be able to change the energy system toward the direction of the goals of Swedish Parliament technical developments and a change of traditional ideas and conceptions in society will be required. These conceptualizations emerge from parts of a social context in which political and economic standpoints play an important role. Therefore it is important to study this context since this provides the preconditions for an evaluation of how steering mechanisms can be used and what effect they can achieve. In our opinion an understanding of the forces and mechanisms for change such as taxes, advice and lifestyles and an understanding of the context in which these forces and mechanisms act -- and will be acting -- in is required to lead and manage the changes in the energy system. When a process of change will be initiated and further developed it is therefore important to focus on how traditional conceptualizations and patterns of thought can be altered.

Purpose

The public sector in Sweden has charged its institutional structures with a new goal for societal development under the rubric "The Sustainable Sweden". This has been the result of international agreements that Sweden has entered into and domestic debates concerning the need for a sustainable development. The interaction between the public sector and the development of the energy system has entered a new phase. At the same time market reorientation has radically changed the public sector's possibilities to directly control the implementation of the sustainability goals in the energy system. Influence through ownership and the direct political control that this entailed has more or less been voluntarily phased out during recent years by governmental and municipal organizations. The desire for a change towards sustainable development has, however, meant that the public sector needs new ways to initiate, push for or support processes of change within the energy system in its new, multifaceted shape.

Therefore in this study we focus on the energy sector and the possibilities to development steering methods for a sustainable energy system by:

- Studying processes of change in different parts of the energy system with the purpose of identifying different forms for strategic change,
- Describing the pressures, barriers and possibilities which are made visible in these processes,
- Discussing and developing methods for managing and steering the processes of change.

Strategies for change processes in the public sector

In the understanding and analysis of change processes we use three types of strategy*: strategy as plan*, *strategy as pattern* and *strategy as perspective* (Mintzberg 1988;199). These ideal categories help us to understand and describe a complex reality. In actual, observable change processes it is rare to find strategies that exactly fit these categories. Instead the three types of strategy may coincide or serve as a complement to one another during the different steps of a process.

Actors who are engaged using a plan typology (strategy as plan) see strategies as a means to in advance and from rational foundations create guidelines and criteria for decision making to achieve a specific goal. The formulation of a strategy is perceived as a conscious and premeditated process in which formal documents are used to steer the actions of various actors towards a predetermined goal. There are many examples in Sweden where planning tools and a planning mentality have been used in the construction of modern society. During the construction of the energy sector these planning tools and mentality have had a strong position in Swedish law such as *Plan- och bygglagen* (SFS, 1987:10) and *Lagen om kommunal energiplanering* (SFS, 1977:432/1991:738).[1]

Strategy as pattern means a focus on the result of the various processes in which organizations or groups meet everyday reality and where such meetings tend to develop into lasting patterns of behavior. For actors using strategy as pattern the process of strategy is evolutionary. The strategy grows out of experimentation, development, implementation and evaluation. Those who use strategy as pattern thus strive to keep themselves open to a complex process. An open attitude and continuous feedback between the emerging way to work and new possibilities for change is therefore more important than a fixed plan of action.

Actors which use strategy as perspective focus on the importance that institutional structures have for strategic work (Bengtsson, 1993). These structures are a product of the history of the organization and the sub-systems that the organization consists of. The structures are made up of the common rules, norms and patterns of thinking which have grown from the common experiences of the organization as well as those supporting structures that have been at work within the organization. Institutional structures are supported by reward systems, recruitment policy, myths, organizational systems, systems of power and accepted descriptions of reality. With the perspective on change it becomes important to focus on the role of institutions in the efforts by organizations to be successful as well as how institutional structures could be used to carry and support strategies.

[1] In English translation these laws could be called The Plan and Building Act, Law concerning municipal energy planning (translator's note).

Patterns of strategy in change processes

By studying four process of change in three southern Swedish municipalities we have tried to map in which ways the three ideal strategies created patterns in and have been operationalized there. The municipalities -- Laholm, Växjö and Ängelholm -- all have different physical and institutional preconditions. Three of these change processes have been reconstructed written sources and interviews of key people involved during the changes. One of the processes, in Hjärnarp, has been studied from within during an on-going change process in which our project was directly involved.

The energy system in Laholm has undergone successive change through two efforts conducted in parallel: the construction of a biogas facility and an extensive promotion and development of wind power. The biogas project took its point of departure from the problems with eutrophication in Laholm Bay at the end of the 1980s and through a process of seeking and learning this problem and its solution could be connected with an energy project. The wind power development began when the energy company raised two wind power plants that then functioned as a model for private investments in wind power. Many different forms of partnerships and kinds of actors have been actively involved in the resulting developments and the significant emphasis on wind power in Laholm.

In both of these projects we find evidence of strategy as pattern. Parallel search and learning processes have been central driving forces that have successively lead towards new solutions in the whole system. The change processes can be characterized by flexibility, a spirit of entrepreneurship and openness towards various actors both within and outside the municipal public sector. Municipal resources have been mobilized to make the possibilities for change more visible -- for example by the active use of the municipal planning process and through a broad pattern of collaboration in various networks.

In Växjö the change process started with investments to solve the energy supply problems which became visible during the oil crises of the 1970s. After a time a municipal development project concerning energy from biomass grew out of the initial investments. Through the transition from oil to biomass, which took place in a number of small steps, a bioenergy culture arose and this culture's value for the development of the municipality and its surroundings became a unifying and powerful force. With an ever increasingly strong bioenergy culture as a base, the development of supporting systems for bioenergy began. Such support systems included the establishment of a local biofuel market, development of new knowledge of the sub-systems involved in bioenergy, and an active, local pricing policy and procurement. Through this work a broad-based and effective cooperation arose around clusters between different actors and a political vision with widespread and deep support.

In Ängelholm as well the changes in the energy system began with the energy crises. After two changes in fuel sources, a changed price structure and a supply agreement between the Ängelholm energy company and a supplier of natural gas the result was a physically and mentally locked situation. A management culture developed where the main purpose was to administer and maintain that which had been achieved with an eye to what was best for the citizens. The ability for the municipality to manage the situation in the best possible way and take responsibility for the continued welfare of its citizens has been the principle consideration and considerable weight has been attached to this. An important part of the municipal responsibility has contained and required a political legitimacy for the different projects and programs. In this management culture we find a good deal of strategy as plan where the planning has insured a political insight and influence over the change process.

The case in Hjärnarp was different since the authors of this study took active part in the process. The change process was formed with the goal to create meetings between the various interests and their needs for problem identification and knowledge concerning the local energy system. The purpose of the meetings was to create a locally based understanding of the system and different actors' relations to it as well as create a common perspective about the development of the system. There were a series of search and learning processes focussed on technical solutions and common values about the local energy system. All of this lead to the founding of an association "Green Heat in Hjärnarp" and a pre-study which was carried out by the energy consultant ÅF. In this case we can see clear evidence of strategy as pattern and strategy as a perspective.

Tools for the implementation of change processes within local energy systems

From the study of these four change processes in local energy systems we have identified three central processes. One process is how problems are understood and connected to a solution in an active *problem understanding*. A second process is how actors, sub-systems and systems are *mobilized*. Third, how and to which people, groups and organizations these changes are *communicated*. We posit that these are central processes in a change process and one can view problem understanding, mobilization and communication as tools for implementation if we conceptualize tools for implementation as the way in which change are implemented and strategic patterns arise. These dimensions in a change process are therefore important management and steering tools in change processes in the context of the public sector.

Problem understanding is the process in which the surroundings, one's own situation and relations between these structures are linked to locally formulated possibilities for change in the energy system. These possibilities for change contain an identification of the problem as well as an idea about a concrete project that could solve the problem. Through problem understanding the agenda is set for the continuing change process and for the future appearance of the energy system. Actors, networks, supporting systems as well as ownership structures and systems of knowledge are activated through *mobilization*. Another aspect of mobilization is how the change process is organized in networks, working groups or new companies. *Communication* includes those activities where changes are made visible, given meaning, diffused and integrated with the active actors, potential stakeholders and other relevant groups. With this definition, communication includes the message itself and the channels or media that is used for these transmissions in the form of calculations, plans or visionary documents, meetings or networks.

Towards the sustainable energy system -- models for change

In situations where actors within an organization are faced with sweeping changes one cannot be sure that accepted ways are sufficient to uncover new solutions and activate possible interests and supporting systems. In these situations new steering and management tools can help to implement and carry out the desired changes. We have seen how problem understanding, mobilization and communication create the central sub-processes in a viable change process. With the help of four models for change developed through the analysis of the case studies we will show how these sub-processes can be used as management and steering tools in very different contexts.

Change through networking

Even if one has limited resources, it is possible to contribute towards change in an energy system by building networks with important actors. This model demonstrates that ownership does not need to be the only way to manage flows and steer developments in a municipal energy system. Instead the focus is on the possibilities to work through others: to make visible problems and/or solutions, to support and be open for other actors' participation in the process of change. Changes stemming from this model are often characterized by a system perspective where one tries to uncover new and previously unused connections between different interests and systems. A basic tenant of this model is openness, continuous feedback between sub-goals and continuous search and learning processes, as well as the retention and combination of several possible problems and solutions in one and the same process.

Problem understanding in this model leads to a search and learning process where system thinking has a dominant position. Via a process of search and learning several possible problems or possibilities for change can be connected to many possible solutions. In a chain of problems and solutions one can connect sub-systems and diverse interests in such a way that new possibilities and system solutions become visible.

Mobilization in this model is oriented towards the activation of diverse interests to participate in the changes as well as support their work in the network. An example of this activation is network constructions where interests are introduced to one another and then connected. In this kind of work it is important to take an open position with regard to the diverse points of departure and strengths that these interests bring together. When cooperation within a network is initiated it then becomes a question of using one's own various resources to support the work that the network has taken upon itself.

The most important task for *communication* in this model is to make visible the whole chain of problems and solutions that will be worked with in the network as well as suggest which possibilities there are for various interests. Making things visible can be done in several ways including via the network itself, working groups or partnerships, with the help of the media or through inexpensive pilot facilities.

In a change process of this kind who is an expert will shift between different actors and organizations as the process continues to unfold. Thus it becomes very important that the individual actors can communicate with each other since they both create change and carry out the change process to its fulfillment. The role of a process leader here is something of that of a spider in a web: structure-builder, coordinator and the one with the overview over processes and actors.

Change through value formulation

Value and norm systems can be used in several ways to realize change. An active interest can use an existing or establish a new normative and regulating system from which internal and external interests can act. A shared set of values can also be useful when actors discover that they share values and this can itself be a driver for change and thus lead to cooperation with the shared values as the unifying perspective. An additional way to approach is that interests cooperate to develop a common set of values which, in turn, leads to actions which are beneficial for all interests as well as the development and sustainability of the system.

Problem understanding in changes of this type focuses on making values apparent and seeing how these can be connected to the development of the energy system as well as the operationalization of them as a force for the development of the energy system. It is important to identify the actors which already have the desired values as well as actors that are located at strategic points in the system and who could become bearers of the desired values. Therefore problem understanding includes the identification, or development, of values and the identification of actors who are or could be bearers of certain values.

Mobilization means a direct implementation and operationalization of the problem understanding. Through mobilization values and actors must be activated and brought together in circumstances which favor the development of shared change processes. During the mobilization phase the developing set of values, which are shared by those involved, must be increasingly accepted by the various actors in their own situation. Further these values must be seen as important and possible to base actions on. To create those circumstances which are needed it is important to mobilize those sub-systems within the energy system in which the shared values can be operationalized.

Communication is of great importance in a process that is steered by the capacity to operationalize shared values and get diverse actors to cooperate with these values as the point of departure. Therefore communication is concentrated on two matters: on the one hand the diffusion of values and their potentials for change and on the other hand the creation of communication possibilities between various bearers. The media for communication can often be vision documents, conferences, models, information centers and so forth. A crucial matter is the ability to anchor values within and outside the municipality and in the various levels of organization in the municipality. In such change processes a core set of values may often be developed to a shared identity on the part of the participating actors, an identity which can also be of strategic importance to market to a wider audience or other communities.

In shared values as a model for change the process leader starts with the rule and norm systems which are available or which have the potential to develop. The task is to make the values visible and create foundations around them so that the rule and norm systems, their foundations and the development of technical systems support one another. It is important to observe differences in perspectives and changing perspectives during the process so that the development of a unifying culture does not keep out important interests or create some form of tunnel vision so that new possibilities are not missed.

Change through management culture

The center of this model is the responsibility of the public sector in the municipality to weigh diverse citizens' interests and thus provide a good supply of services and goods. The common position is that the actors in the public sector work to administer public funds in such a way that as many as possible find their needs satisfied. This kind of process is supported by a centralized administration where the active individuals are in the system and where the formal tools and decision-making processes are well established. A precondition for this is often ownership or at least partial ownership, which permits direct control.

Formal tools and decision-making processes are thus important aspects of this work since this makes it easier to present the process of change and in this way create confidence and legitimacy among the citizens. For this reason the goals are established as far in advance of their realization as possible. This kind of change model best fits changes in activities where the changes can be carried out essentially internally and through investments using one's existing resources. An organization of this kind often has good access to internal technical or other relevant competence, which makes it easier to implement common goals.

The creation of guidelines and goal formulation is central to the *problem understanding* in this model. The guidelines and goals are to be implemented internally in the organization at several different levels. Frequently a few people with experience can take care of the problem understanding (guidelines and goals) and insight in the organization's various activities. Since legitimacy in the eyes of the citizens is an absolute requirement an important part of problem understanding involves politicians and political bodies. Formal tools such as spreadsheets, municipal planning documents etc, can be used in this process and for the understanding of the goal of the solution.

Mobilization is primarily internal; that is to say that the point of departure is internal activities and systems as well as those actors that work within this framework. Investments are an important part of the mobilization and work is often organized around activity and development plans.

Communication is also mostly internal and describes which parts of the goals that must be implemented in which units so that the primary goal can be realized. This communication is often formal via such media as activity plans, calculations, and budgets as well as in personnel and management meetings.

It is clear that process management in this model is active but formalized with a small group responsible for goal formulation and implementation. Internal experts are important and equally important are established channels of communication: within the upper management and between management, leading politicians, experts, and other actors. Through this formalized process which builds upon established divisions of work and responsibility, the on-going work is less dependent on particular individuals. Yet, at the same time, it is very important that all parts of the organization are activated even if implementation is within each unit in isolation. Clarity in communication and the possibility to return to the goal formulation during the entire process is a very important aspect of this model. What is decisive is whether the possibilities or the need for change can be motivated and made legitimate in the various parts of the organization and that an openness that the different organizations can carry out changes in its own way. It is first then that the various units and actors in the organization can be given responsibility for and the possibility to actively participate in the process.

Change through local participation

If change is driven by local participation then developments will be less dependent on the municipal administration or the resources of the public sector. Instead cooperation between sectors and the establishment of good communication is the focus. The goal is to actively involve citizens in the work and let the needs, problems and solutions -- which people formulate based on their daily experiences

-- steer change. To establish this externally-oriented method of working requires that the political system, the municipal energy company and municipal administration is see the active participation of citizens as positive and a necessary part of the change process. Participation must be seen as a guarantee for effectiveness but also as necessary if the municipality is to fulfill the goal of establishing forum in which the democratic rights of citizens are safeguarded and then transformed into practical action. In this kind of organization it becomes important to establish and support an attitude that the advantages of citizen participation outweigh the possible disadvantages such as the additional coordination, more negotiation and public hearings and the additional time that this work can entail.

Problem understanding in this model is primarily about how citizens can become involved in the process and how the diverse perspectives that arise in this process can be made clear, be addressed and integrated. The process itself is thus the focus of problem understanding and this often leads to testing, combining and the creation of participatory forms of working and meeting. As the process continues to develop the focus will shift towards specific chains of problems-needs-solutions and this means that problem understanding in this model can be similar to problem understanding in those processes where the goal is to work through others.

Mobilization here involves two parallel activities: mobilization of the actors and the mobilization of the knowledge and perspectives that the actors carry into the process. This mobilization occurs during the chosen forms of meeting and work where the actors and their perspectives are brought together and reconciled.

Communication plays a decisive role for several reasons. First, it is important to be able to communicate the value and orientation of the work for the actors that one wants to participate so that participation is understood as both important and legitimate. Second, it is absolutely necessary for the success of the process to be able to communicate the chosen work forms, their basic structures and purposes. Third, the entire process is driven by communication between actors and the perspectives that they bring into the process. The democratic project is thus in the first instance a communicative model.

In a democracy project of this kind, process management takes center stag. The task of the process manager is to develop meeting places and forms that support the meeting of expert and layman knowledge between different groups and actors. The process manager does not need to contribute with technical or other expertise concerning the special system or the organization that is to be changed. Instead the key is the communicative and mediating role of the process manager and her knowledge about group dynamics, which factors influence need, problem and solution formulations (age, gender, ethnicity) and the different forms of participatory work. An important step in change in this model is to also to create contact networks within the municipality and its administration as well as outward towards companies, associations and other groupings. The organizational base for such processes may already exist in the municipality such as Agenda 21 or Citizens offices. For those municipalities that choose democracy project as the change model it should be natural but also of great importance to use these already existing offices given their past and on-going efforts to function as coordination and participatory centers.

The models in market processes

Our opinion is that the power of competition is created in market processes where actors interpret and understand their surroundings and their situation. Various alternatives for change are created with this interpretation as the point of departure. Based on this perspective one can say that the market process is determined by how the problem is understood and then connected to solutions as well as how actors, systems and sub-systems are activated and how the possibilities for change are made visible and communicated. The three types of strategies point to different ways to create the possibilities for change and then carry them out.

Competition in the energy sector is characterized by increasingly complexity: greater numbers of actors and increased deregulation. At the same time the actors in the energy sector are covered by the political directives about the desirability for change in the direction of sustainable energy systems. In this context it is not enough to have competitive prices and products or find competitive niches. Instead it is important to have a method to manage changes. With this method one has the capacity to meet changes as well as initiate change. With this kind of perspective the future is not given. The future is uncertain and open for various paths for development. The models that were presented should be seen as different ways to manage and implement changes in the new situation.

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Trends of Bioenergy Introduction to Rural Areas in Japan

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Abstract

The situation around bioenergy in Japan have drastically changed in this a year. In the "Law Concerning Promotion of the Use of New Energy" enforced in 1977, biomass energy use was not positioned as a new energy. However, the New Energy Law was revised in this past February and various measures have been adopted for the development of biomass conversion technology and bioenergy introduction. Under such situations, many programs for bioenergy introduction to rural areas have been buckled down. Among them, this paper described an instance at Kahoku Town, Kochi Prefecture.

Keywords: Bioenergy introduction, feasibility study, biomass potential

Introduction

According to a survey in FY2000 given by the Agency of National Resources and Energy (ANRE), the estimated existing volume of bioenergy in FY2000 is about 26 Mkl as crude oil equivalent. Figure 1 shows biomass potential in Japan. The industrial waste such as black liquor, bagasse and sawmill wastes are most dominant component, and accounts for more than 60% of biomass potential. Second is agricultural waste of 18%.

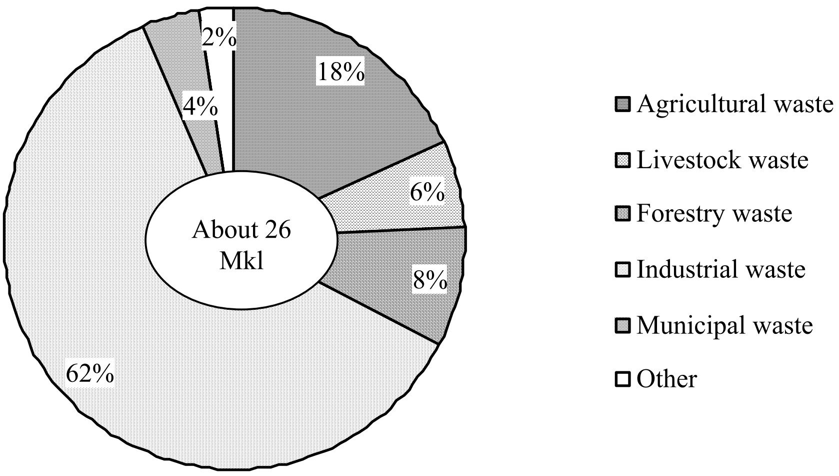

Figure 1. Biomass potential in Japan

The energy use of biomass was about 5.7 Mkl as crude oil equivalent in FY1999. Most of biomass utilized was the industrial waste. Table 1 shows examples of introduction of bioenergy facilities. For the energy conversion technology, all the cases are only on direct combustion or on methane fermentation. (Presently, there are some cases of biodiesel oil production from virgin rape seed and waste food oil.)

After COP3 held at Kyoto 1997, bioenergy was recognized as a clean and renewable energy source and programs of the use of bioenergy have been promoted.

Table 1. Examples of bioenergy introduction

Conversion technology	Number of cases	Biomass species
Direct combustion	56	Chaff, bagasse, fowl droppings, wood chips, coffee grounds
Methane fermentation	127	Livestock excreta, waste liquor of food manufacturing, sewage, night soil

Changing in Situation around the Bioenergy

The "Law Concerning Promotion of the Use of New Energy", enforced in 1977, was a fundamental law of the policy-supported targets for promoting positive introduction. Under the law scheme, bioenergy was not positioned as a new energy, except for the incineration of black liquor, bagasse and sawmill wastes.

The advisory committee for long-term prospects of supply and demand of natural resources and energy prepared a report in July 2001, describing "the biomass use as energy is positioned as a new energy in the Law on New Energy Development, the positive promotion of introduction of the biomass energy use should be done, and the investigation for revising necessary ordinances is expected". Responding the report, the Law was revised this past February, thus biomass has finally become a target of new energy sources.

The committee has also determined the introduction target of new energy in FY2010. According to the target, biomass power generation and biomass heat use are clearly described in the biomass category, adding to the conventional black liquor and waste materials. The target of the introduction of the bioenergy is about 6 Mkl as crude oil equivalent. The introduction target contributes to slightly above 30% of the total supply target for the new energy of 19.1 Mkl.

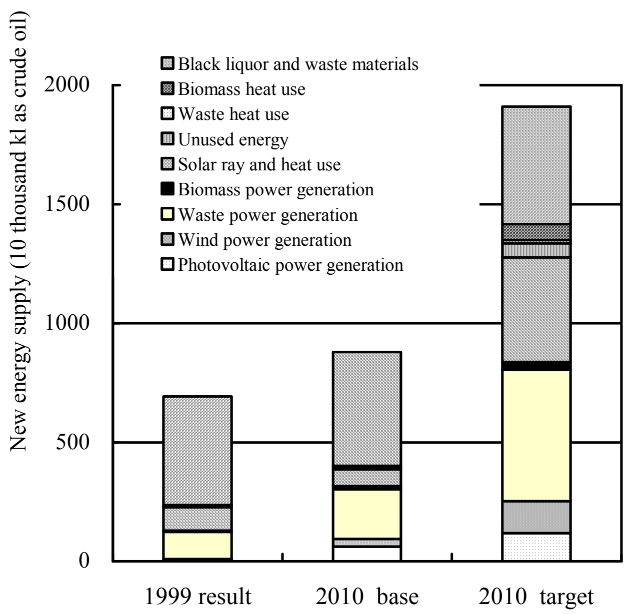

Figure 2. Target of new energy introduction

Bioenergy Projects by NEDO

Under such situations, NEDO started two projects; Development of efficient technologies for co-firing, gasification, anaerobic digestion and ethanol production, and Promotion of bioenergy introduction. At present, some feasibility studies are just going. But it is difficult to realize bioenergy introduction.

There are some issues on introduction of bioenergy, especially using wood biomass. Japanese forestry is now at a crisis. Domestic woods are very expensive, compared with foreign woods. Therefore, forestry is going out of use, and many forests have not maintained for several ten years. The activation of forestry is most important issues for the energy use of wood biomass. Expansion of subsidies to installation of bioenergy facilities and incentive tax system for bioenergy are political issues. The construction of biomass collection system is also important. We have to broaden understanding of people to bioenergy. Efficient utilization of heat is a difficult issue. In Japan, distinct heating is not popularized. Therefore, heat from biomass is efficiently utilized in only big facilities and factories.

Feasibility Study at Kahoku Town

In this paper, an instance at Kahoku Town, Kochi Prefecture is introduced. Kochi Prefecture is located at southern part of Shikoku Island and its forestry area is 84%. Therefore, abundant wood resources are utilized in Kochi Prefecture. Further, high performance machines such as processors are actively induced. Kahoku Town has the area of 130 km^2, population of 5,758 and four public facilities. Since there are many sawmills and wood markets around Kahoku Town, it is easy to gather biomass fuels from nearby towns.

Figure 3 shows a system flow of model. Three cases of co-generation systems were considered. In the case 1, a gas turbine of 250 kW runs 10 hours a day. All the electricity and heat production is utilized in four public facilities. In the cases 2 and 3, a gas turbine of 500 kW (case 2) and a steam turbine of 1,000 kW (case 3) continuously run. Their heat production is supplied to the public facilities, but all electricity produced is sold. Therefore, the public facilities bought electricity from grid.

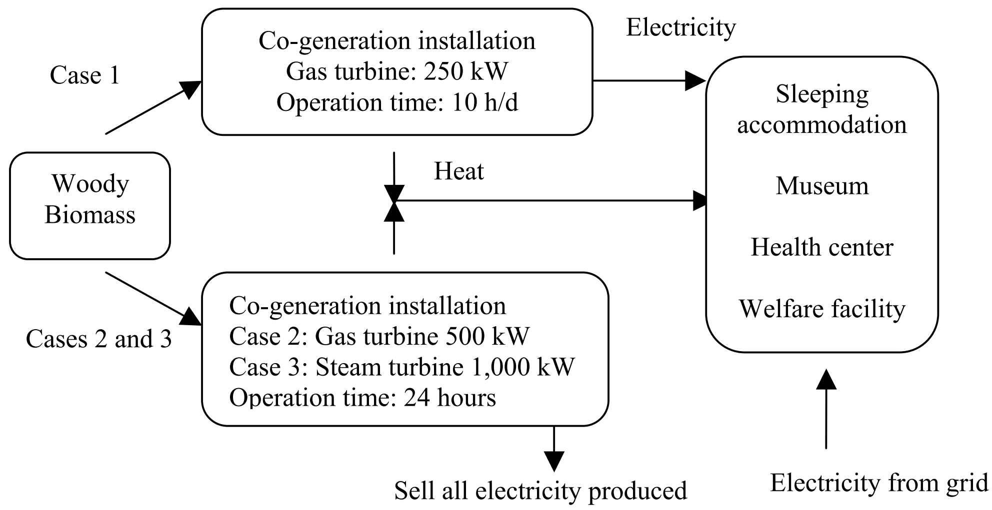

Figure 3. System flow of model

Table 2 shows costs of the biomass feedstock used. Two kinds of the feedstock, sawmill waste (most of that is bark) and the forestry waste, are utilized. Available amounts of sawmill and forestry wastes are 12,056 Gcal/y and 44,872 Gcal/y, respectively. Since the cost of sawmill waste is much cheaper than that of forestry waste, all cases precede use of sawmill waste. In the case 3, since large amount of feedstock is needed, the rate of expensive forestry waste is higher than that of sawmill waste, and total cost of the case 3 is higher than that of the others.

Table 3 shows energy balance of each case. In the case 1, most of electricity produced is utilized in the facilities and about 30% of excess production is sold. But at night, it is needed to buy about 400 MWh of electricity. For thermal utilization, all cases produce excess amount of heat compared with the total available capacities of four facilities. Therefore, the heat utilization efficiencies are very low.

Table 4 shows results of economical analysis of the case 1. The equipment cost includes the co-generation installation, the absorption type refrigerator to cool in summer season and the thermal supply pipe arrangement. Since the distinct heat system is not popularized in Japan, the cost unit of the thermal supply pipe is very high and its cost accounts for more than 50% of the equipment cost.

Table 2. Cost of biomass feedstock

	Available amount 1000 Mcal / year	Unit cost \ / Mcal	Amount (1000 Mcal/y) and ratio (%)					
			Case 1		Case 2		Case 3	
Wastes from sawmills (mainly bark)	12,056	0.7	4,019	88%	12,056	72%	12,056	32%
Forestry waste (tree top, branch and leaf *etc*).	44,872	4.33	558	12%	4,382	28%	25,162	88%
Total	56,929		4,576		16,741		37,688	
Total unit cost (\ / Mcal)			1.14		1.72		3.17	

Table 3. Energy balance

			Case 1	Case 2	Case 3
Rating efficiency	Electric power	%	22.5	22.5	22.0
	Thermal recovery	%	56.0	56.0	60.0
Electric power output	Self-consumption	MWh/y	700	0	0
	Buying output	MWh/y	413	0	0
	Selling output	MWh/y	295	4,380	8,760
	Total	MWh/y	1,004	4,380	8,760
Thermal utilization	Total heat exhaust	Gcal/y	2,480	8,705	22,601
	Efficient utilization	Gcal/y	1,563	1,563	1,563
Actual efficiency	Generator Loading	%	100	100	100
	Heat exhaust utilization	%	50.6	18.0	8.8
	Total co-generation efficiency	%	50.8	32.6	28.3

In the daytime, the surplus of electricity (295 MWh/y) is sold. However, there is no incentive to bioenergy and the selling cost unit is very cheap. Since the cogeneration system run between 8 am and 6 pm, electricity of 413 MWh/y needed after 6 pm has to be bought. Thus, the co-generation system can not supply all electricity used in the public facilities, while total heat production from the co-generation system largely exceeds the available capacity in the facilities.

In the case 1, two workers are employed. Total expense per year is 41,817 k\/y and the total cost unit is consequently 37.28 \/kWh. The total cost unit is higher than the buying cost of 21.2 \/kWh. However, this result may be promising because this calculation was made under the conditions without any incentive tax and subsidies to bioenergy.

In the cases 2 and 3, the total costs were calculated as the same manner in the case 1 and the results are shown in Table 5. Under the situations without any incentives to bioenergy, selling electricity produced from these co-generation systems of cases 2 and 3 is very difficult. From comparison between the cases 2 (500 kWh) and 3 (1,000 kWh), there is no scale-up merit due to high cost of feedstock.

Table 4. Economical analysis (Case 1)

Equipment cost	Co-generation installation	250,000 k\	1 million \ / kW
	Absorption type refrigerator	20,000 k\	120 USRT
	Thermal supply pipe arrangement	300,000 k\	300 k\ / m
	Total	570,000 k\	
Electric output	Total electricity produced	1,004 MWh/y	
	Self-consumption in the facilities	709 MWh/y	
	Bought electricity	413 MWh/y	At night
	Sold electricity	295 MWh/y	In the daytime
	Selling cost unit	4 \/kWh	
	Income by selling	1,181 k\/y	
Thermal supply	Total heat production	2,379,627 Mcal/y	
	Available capacity in the facilities	1,562,889 Mcal/y	
	Thermal utilization efficiency	51%	
	Thermal supply income	13,597 k\/y	8.7 \/Mcal
Running cost	Labor cost	12,000 k\/y	2 employees 6 million\/y
	Maintenance and utility cost	1,506 k\/y	10% of facilities depreciation
	Feedstock cost	5,217 k\/y	
	Total	18,723 k\/y	
Expense per year	Facilities depreciation (except for thermal supply pipe)	21,006 k\/y	Interest: 2% Durable year: 15 Expense rate: 7.76%
	Facilities depreciation (only thermal supply pipe)	10,980 k\/y	Interest: 2% Durable year: 40 Expense rate: 3.66%
	Running cost	18,723 k\/y	
	Ash treatment cost	854 k\/y	
	Buying electricity cost	5,033 k\/y	21.2 \/kWh
	Selling electricity income	-1,181 k\/y	
	Thermal supply income	-13,597 k\/y	
	Total expense per year	41,817 k\/y	
Total cost unit		37.28 \/kWh	

Table 5. Summary

Case 1	Gas turbine: 250 kW Operation time: 10 hours/d Feedstock cost: 1.14 \/Mcal Electricity and heat are utilized in four facilities Co-generation efficiency: 50.8%	37.28 \/kWh (Buying cost: 21.2 \/kWh)
Case 2	Gas turbine: 500 kW Operation time: 24 hours Feedstock cost: 1.72 \/Mcal Sell all electricity produced Co-generation efficiency: 32.6%	19.78 \/kWh (Selling cost: 4 \/kWh)
Case 3	Steam turbine: 1,000 kW Operation time: 24 hours Feedstock cost: 3.17 \/Mcal Sell all electricity produced Co-generation efficiency: 25.3%	21.7 \/kWh (Selling cost: 4 \/kWh)

Acknowledgement

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Results and Findings of the Summer Research Camp on Energy and Climate – Kupa 2001

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Abstract

"Summer Research Camp on Energy and Climate – Kupa 2001" was a part of the first phase of the Project called "Sustainable Future for the Kupa Valley". Eko Liburnia implemented the Project in collaboration with NGOs SE-F and Vitra (Slovenia) and OVE (Denmark). The Project area included six municipalities on both sides of the river Kupa, which represents historical natural border between Croatia and Slovenia.

The Camp was conducted from 6th-15th July, 2001 with the main objectives being: data collection on energy culture using the door-to-door survey method and raising of the environmental awareness among local population. The survey's main tool was a standardised Project questionnaire including eight different sections: general personal data; knowledge of the community; characteristics of the residential building; present way of heating the building; potential wooden biomass supply; existing environmental awareness; division of jobs within the family; and personal interest in participating in the Project. The outcome was 430 filled-in questionnaires, creating Project area database to be used in future activities. Finally, 77% of the interviewed households have expressed their wish to participate in the following Project's phases.

Keywords: wooden biomass, door-to-door survey, socio-economic aspects

Background

From the 1st of July 2001 to 31st of January 2002, Eko Liburnia implemented the first phase of the Project titled "Sustainable Future for the Kupa Valley" in collaboration with NGOs Slovenski E-Forum and Vitra from Slovenia and OVE from Denmark.

The Project area includes the wider area of upper stream of Kupa River and its tributary, Čabranka River, which represent the historical natural border between Croatia and Slovenia. The municipalities comprised with the Project area are municipalities of Osilnica, Kočevje, Kostel and Črnomelj on the Slovenian and municipalities and towns, respectively, of Čabar, Delnice, Brod Moravice and Vrbovsko on the Croatian bank of the Kupa River.

The main aim of the Project is promotion of the efficient use of energy and renewable energy sources among the local population, with special emphasis on the use of the wooden biomass due to the Project Area natural characteristics (70% of forest and woodlands).

The idea was to use wooden biomass as a tool for local development from economic, social and environmental aspects. The idea rose due to the following facts of the Project area:

- The main industry of the area was traditionally based on wood (sawmills, furniture, fire wood, parquet and other wood processing industry).
- Pitfalls of transition and privatisation led to closing and/or shrinkage in production of the industry, which caused high level of unemployment.
- Remained wood industry is mainly harvesting high quality wood for export as raw material.
- Private and mainly small-scale but illegal harvesting woods for heating.
- Moving out, ageing and impoverishment of the local population.
- Uncontrolled and rapid choking with rank vegetation of agricultural areas (arable lands, pastures, orchards).
- Due to the low level of industry, the area has almost intact biodiversity and rare virgin forest that represent solid ground for development of green entrepreneurship.
- Large environmental risk caused by the increasing traffic of tank lorries carrying fossil fuel.

Therefore, the Project's mission is establishment of the awareness on the relationship between the need of mankind to protect the global climate and the need for recovering the local/regional economy based on the sustainable principles on the one hand, and cross-border cooperation among municipalities, NGOs and business sector on the other hand. The aim is to reach the "win-win" possibilities through establishing cross-border network which will be connected to global networks promoting ecology (climate) friendly technologies, management and financing. Furthermore, the aims are:

- Increasing the knowledge on the importance of the sustainable forestry and cross-border rules on environmental protection.
- To show and promote EE as economically viable solution;
- Disseminate information on various advanced technologies on bio-fuels production based on wooden biomass (wooden chips, briquettes);
- Raise awareness on necessity of public participation as a pre-term for successful implementation;
- Transfer of know-how on the organisation of local/regional market;
- Set up the basis for the other cross-border activities oriented towards sustainable development, such as ecotourism, organic agriculture…

At the first phase, Project activities included: summer research camp, six open-to-public lectures (EE and RES, Every House - the Sun House, Organic Agriculture and Ecotourism on Farms, Green Entrepreneurship, RES and Climate Protection, EE and RES at Slovenian Households), two expert workshops for local decision-makers and study trip to Denmark (green accounting and eco-schools).

The present state of the Project is stand-by with a promise from the local decision makers on both sides of the Kupa to meet again in the near future.

Summer Research Camp on Energy and Climate – Kupa 2001

Summer Research Camp on Energy and Climate (SRCEC) – Kupa 2001 was held from 6th to 15th of July 2001. It was volunteering by 21 students (mainly students of Anthropology and Engineering from Slovenia) and coordinated by SE-F, Vitra and Eko Liburnia.

The main objectives were data collection on energy culture using door-to-door survey method and raising the environmental awareness among the local population. The main tool for this double role of the participants was standardised questionnaire in native languages (although inhabitants mostly understand both languages, the purpose of this was to be as closer as possible to the interviewed person).

The questionnaire was divided into eight sections: general personal data; knowledge of the community; characteristics of the residential building; present way of heating the building; potential wooden biomass supply; existing environmental awareness; division of jobs within the family; and personal interest in participating in the Project.

To each participant, the questionnaire was explained to details, he/she was instructed how to execute the interview, informed about the issues of the climate change, RES and EE and told how to disseminate the information about those issues after the interview.

Every day of the SRCEC, according to the topographical map (1:100m), participants were coordinated from village to village, from door to door (and sometimes sat on the main square of a settlement) and made the survey covering the whole Project area. Each evening of the camp, they shared their experiences from the field and the fulfilled questionnaires were taken to the main office in order to be input at the PC.

The main outcomes of the SRCEC were 430 standardised questionnaires fulfilled, six lectures with 18 participants in average, 12 students were trained in Microsoft Excel. Survey has covered 142 households on the Croatian side and 257 households on the Slovenian side (the final number of correctly fulfilled questionnaires was 399). The database was created in order to be used for the future phases of the Project.

After the SRCEC, Eko Liburnia made the database analysis according to the Project beneficiaries' demands.

Results

It should be taken into the account; the results presented in this paper are only general outcomes of the whole data analysis. In order to make the paper simpler, the following abbreviations are used in whole figures: SLO for the Slovenian bank of the Kupa river and HR for the Croatian bank of the Kupa river.

Heating

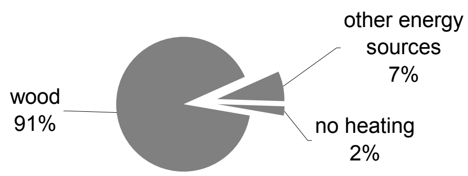
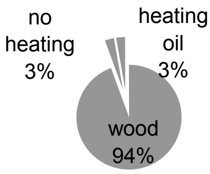


Figure 1. Structure of heating energy sources (HES) - %

Data analysis shows that a great majority (91%) of inhabitants in the Kupa valley use wood as heating fuel (Figure 1). Wood is traditional energy source in the area. In the structure it can be seen that on the Croatian side (Figure 2), there is 94% of households heated with wood logs and only 3% uses oil as heating power (and only alternative). On the other, Slovenian, side, 88% of households is heated on wood logs and 10% uses some other heating power - oil, gas or electric power (Figure 3).



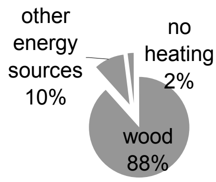


Figure 2. Structure of HES (%) – HR **Figure 3.** Structure of HES (%) - SLO

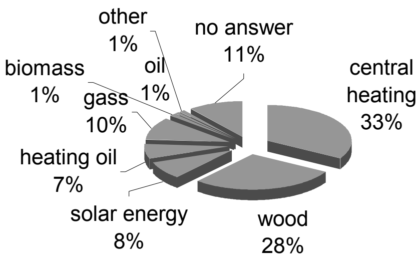


Figure 4. Optimal heating (%)

But, when asked "Which heating would be optimal for you, without concerning finances and other obstacles?" optimal heating rank-list looks like this (Figure 4): Something more than one third of the questioned households find central heating (on whatever fuel), 28% wood, and 1% biomass as optimal heating. If summed all together, 62% of answers are referring positively on the use of biomass, either directly or indirectly. With certain reservations, to this percentage is possible to add additional 8% referring to the solar energy as optimal heating. Those households could be marked as "environmentally aware" but, in present circumstances and with current knowledge, it is unlikely to execute solar heating in the area of Kupa valley. If added, total of positive answers regarding biomass would be 70%.

Answer comparison of the left and right bank of the Kupa river, (Figures 5 and 6), it is possible to spot great similarities. Namely, from both sides 62% of answers have positive (direct or indirect) sound, although the structure of the answers (central heating, woods, new technologies/biomass) is slightly different. If solar power included, the percentage amounts 71% on the Slovenian side and 69% on the Croatian side.

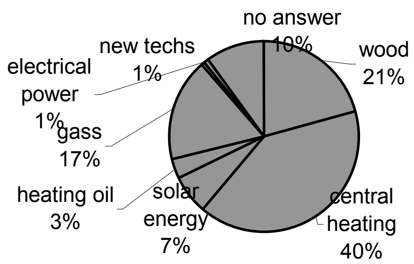


Figure 5. Optimal heating (%) - HR

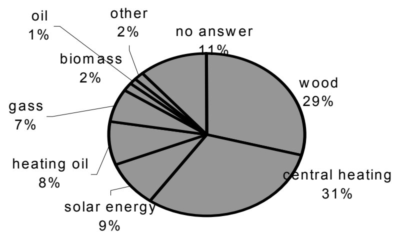


Figure 6. Optimal heating (%) - SLO

Wooden biomass

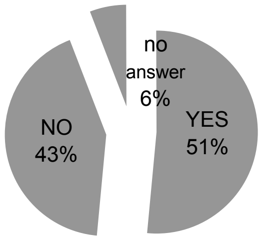


Figure 7. Have you ever heard about wooden biomass?

Half of the questioned persons does not know or have never heard or does not want to respond on the question related to the biomass (Figure 7).

Comparison of the both riverbanks shows that biomass as a term is better known on the Slovenian side (47% HR vs. 54% SLO). But, as above mentioned, every interviewer had to explain the terms of biomass and wooden biomass and related issues after completing the questionnaire. Therefore, these results came across the survey but the present state is that every household questioned has at least the basic knowledge of the wooden biomass.

Environmental issues

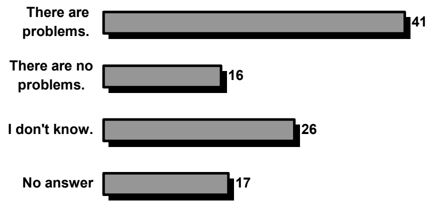


Figure 8. Are there any environmental problems connected with energy? (%)

Researching the level of environmental concern and knowledge has shown results that ask for answers. Many participants were surprised by the result. Only 41% of inhabitants have answered with "yes" on the question "Are there any environmental problems connected with energy?" (Figure 8). Results are more or less identical at the both riverbanks.

If answers "no", "I don't know" and "I don't want to answer" are understood as different levels of ignorance and/or lack of information on actual environmental problems, the chart looks like this (Figure 9 – N A for negative answers and P A for positive answers):

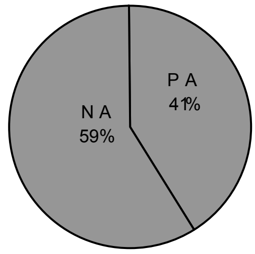


Figure 9. Environmental problems and energy - generalised (%)

But, we believe that we have managed to raise the environmental concern through our summer camp while every participant was instructed to "serve" as walking environmental information source.

Insight to the future

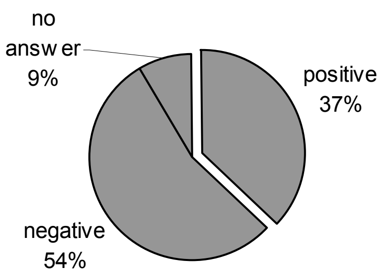


Figure 11. Thinking about the future (%) SLO

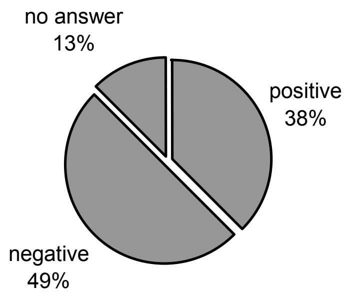
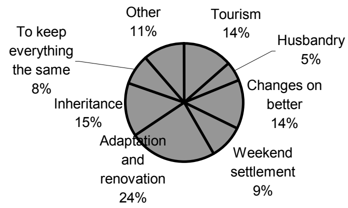


Figure 10. Thinking about the future (%) HR

Sociological part of the survey was finding out aspirations and thoughts about the future and perspective of the inhabitants of the Kupa River valley. The results showed crushing quality of inhabitants' spirit (Figures 10 and 11). As many as 54% on the Slovenian side and 49% on the Croatian side think negatively about the future, and, all in all, only 37% and 38% respectively has some positive attitude.

Positive attitudes have some differences in the structure if compared from the both sides (Figures 12 and 13).



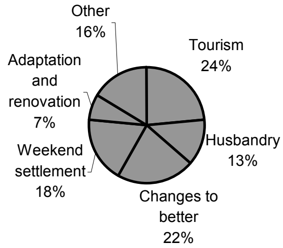


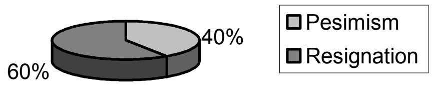
Figure 13. Positive perspectives (%) SLO **Figure 12.** Positive perspectives (%) HR

On the Slovenian bank of the Kupa River, majority among "happy" 37% would like to adapt or improve buildings (24%), or to leave the household bequeathed (15%) or would like to deal with tourism (14%) or they just passively hope for the better (14%).

On the Croatian bank of the Kupa River some of these positive attitudes are not even mentioned. For instance, there is no wish to leave everything as it is or to bequeath. The dominated perspectives are: tourism (24%), passive hope for the better (22%), weekend-settlement (18%). Adaptations and improving of the buildings amount less on this side for weaker purchasing power of the Croatian inhabitants than Slovenian.

It is also interesting the rather representative category of weekend-settlements (9% on the Slovenian side and 18% on the Croatian side). The inhabitants would like to transform their settlement (village, town) into weekend-settlement, without stable inhabitants. This category is very complex and draws many questions. Does that mean that the inhabitants are willing to move out from their houses? If so, why?

Negative attitudes are divided into two categories: pessimism (answers like "there is no future", "everybody will become extinct" and similar) and resignation (answers like "nothing will change", "I don't know", "nothing" and similar).



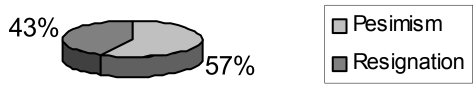


Figure 14. Negative perspectives (%) SLO **Figure 15.** Negative perspectives (%) HR

Although Croatian side has shown as slightly less negative (49%) than Slovenian side (54%) (Figures 11 and 10), the structure shows that Croatian residents of the Kupa River valley are mostly resigned (60%) and Slovenian residents are more pessimistic (Figures 14 and 15).

Willingness to participate in the Project

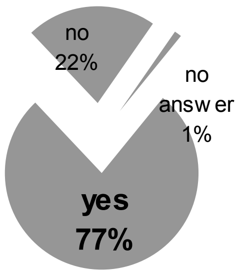


Figure 16. Participation in the future project activities (%)

But, in order to put add some colour at this black and grey picture, 77% of households have expressed their wish to participate in the following steps of the Project and "Sustainable Future for the Kolpa (Kupa) Valley".

Conclusion

The whole first phase of the Project led to the following conclusions, which were only underlined by the experience from the field:

- Unavailability of modern biomass heating systems on regional and national level;
- Lack of information on the modern environmentally friendly heating technologies;
- Not very high level of environmental knowledge and awareness among local population;
- Low purchasing power of the local inhabitants;
- Lack of support and tool for using biomass as heating fuel both on national and regional level;
- Poor cooperation between regional and national authorities (forestry, rural development, environmental protection, industry, tourism).

But, there is a strong belief that there is a critical mass of local inhabitants to continue the Project.

Biomass based efficient energy alternatives in Korčula

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1 Introduction

The main purpose of the study described in this paper is to produce a basic project to evaluate the technical and economic feasibility of a seawater desalination plant running on the energy generated by the disposal of marc waste resulting from the process of olive oil production in all existing farming co-operatives in the isle of Korcula.

This project is part of the activities to promote energy efficient projects in the international arena that the Institut Català d'Energia (ICAEN) has been developing in the last few years.

To be specific, the overall objective of the project is to define sustainable energy alternatives for the isle of Korcula, bearing in mind all energy, water and environment parameters. However, as observed by the Identification Mission carried out in June 2000, the global objective will be developed as from independent projects. The need to make progress towards a pilot plant that could become the base and reference for future comprehensive actions was agreed jointly with the partners of the Hrvoje Pozar Energy Institute.

2 Social and Ecomonic Cornerstones of Croatian Islands

Recent social and economic history of the Croatian islands is best reflected in the related demographic trends. Since 1857 (population of 117,481), when the first official census took place, the islanders reached their peak in 1921 (population of 173,503), in terms of their number and activities, and subsequently dwindled below the last century figures in 1991 with the population of 110,953 inhabitants [1].

In 1991, an average island settlement had 417 inhabitants, which was below the Croatian average. There are no larger urban agglomerations on the islands; the largest town (Mali Lošinj) has 6,566 inhabitants. The Croatian islands have always been less inhabited than other Mediterranean island groups. In the twenties and thirties many islanders emigrated overseas, and in forties and fifties they emigrated to bigger towns on the coast and mainland. In the sixties they left abroad as migrant workers. This negative trend continuous even today.

The actual demographic situation shows how serious the consequences of such trends are. The island age distribution, after so many decades of emigration and natural regression, is extremely unfavourable. The average age of the islanders is 40 years, the share of population over 60 is 25,7% and the share of the people younger than 15 is 17,4%. The biggest demographic and economic problem is the reduction in the share of reproductive or working population. On the Croatian islands there are 56,9% inhabitants between 15 and 60 [2].

Based on the natural environment, the island economy is simple, and its structure, as compared to the mainland economy, has always appeared to be scarce. Today, the islands still lack entire branches of economy, and the economic units which often are the only representatives in their branches can have as little as ten employees.

The history after WWII differed on the Croatian islands from that on other Mediterranean islands. As the only ones remaining under socialism, they were the only ones to experience rapid industrialisation, concentration of rural population in few towns, insensitive treatment within the general economic policy reduced to subsiding under developed regions,… This all affected many of the Croatian regions, whereas the islands yet again turned out to be more sensitive then the mainland. The island economy did not develop, while the mainland economy was more appealing than ever. Already in the fifties there began the emigration, and in the sixties there was only one island in Croatia whose population was not dwindling.

The island economy is still poorly structured. Agriculture is neglected and tourism dominates followed by trade, shipping and some industry: ship maintains, fish processing, stone quarries, wine production and distilleries as the most important. Some 45,000 islanders are employed today, of whom somewhat less than 40,000 on the island. The rest live on the islands and work on the mainland. The share of the islands in the economy of Croatia never exceeded 5-7%, no matter what indicator was in question. After long marginalization, slow economic rise and quick falls, immigration and desertion, the island economy is still rather low. Special attention deserve merely tourism for its profitability, agriculture for its inadequately used resources, fish processing for its exceptional social and even demographic importance at some places, and traffic on which the overall position of the islands within the Croatian and Mediterranean economic area depends [3].

3 Energy and Water Problem Approach in Korčula

In cooperation between Energy Institute Hrvoje Požar (Zagreb-Croatia) and Catalan Institute of Energy (Barcelona-Catalonia) several missions were held in order to first identify and define the scope for possible renewable energy projects in Croatian Islands.

Aim for such missions is to get a direct knowledge of local specific problems to be solved, to identify possible partners and recipients for possible projects and to start considering possible legal or technical barrier to be overcome.

Korčula Island was finally selected because of several key factors:

- Reduced depopulation in comparison to other islands.
- More or less equilibrated presence of different activity sectors (agriculture, service and industry).
- Enthusiastic partnership of one cooperative for wine and olive oil production in Smokviča.

After several meetings with authorities in Zagreb (national level), Dubrovnik (regional level) and Smokvica (local level), as far as some informal interviews with other key people in Korčula Island, it became evident that two major problems were being faced:

- Lack of water supply in some parts of the island.
- Need for treatment of agricultural waste (residues of olive oil production).

It is important to notice that, regarding to energy problems, it was not possible to state any kind of difficulties in energy supply, distribution or usage. There exist a WATER+WASTE problem that, after several studies and calculations was defined as:

- Need for 100.000 cu.m/year (in order to increase olive output in a 10 years plan).
- Need for treatment for 2.000 metric tonnes per year of olive waste (10 years plan).

4 Possible Energy Alternatives

After previous Identification Mission held in June 2000, several alternatives to produce water were defined and analyzed. Most important ones were:

- Hybrid Wind-Diesel plant to produce energy to be used in a Reverse Osmose (RO) or Mechanical Vapour Compression (MVC) plant for producing agricultural water.
- Diesel cogeneration to produce thermal and mechanical energy to be used in agricultural water production plants (Multi-Effect Distillation (MED) and RO).
- Biomass combustion plant to produce steam to be used in distillation plants (MED or Multi-Stage Flash (MSF) technologies).
- Biomass combustion plant to produce steam to be used in steam turbine to produce energy to be used in a RO or MVC plant for producing agricultural water.

It becomes evident that first two alternatives are focused only in water production whilst last two alternatives consider both water and waste problem. In February 2001 a new Mission was held in order to collect necessary data for producing feasibility studies according to previous technologies.

5 Biomass into Water

After considering state-of-art and available technologies, marketed sizes and capacities, energy consumption, EU standards a.s.o., a global proposal for reducing agricultural waste and, simultaneously producing agricultural water, was elaborated. It consists in three different areas:

- Biomass combustion plant – It transforms olive waste into steam. Located in Smokvica.
- Condensing steam turbine - It transforms steam into power. Located in Smokvica.
- Reverse Osmose plant - It transforms power* into water. Located in Brna.

In figures 1 to 4, previous processes (including seawater pre-treatment) are presented:

* Energy for a sea-water desalting process.

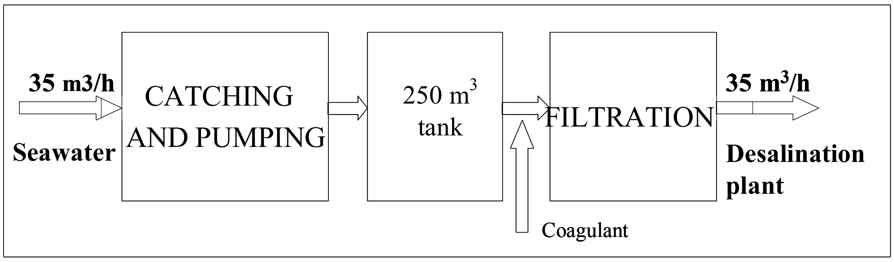

Figure 1. Sea-water pre-treatment

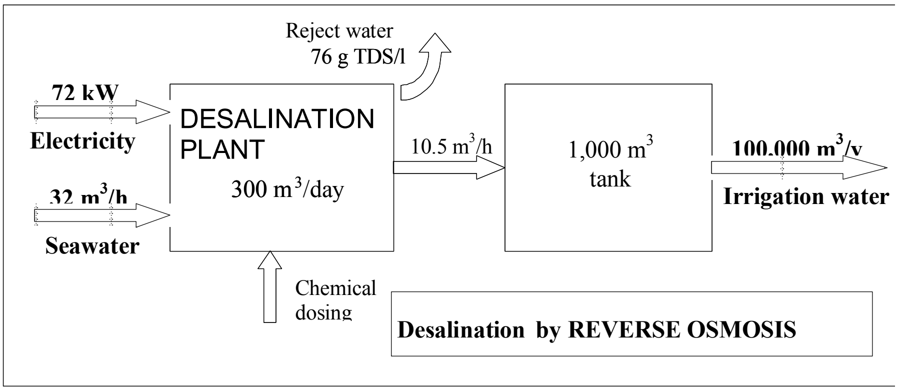

Figure 2. Sea-water desalination

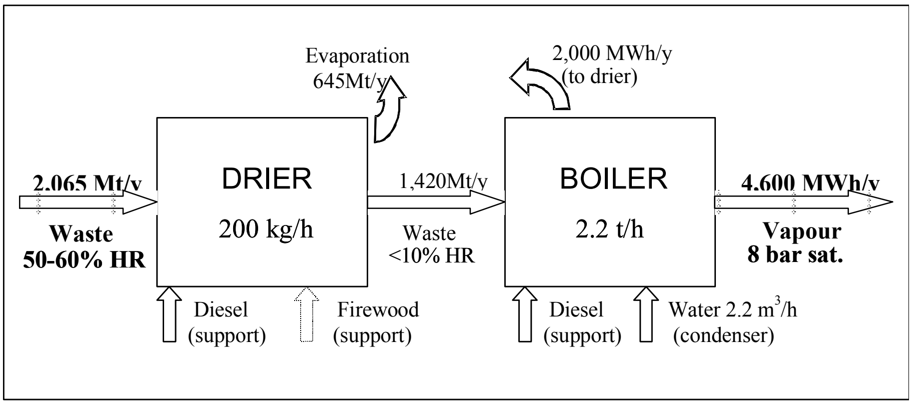

Figure 3. Biomass combustion plant

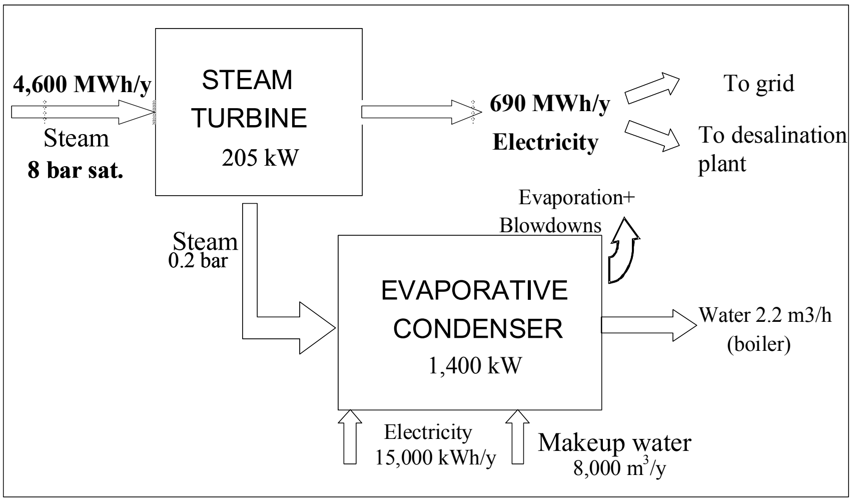

Figure 4. Steam turbine plant

Following tables show expected energy and economic balance:

Table 1. Energy balance of the analyzed project concept

ENERGY BALANCE	REFERENCE	RO
FARMING WASTE (t/y)	2,065	0
THERMAL GENERATION (MWh/y)	0	4,600
ELECTRICITY GENERATION (MWh/y)	0	690
WATER GENERATION (m³/y)	0	100,000
WATER PURCHASES (m³/y)	100,000	8,000
LIGHT-OIL PURCHASES (l/y)	0	23,000
ELECTRICITY PURCHASES (MWh/y)	0	615
ELECTRICITY SALES (MWh/y)	0	690

Table 2. Economic balance of the analyzed project concept

ECONOMIC BALANCE	REFERENCE	RO
FARMING WASTE (Kn/y)	¿?	0
WATER PURCHASES (Kn/y)	900,000	72,000
LIGHT-OIL PURCHASES (Kn/y)	0	71,000
ELECTRICITY PURCHASES (Kn/y)	0	615,000
ELECTRICITY SALES (Kn/y)	0	-690,000
BOILER-TURBINE MAINTENANCE (Kn/y)	0	65,000
DESALINATION PLANT MAINTENANCE (Kn/y)	0	164,000
TOTAL (Kn/y)	**900,000+¿?**	**297,000**

Estimated investments for this project are divided into three areas:

- Biomass plant: 1.3 M Kn
- Steam turbine plant: 2.5 M Kn
- Desalination plant: 2.8 M Kn

6 Conclusions

Since development of feasibility project, all efforts have been devoted to search for and evaluate financing possibilities. Main constraints are related to the reduced size of the biomass plant, which increases specific investment and externalities of waste production, which are not taken into consideration in this project. As a result, short-medium term pay-back periods are not realistic.

However, specific situation of Croatian islands can generate other non-economic benefits such as:

- Sustainable project – Sustainable agriculture.
- Reducing water transport needs from the continent.
- Reducing waste transport needs to the continent.

Summarizing: an interesting approach to water and waste problems in Croatian islands has been generated using energy as a vehicle to transform waste into water. Financing tools for making possible such pilot plant in Korčula are in development. In parallel to this, other benefits related to effective Croatian-Catalan cooperation are already a reality.

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Socio-economic Aspects of Wood Energy Systems in Developing Countries: A Focus on Employment

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Abstract

Energy is both an engine of development and a source of many of the economic and environmental problems we face today. Clean and affordable energy service is not only essential to poverty alleviation but also when locally available, as in the case of fuelwood and charcoal, can provide a host of other development benefits such as: mobilization of investment, the generation of rural jobs, urban and rural public health improvements, and local self-reliance.

Biomass is the dominant form of energy for about half of the world's population and woodfuels also the major forest product in many nations. Woodfuels are usually integrated into larger multi-purpose systems within forests or agricultural areas that are a source of food and fodder, timber and non-timber forest products, a reservoir of biodiversity and traditional medicines, a windbreak and a shade provider, performing all of these functions, at little or no cost, for the world's poorest communities. In addition, proper woodfuel resource management contributes to sustainable forest management (SFM), to the reduction of deforestation and to the restoration of degraded lands.

Most value added from village-scale wood energy systems is retained locally and helps to reduce poverty – in sharp contrast to fossil fuels and most other renewable energy options. Therefore, appropriately harnessed wood energy systems can significantly contribute to sustainable development, particularly in the poorer areas of these countries.

Various authors throughout the globe have documented various experiences. However, the cases have mostly been site-specific and situation-specific and are not sufficient for the generalization of their socio-economic impacts and benefits.

In these days in which poverty alleviation and improved livelihood are critical issues for project implementation, employment generation and income-creation by wood energy initiatives (and bioenergy as well) becomes a real challenge.

This paper intends to summarize some information available from case studies in order to raise main issues regarding the direct and indirect socio-economic impacts of wood energy systems at macro (investment needs, impact on national incomes, etc.) and micro level (job and income generation, etc.) in order to quantify the real, measurable, and long-term benefits expected to promote rural development when new forestry, energy, and environmental policies are enacted.

Introduction

Today's major societal concerns are especially focused on poverty alleviation and environment conservation. In this particular context, woodfuel (and its energy generated) can play a crucial role to overcome these concerns.

In fact, woodfuel share among all wood use accounted for 80 percent among developing countries and 31 percent among developed countries (FAO/WEC 1998). This reflects the importance of bioenergy use both as a household fuel (for cooking and heating) and as an industrial energy carrier (for power and heat generation).

Among the many socio-economic aspects of bioenergy, the employment function is one less written about at a greater length. Yet it is often cited as a major benefit of bioenergy.

The following topics summarize the FAO paper on "Socio-economic aspects of bioenergy: A focus on employment" prepared by Elizabeth M. Remedio Department of Economics, University of San Carlos, Cebu City, Philippines.

The paper attempted to review the employment creation attributes of bioenergy. It uncovered the work of many bioenergy experts and scholars in their effort at quantifying the impact and role of employment in the bioenergy sector.

Major impacts

The utilisation of woodfuels for energy production is a multidisciplinary system which is integrated into larger multi-purpose systems within forests and/or agricultural areas and with several economic, social, technological and environmental impacts for the people living in and around the areas involved.

Various experiences have been reported worldwide by many authors and experts. Most of the cases analysed show that the economic and socio economic impact of wood energy systems are very site specific and situation-specific which makes it difficult to be properly generalized.

In these days in which poverty alleviation and improved livelihood are critical issues for project implementation, employment generation and income-creation by wood energy initiatives (and bioenergy as well) becomes a real challenge and need more detailed studies and analysis.

Table 1. Estimated Employment Figures [1,2,3]

Pakistan	600,000
India	3 to 4 million
Philippines	700,000 hhs
	140,000 hhs
Brazil	
Ethanol industry alone	700,000
Ethanol industry	800,000
Charcoal industry	200,000
Charcoal production	120,000
Kenya and Cameroon	30,000
Ivory Coast (*)	90,000

*Charcoal industry

For this reason, FAO' Wood Energy Programme has initiated a number of activities aimed to study the economic impacts of wood energy systems in both developed and developing countries. The studies were focused in two main aspects at macro and micro level.

At macro level, the activities intend to describe the capacity of wood energy systems for the mobilization of funds and the redistribution of incomes into different economic layers of the society. At micro level, the activities revised describe the role of wood energy systems for "income generation" and "employment" especially in forest and other rural areas where woodfuels are used.

Main results and findings

The main findings and results of the review are summarized in the following paragraphs and tables.

Table 1 shows employment figures collected from some studies carried out in some countries mentioned. Please note that the figures for Kenya, Cameroon and Ivory Coast are only for charcoal production.

Other studies dealt with woodfuel production using energy plantations. Table 2 illustrates the results. For the more labour-intensive systems, much of the work involves wood growing activities. Also, manual harvesting operations generate many jobs. For the intercropping system, only jobs related to wood production were included, so employment in that system has somewhat lower values in the study. Total employment in wood and crop production would probably have given higher values. The large-scale mechanized system generates fewer jobs than the small-scale farm systems. Still, even the large-scale system generates about three times as many jobs per energy unit as do mechanized systems in northern Europe.

Table 2. Employment on Biofuel Production (person years/PJ) [4]

	Establishment	Weeding	Harvesting	Transport	Chipping	Administration
Intensive production	112	338	248	70	13	19
Intensive inter-cropping	71	196	251	71	13	19
Large scale "Forest Energy"	34	59	85	51	13	11

The earnings (Table 3) in the local community are higher for the manual systems. Most of the production is carried out by manual labor, and transport and related work are carried out with locally available trucks and tractors. In the mechanized system much of the revenue from fuel production is used to pay the costs of the system, and trickles down to the local community.

Table 3. Earnings on Biofuel Production (US$/PJ) [4]

	Establishment	Weeding	Harvesting	Transport	Chipping	Administration	Total
Intensive production	82,305	205,761	257,202	68,587	13,717	68,587	696,159
Intensive inter-cropping	54,870	126,886	257,202	68,587	13,717	68,587	589,849
Large scale "Forest Energy"	17,147	27,435	37,723	20,576	13,717	34,294	150,892

A study sponsored by the European Union, BIOSEM, was carried out in 1997–1998 to study these effects in bioenergy projects in several European countries (EU/AEAT 1999). The projects included in the study varied in size and type. However, the results may still serve as a basis for general comparison and conclusions (Table 3).

Table 4. Employment and earnings in selected European projects [4]

	Direct jobs	Indirect jobs	Inducted jobs	Total jobs per PJ	Labor earnings (keuro/PJ)	Country
SRC, gasifier	51	11	36	98	1116	UK
Miscantus, heat	321	0	214	534	7054	Belgium
27Forest residues, CHP	52	33	30	115	1566	France
Triticale, proc. heat	134	60	28	222	3858	Germany
Artichoke, heat	269	19	93	380	1745	Greece
SRC, gasifier	36	21	23	80	1010	Ireland
Ind. residues, CHP	41	11	13	65	974	Italy
Waste, CHP	13	2	27	42	240	NL
Logg. residues, heat	52	2	21	76	724	Sweden

It is obvious from the results that projects based on agricultural crops generate much employment and earnings. However, the main reason why these projects are potentially economically feasible is the assumption that fuel production is subsidized under the CAP (Common Agriculture Policy), as it is performed on set-aside land.

Large projects tend to have a lower relative impact on employment and earnings than small projects. In fact, this observation is the other side of the coin from the generally accepted understanding that there is an economy-of-scale effect for energy plants in general, as well as for biofuel projects.

Table 5. Employment generated by different energy options [1]

Fuel Type	Amount of fuel per Terajoule (TJ)	Employment per TJ energy in person days[1]
Kerosene[2]	29 m^3	10
LPG	22	10-20
Coal[3]	43	20-40
Electricity[4]	228 MWh	80-110
Fuelwood[5]	62	100-170
Charcoal	33	200-350

Rural Income and Employment

Studies show that wood and other biomass resources generate at least 20 times more local employment within the national economy than other forms of energy, per unit (Table 5). Rural off-farm incomes are generated from the huge amount of manpower (unskilled labor) required for harvesting, processing, transporting and trading of the fuels.

Wood fuel trade, however, occurs mostly at a small scale and in the informal sector. As such, no comprehensive statistics of its scale, magnitude or total number of employed people exist. Nevertheless, several studies have been conducted in recent years that give a picture of wood fuel flows.

In Phnom Penh, Cambodia, wood energy supply from rural areas encompasses a multilayered system of traders generally described as informal and unregulated. Urban demand by households and industries is high, since it is the main energy source (FAO RWEDP)

Last but not least, Table 6 shows the investments between different energy options summary results.

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[1] Employment covers growing, extraction, production, transmission, maintenance, distribution & sales, including reading meters. It excludes employment generated outside the country for fuels that are imported in semi-finished state.

[2] This assumes that crude oil (for refining), kerosene and LPG are imported.
[3] This varies according to capital intensity of the mine, the seam thickness, the energy value of the coal and the distance from the demand centers.
[4]This varies according to production methods, ranging from hydro to traditional oil/coal fired units and the efficiency of electricity generation, transmission and distribution.
[5] This depends on the productivity of the site, the efficiency of the producers and the distance from the markets.

Table 6. Investment costs per job created [2]

Bioenergy sector	US$ 15,000 to 100,000 per job
Ethanol agro-industry	US$ 12,000 to 22,000 per job
Petro-chemical industry	US$ 800,000 per job
Hydro power	US$ 1,000,000 per job

Conclusions

The review of studies carried out showed that wood energy systems can contribute in:

- developing rural areas,
- alleviating poverty and
- reducing rural-urban migration.

However, many gaps of information still exist in our understanding of the poverty alleviation function of bioenergy. Therefore, more studies are needed in this particular field in order to contribute to adopt sound and more sustainable wood energy systems.

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Bioenergy in the Overall Philippine Energy Mix[1]

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The role of bioenergy in the overall Philippine energy mix cannot be underestimated. Data from the Philippine Yearbook 2001 (NSO 2001:14-4) show that total energy consumption in the year 2000 was 249.47 million of barrels of fuel oil equivalent (MMBFOE). Of the total, 49 percent was obtained from indigenous sources and 51 percent from imported energy.

While biofuel is an important energy resource in the Philippines (Figure 1), much is not known about it, hence its value and contribution to the economy is not well appreciated. Bioenergy use, production, distribution and trade continue to be an area only few are willing to spend time and effort to understand, reflect and synthesize. What is generally believed is that firewood gathering and charcoal making are the causes of deforestation and water shortage, hence these activities should be regulated and controlled. As a matter of fact, there is not one single agency in the Philippines tasked to undertake, monitor and follow through the trends and patterns of bioenergy in a regular basis and in the context of energy, agriculture and biodiversity and, economic development.

The World Bank/UNDP and National Statistics Office/Department of Energy conducted two major studies in Philippine household energy consumption in 1989 and 1995, respectively. Both studies provided comprehensive accounts of household energy consumption patterns for the archipelago at two different time periods. Recently, a desk study detailing woodfuel use and production was also commissioned by FAO (Remedio and Bensel 2002a). These three strategic documents support the notion that biofuel is and will

[1] Prof. Terrence G. Bensel of the Allegheny College, Pennsylvania, USA has been collaborator and co-author in conducting the 1992 and 2002 biofuels study for Cebu.

be a major resource of household and industrial energy in the past decades and will continue to be so in the years to come.

In terms of economic significance, a UNDP/ESMAP report estimated that 536,000 households earned income from gathering and selling wood and other biofuels, 158,000 households made and sold charcoal, and 140,000 households were involved in the biofuel trading and distribution network in both the rural and urban areas. Altogether, these estimates suggest that approximately 10% of all rural households in the Philippines receive income from selling biofuels. Furthermore, it was estimated that the sales in biofuels, on the average, is 40% of the total income for these households (UNDP/ESMAP 1992). This also translates into savings in foreign exchange of millions of US dollars from using indigenous resources instead of imported fossil-based fuels.

Cebu

The province of Cebu is located in Central Philippines. It is one of the four provinces comprising Region VII (there are a total of 16 Regions in the country). Geographically, the Philippines consists of 7,107 islands divided into three major groups: Luzon (northern islands), Visayas (central islands, and Mindanao (southern islands). Among all the island provinces in the Visayas and Mindanao, Region VII, provided the highest Gross Regional Domestic Product for the years 1998-2000 (NSO 2001:3-39). Over the decades, it is general knowledge that GRDP for the region may largely be accounted for by the growth and expansion of the city and province of Cebu because it is strategically located and is historically known to be the industrial and commercial center for Visayas and Mindanao.

While industrialization and urbanization rates and human development index is relatively high compared to the other seven regions in the Visayas and Mindanao, it nevertheless also recorded as the fourth highest in terms of magnitude of poor families and population, 429,928 families and 2.5 million people, respectively. This implies that it is a microcosm of the overall income and poverty trend in the country where 40 percent of the entire population continue to suffer from underdevelopment and below poverty income threshold levels (NSO 2001:3-39;2-25).

Dynamics of Bioenergy Industry in Cebu

Cebu, an island province of the Philippine archipelago, depicts a small-scale replica of the way things are at the national level. The patterns of bioenergy use, production, distribution and trade in the city and province of Cebu are typical in the rest of the countryside. What is unique in the case of Cebu is the fact that this island province has long been deforested. A World Bank report claimed in 1989 that Cebu is 99.6 percent deforested (WB 1989). In addition, the island has been reported to be 94 percent deforested dating back to 1870 (Ahern 1901; Roth 1983, cited in Poffenberger 1990).

If Cebu is known to have no pristine forest at least for the last century, how is it that the woodfuel and biofuel industry apparently is a thriving one? Where do the bio-resources come from and for what is it used for? Who are the key players? What socio-economic contribution does it provide the local economy? What role do policy makers play in the management and sustainability of bioresources? What issues and challenges lie ahead?

Biofuel use in the residential sector

Biofuel as primary or secondary household cooking fuel

In the Philippines, there are a number of end uses for biofuel: Cooking and ironing are the two most pronounced uses. Biofuel, particularly fuelwood and charcoal is utilized either as the main or secondary household cooking fuel among Cebuanos. Table 1 shows a trend comparison of primary fuels used for the years 1960 up to 2002. Clearly, in the year 2002 the main household cooking fuel is LPG among Cebu City residents. In that span of a little more than a decade, however, fuelwood and kerosene continue to be the second and third alternative cooking fuels, respectively (Bensel and Remedio 1993; Remedio and Bensel 2002b).

Table 1. Primary cooking fuels in the residential sector of Cebu City 1960 – 2002 (in percent and number of households using)

	1960		1970		1980		1990		2002	
	%	# HHs	%	#HHs	%	#HHs	%	#HHs	%	#HHs
Fuelwood	91.8	37,513	65.1	36,449	57.6	51,136	36.9	42,277	23.0	33,882
Charcoal	0.2	82	0.2	115	-	-	4.6	5,272	3.4	5,063
Kerosene	5.4	2,207	14.4	8,058	12.5	11,098	22.5	25,804	20.3	29,987
LPG	1.0	409	18.4	10,290	27.6	24,459	31.6	36,207	51.2	75,552
Electric	0.8	327	1.7	966	1.8	1,638	4.1	4,646	1.8	2,726
Others	0.8	326	0.3	154	0.5	439	0.3	327	0.3	389
None	-	-	-	-	-	-	0.2	175	-	-
Total	100	40,864	100	56,032	100	88,770	100	114,708	100	147,599

Source: Information for 1960, 1970, 1980 and 1990 was derived from government census reports and appears in Bensel and Remedio, 1993. Information for 2002 appears in Remedio and Bensel FAO unpublished report on Cebu Biofuel Case Study, 2002.

A closer look at the *number* of households using different types of cooking fuels on the other hand, reveal that the figures are not as conspicuous as it were in percentage terms. From 1960-2002, there is a striking decrease in percentage terms of about 68% of households using fuelwood as a primary cooking fuel, but in terms of the number of households actually using, the decrease is only 9 percent. Comparing 1960-90 figures in fact depict increases in number of households using. Figure 2 shows the dramatic rise for the demand of LPG and notably the relatively *steady* use of fuelwood as a primary cooking fuel.

Many households in Cebu (as well as in the rest of the country), make use of multiple cooking fuels, with fuelwood, charcoal and biomass residues often utilized as a secondary or backup fuel. Figure 3 illustrate that the percentage of households in Cebu City making use of different cooking fuels on either on a primary or secondary basis. What is not shown but should be noted is the fact that close to 15% of Cebu's households also make use of other biomass as fuels (coconut shells and husks, bamboo and sawdust). The practice of using multiple fuels suggests that certain types of food are cooked using certain types of fuel (e.g. cooking rice will use LPG or electric rice cooker; tenderizing hard meat will use fuelwood or charcoal).

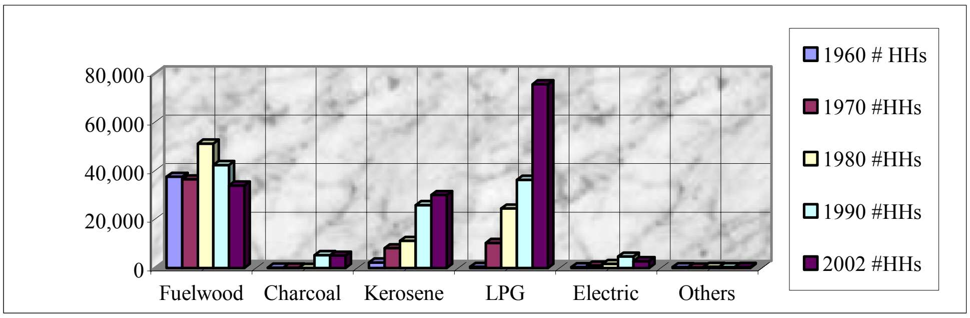

Figure 1. Primary cooking fuels among Cebu City households

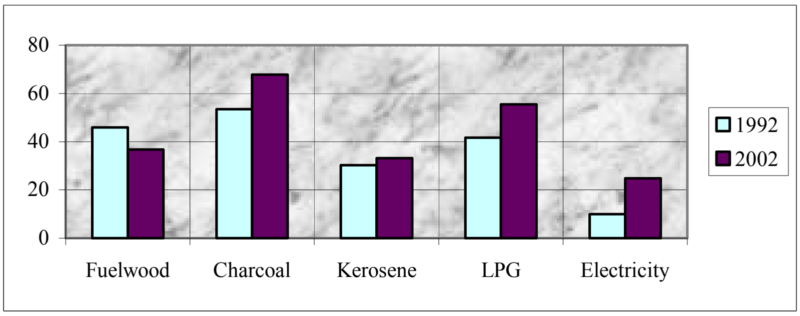

Figure 2. - Percentage of households using cooking fuels on either a primary or secondary basis, Cebu City, 1992-2002

Factors affecting the demand for biofuel use among households

Fuel choice decisions among Cebu City households are driven by a number of factors namely: Income, price, availability and ease of purchasing, taste and preference and fuel quality, as perceived by consumers. Figures 4 and 5 show how income affects the choice of primary cooking fuels. Interesting, the lowest income group for 2002 can already afford to use LPG along with other fuelwood, kerosene and charcoal compared to the lowest income bracket in 1992.

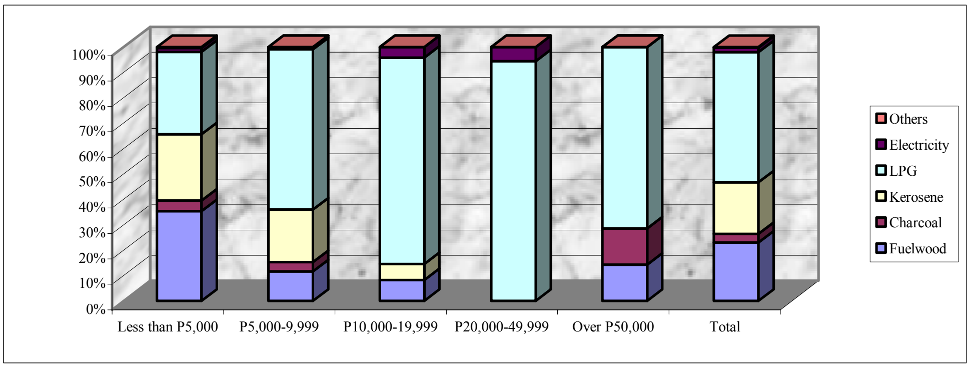

Figure 3. - Primary cooking fuels vs. monthly household income (in percent), Cebu City, 2002

Many households prefer the use of fuelwood for various reasons. One, it is perceived to be economical, two, food cooked in wood stoves tasted better and, lastly, fuelwood is believed to be a good backup fuel for LPG. Households who choose to use LPG and electricity use them because it is found to be convenient, time saving and clean. Charcoal is typically preferred since it is best for barbecue and roasted food. Likewise, it is perceived to be a cleaner fuel than fuelwood and that food is thought of to have a better taste. Culture also determines certain habits. Filipinos are known to be festive the whole year round. Regardless of socioeconomic status, they will find an excuse to celebrate Christmas, New Year, birthdays, baptism, weddings, anniversaries and most importantly, town fiestas in honor of patron saints. No celebration takes place without the famous *lechon* (roasted pig) as the center piece on the table.

Households reported a variety of reasons why they do not choose to use certain fuels for cooking. For non-fuelwood using households, they perceive it to be smoky, dirty, a fire hazard and inconvenient. Charcoal is reported to be expensive, dirty and inconvenient. Non-LPG using households claim that LPG stoves and fuel are expensive to acquire and they think that it is "dangerous". Kerosene is dirty, unsafe, and food can smell and taste bad.

Fuelwood using households acquire this fuel in one of two ways. Some purchase them from stores while others gather them for free from one's own property, from construction sites (scrap wood), warehouses and elsewhere. Fuelwood is typically bundled up and can be purchased from nearby convenient stores or markets priced according to size of bundles. Charcoal is also easily available almost anywhere and the ones for retail is normally placed inside small plastic bags either in two-peso bags or five-peso bags[2]. Charcoal can also be purchased in sacks with prices ranging anywhere from PHP 80.00 to 150.00 depending on location and wood species. Kerosene is purchased in very small quantities (less than one liter) using any kind of bottle or container (PHP 17.00 per liter). The most common LPG container is the 14-kg and the 11-kg tanks which can also be purchased anywhere within less than one kilometer from any dwelling within the central business of the city at prices ranging from PHP 270-300 per tank depending on size of tank and location of store.

Fuel-switching trend among households

It was reported in 1992 (a survey of 603 households) that there was a shift (35% of 113 cases) from fuelwood to kerosene (Bensel and Remedio 1993). In 2002 (a survey of 384 households), the shift (34% of 52 cases) was mostly from kerosene to LPG and followed closely by fuelwood to LPG (Remedio and Bensel 2002b). While the overall trend in Cebu City is to shift from biofuel to LPG, studies indicate that this is not a clear-cut matter of shifting from an inferior to a premium fuel. Households have a variety of reasons for such changes. Those who shift from inferior to premium fuels claimed that the main reason for switching was convenience, meaning that the use of LPG, for instance, allowed them to save time. Moreover, these fuels were perceived to be safer and cleaner to use. Households who moved from using premium fuels to inferior ones disclosed that economic reasons were the main driving factor.

Biofuel use in the commercial and industrial sector of Cebu

Types of industrial and commercial usage

Among commercial and industrial establishments, biofuel end use is also related to food preparation. As such, types of outlets where biofuel is utilized include: restaurants, eateries, prepared food vendors such as barbeque and *lechon* vendors, bakeries, *poso* makers, noodle factories. Institutions and various industries such as hospitals, schools and prisons, as well as blacksmiths and iron gates manufacturers, fashion accessories manufacturers, and rattan furniture makers, are also among the highest consumers of scrap wood, coco-lumber and charcoal.

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[2] Exchange rate is US$ 1.00 = Philippine peso PHP 51.00 (August 2002).

Trade and distribution of biofuel[3]

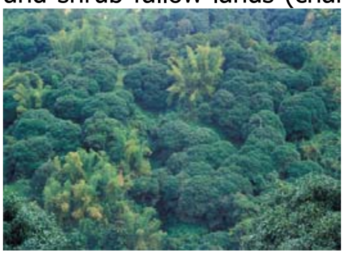
Biofuel flows

In Cebu, at least for the past five decades, trade in biofuel has been known to be a thriving and sustainable informal sector industry. Given that the pattern of biofuel and woodfuel flow is a remarkable rural to urban trading and distribution network. This industry is providing incomes, jobs and livelihood to hundreds of families both in the countryside and in the urban center. A huge network of multi-level intermediaries characterizes the industry. In 1993, it was estimated that a total equivalent amount of US$ 4M (using 2002 prices) of biofuels is harvested, distributed and consumed on an annual basis (Bensel and Remedio 1993; 2002b). It may be said however that there is no one single system of biofuel trading in the province. Instead, it is highly dependent upon the location and distance of biofuel production sites, presence of growers, manufacturers, rural and urban traders, type of fuel being traded and regulatory policies in transporting biofuels. In general, the biofuel marketing system in Cebu appears to be competitive and efficient.

The production and management of biofuel

Types of land use, harvesting and conversion practices

Biofuel production may be found several types of land uses such as: Tree fallow and shrub fallow lands (characterized as coppice lands); woodlots; tree plantation sites; reforestation sites; agro-forestry systems (fruit trees or scattered trees); and in brushland and shrubland areas. Most of the woodfuel production in Cebu originates mostly only from a handful of species. These are: *Leucaena leucocphala,*



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[3] Photos courtesy of Prof. Terrence G. Bensel, Allegheny College, Pennsylvania, USA 1992 and 2002.

Leucaena glauca, Gliricidia sepium, Gmelina arborea, and *Swietenia mahoganii.* Woodfuel coppice lands are normally harvested in rotational patches every 2-5 years. Trees are cut and carried or transported to leveled areas where they can be split, bundled according to sizes of fuelwood or converted into charcoal.

In Cebu, charcoal makers either use local techniques such as the *ham-ak* method where wood is piled on a slope above ground, and then cover it with grass, weeds, banana leaves and a layer of soil before putting fire on it. The other method, the *tinabonan* approach, is a charcoal pit dug on a slope, filled with wood and covered with a metal sheet after firing. The *ham-ak* approach can generate a larger amount of charcoal (60 sacks at a time), and better quality charcoal is produced. The disadvantage (hence the advantage of *tinabonan*) though, is that it requires close monitoring, 24 hours a day over 2-3 day period.

Consumption and Production Estimates

All told, Table 2 summarizes biofuel consumption estimates for Cebu City's commercial/industrial and residential sectors (Remedio and Bensel 2002b). There is a general shift away from fuelwood and biomass residues in the commercial/industrial sector from 1992-2002, while charcoal consumption by businesses more than doubled during this period. Even if restaurants, eateries and other prepared food vendors are historically the largest commercial users of biofuels, they have tended to shift away from the use of these fuels because of problems with smoke.

Table 2. Summary of biofuel consumption estimates in the commercial/industrial and household sectors, Cebu City, 1992 and 2002.

End User	Charcoal Consumption (MT/year)		Fuelwood Consumption* (MT/year)		Biomass Residue Consumption (MT/year)	
	1992	2002	1992	2002	1992	2002
Commercial & Industrial Sector	*6,618*	*14,261*	*16,046*	*6,596*	*9,592*	*998*
Restaurants/Eateries/FoodVendrs	1,327	5,800	7,206	1,433	8,588	91
Barbecue/*Lechon* Vendors	4,744	8,329	14	1,103	35	--
Bakeries	533	--	3,507	3,091	83	--
Poso Makers	--	--	527	427	640	907
Others	14	132	4,792	542	246	--
Household Sector	*7,966*	*8,781*	*45,272*	*47,592*	*10,208*	*18,086*
TOTAL	14,584	23,042	61,318	54,188	19,800	19,084

* Consumption of coconut fronds has been shifted from fuelwood consumption to biomass residues consumption

Combining household and commercial/industrial biofuel consumption shows that aggregate fuelwood use in Cebu City has declined around 12% from 1992-2002, biomass residues use also decreased by 4%, and charcoal consumption has dramatically increased by 58%. Evidently, as urbanization continues in Cebu City, both households and businesses are tending to shift away from fuelwood and biomass residues use primarily because it requires more space and generate too much smoke. On the other hand, an important note should be made on why cultural taste and preferences and economic considerations are the two most important reasons bioenergy continue to occupy a significant share of the total energy market at present and in the years to come. Having said that, biofuel suppliers are also increasingly meeting such demands by providing less smoky, less bulky charcoal. More importantly, since it takes approximately 4-6 tons of wood to make one ton of charcoal, this shift in biofuel consumption patterns could impact on overall demand for forest resources in the province.

Conclusions

Despite the rapid urbanization feat in the second premier city of the Philippines, thousands of households in the city and province of Cebu continue to depend upon biomass resources as their source of primary or secondary household cooking fuel. Commercial and industrial establishments that are prepared (native) food-related also largely depend upon biofuels for the production of their services. These patterns in consumption and production of biofuels have generated incomes and jobs for thousands of families who are involved in the intricate, multi-level biofuel flows and saved the economy millions of foreign exchange every year in lieu of the use of imported fossil-based fuels.

Despite the significance and importance of bioenergy in both the local and national economy, there is still a need to improve the productivity and efficiency of biofuel production as it impacts on the environment. Likewise, government policies on the cutting and transporting of such fuels need to be reviewed at greater length in order to deeply understand the philosophy behind such regulations. While many of these policies may serve to underscore conservation goals on environmental resources, some regulations involving transport permits and protected areas tend to discourage biofuel producers from a more efficient, and sustainable management of the production and trade of these biofuel resources.

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Bioenergy Projects in Remote Communities in Northwestern Canada

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Abstract

Interest in biomass as renewable energy has increased over the last year in the study area. The study area encompasses a large geographical region including Canada's three Prairie Provinces and the Northwest Territories (Figure 1). Efforts to establish bioenergy projects have focussed on remote rural communities. Most remote communities in the study area are located in the forested northern region and are populated predominantly by people of aboriginal ancestry. As a result, projects in these communities must be sensitive to the aboriginal culture and consistent with the communities' values.

Four bioenergy projects were initiated and funded by the Canadian Forest Service during the last year. These were located in Fort Simpson in the Western Arctic, the villages of Beauval and Buffalo Narrows in Northern Saskatchewan, and in the First Nation community of Berrens River in Northeastern Manitoba. These projects are pre-feasibility studies to provide preliminary data on energy requirements and costs or on the forest resource that could fuel biomass systems in communities. The projects were not intended to lead directly to the implementation of a biomass system but to identify further work that needs to be undertaken before investments are made. The projects will provide background material to inform community leaders and to gain their support for bioenergy.

The Canadian Forest Service also funds community-based projects in the study area through its "Model Forest Program." Although these community-based projects under the Model Forest Program do not have bioenergy as a prime objective, they are focussed on understanding rural economies and community interactions within the forest sector.

Summary of bioenergy projects in the study area

Fort Simpson, Northwest Territories

The community of Fort Simpson is located at the confluence of the McKenzie and Liard Rivers in the Western Arctic at latitude 62 degrees north. The community has a population of about 1200, of which 66% are of aboriginal descent. The community is serviced by all weather gravel roads however access is limited at the river crossing during spring thaws and during initial freeze-up. Electrical power is supplied by diesel generators. Heating is mainly by fuel oil or wood although lesser amounts of electricity and propane gas are also used. 50% of the dwellings are owned by their occupants.

The Fort Simpson project had four objectives:

- quantify current energy consumption patterns in the community;
- describe the local forest resource and its availability for community bioenergy projects;
- estimate the sustainability of the forest resource under scenarios of increased use for bioenergy; and
- estimate socio-economic benefits that could accrue to the community from conversion to bioenergy.

One quarter of the 420 residential dwellings was visited to obtain energy consumption information from the occupants. Government records and existing literature were used to estimate consumption in commercial and community buildings.

The survey found that fuel oil was the most common energy source for space heating. Only 14% of dwellings used wood alone with most (44%) supplementing their oil, propane, or electricity systems with wood. Commercial and community buildings do not use wood but rely entirely on fuel oil.

Forest inventory estimates indicate 30,000m^3 is available annually near the community on a sustained basis. The community will require 6-15% of this volume for dwellings and 6-18% for commercial and community buildings depending on the number of dwellings or buildings that will convert to bioenergy. The surrounding forest resource therefore will easily supply the biomass needs of the community and still have surplus volumes for any commercial forestry operations in the future.

The study concluded that residential conversions to high efficiency wood stoves will require six years for payback while commercial and community buildings will require up to 10 years. However the survey also indicated those residents who rent their dwelling are not likely to invest in conversion to high efficiency wood stoves. Landlords have no incentive to make the investment under current conditions.

A major objective for community leaders was how conversion to biomass fuelled heating would contribute to local employment. The study estimates that if from 10% to 50% of dwellings converted to biomass, 92 to 462 harvesting man-days of employment would be created. Conversion for commercial and community buildings would result in 321 to 964 harvest man-days.

The project was seen as a useful exercise by community members. Consultations with community leaders and participation in data collection by community members increased the acceptance of the study at the community level. As a result, future implementation of any aspect of the study will be readily accepted.

Beauval, Saskatchewan

The village of Beauval is located in Northeastern Saskatchewan in the commercial forest zone. Beauval's population of 850 people, is largely of aboriginal descent. The project is focussed on the financial analysis for a district heating system to provide heat to clusters of larger public and community buildings in the village. The heating system will be fuelled by wood waste from a sawmill which is expected to be built nearby. Once operational, five to six permanent jobs will be created to maintain and operate the system.

Preliminary analyses indicate high capital costs are a deterrent to implementing a biomass system. The project likely could not proceed without financial assistance from economic development or environmental grants available to some communities. The planned sawmill will not generate sufficient wood wastes to supply the anticipated biomass plant. However, a smaller version could be feasible. In addition, current lumber markets may jeopardize construction of the new sawmill thus affecting the potential viability of the biomass system.

Buffalo Narrows, Saskatchewan

The community of Buffalo Narrows is located in the commercial forest zone in Northeastern Saskatchewan and has access to considerable forest resources. The community with a population of 1050 - mostly of aboriginal decent - is accessible by all weather roads and is serviced by the provincial electric grid. Electricity is widely used for heating.

The objective of the project was to explore the feasibility of a 2 MW co-generation demonstration plant. Electricity from the plant will be used by the community households or sold to the provincial grid. Heat will be available for valued added industries such as a planned hardwood drying kiln, heating greenhouses, and space heating buildings.

Ample forest biomass resources are available to supply the plant over its 25-year life expectancy. This biomass will be in the form of wood waste from an existing sawmill, considerable areas of fire-killed wood, and from standing timber.

The results of the study indicate such a plant could be financially viable but only if capital costs are absorbed by an outside agency or government.

Berrens River, Manitoba

The community of Berrens River is located on the eastern shore of Lake Winnipeg in Northeastern Manitoba. Berrens River is a First Nation community with a population of 2350 people. Many of its members maintain traditional activities tied to the land.

Although the community is considered remote because access is limited to winter roads only, it is connected to the provincial power grid. This remoteness however does contribute to intermittent power outages that may take up to several days to repair.

The community is considering a forest biomass system for two reasons; (1) to dispose of waste wood from an anticipated sawmill to be built near the community; and (2) to provide low-cost heat from a biomass fuelled district heating system. The project was intended as a pre-feasibility study.

Larger buildings in the community rely mainly on electricity for their heat requirements. Clusters of these buildings such as the community buildings and the school are ideal for conversion to a biomass fired district heating system because of their close proximity to each other. Residential dwellings in this community are more scattered and have a lower priority for inclusion in a district heating system.

During the initial stages of the study, special efforts were made to discuss the project and the technology to community members and leaders to gauge public opinion and to expose any potential objections to a community energy system.

While the project had several objectives, work focussed on identifying suitable building clusters and on holding community discussions on a possible district heating system. The study did conclude however that grants would be needed to offset capital costs to make the project viable.

Conclusion

The four pre-feasibility studies appear to have inconsistent results. This may in part be due to the different objectives. The Fort Simpson project determined the individual homeowners would need to make a personal investment in high efficiency wood stoves to create the demand for firewood and thus create employment in wood harvesting. Most wood currently used for heat in that community is harvested by the user himself so the employment effect may be indirect. With conversion to wood heat, income would be redistributed from the fossil fuel provider to the fuel wood harvester which in this case is the homeowner.

The Beauval project in Northern Saskatchewan could not proceed because of an inadequate wood supply and in addition would not be feasible without government grants to offset capital costs. The project at Buffalo Narrows on the other hand had ample wood fuel supplies but it too was dependent on financial assistance to offset capital costs before being viable.

The Berrens River project's main objective was to determine if the community buildings were spatially located to accommodate a district heating system and to inform the community about bioenergy systems. That study also concluded that capital costs were a main deterrent to project implementation.

The Fort Simpson project could be successful at an individual homeowner level if that individual chose to invest in the higher efficiency wood stove. The other three projects however were dependent on a large capital investment for the benefit of the entire community as opposed to individuals. The initial capital investment appears to be the main hurdle to implement biomass fuelled energy systems in remote communities.

Modelling socio-economic aspects in cases where wood fuels originate mostly from natural forests

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Extended Abstract

Biomass utilisation, bioenergy technologies, their market share, and research interests in these issues vary considerably between different countries. Nevertheless, in most of the countries socio-economic benefits of bioenergy use can clearly be identified as a significant driving force in increasing the share of bioenergy in the total energy supply. In most countries regional employment created and economic gains are probably the two most important issues regarding biomass use for energy production.

Socio-economic impact studies are commonly used to evaluate the local, regional and/or national implications of implementing particular development decisions. Typically, these implications are measured in terms of economic indices, such as employment and monetary gains, but in effect the analysis relates to a number of aspects, which include social, cultural and environmental issues. The problem lies in the fact that these latter elements are not always tractable to quantitative analysis and, therefore, have been precluded from the majority of impact assessments in the past, even though at the local level they may be very significant. In reality, local socio-economic impacts are diverse and will differ according to such factors as the nature of the technology, local economic structures, social profiles and production processes [1]. In cases where wood biomass originates mostly from natural forests, what is the case in Croatia and Slovenia, estimation of direct socio-economical and environmental impacts of bioenergy systems is even more complicated. In regions where natural forests covers more than 50 % of land, population is depending more on income from forests and they are traditionally using wood biomass for heating and cooking. The impacts of increased use of wood biomass are more dispersed between different activities. The challenge for the future is determination and quantification of different impacts on individuals, population and environment.

After completing an overview of the existing tools for socio-economic modelling of different bioenergy systems as well as data needs for selected regions in each of the participating countries, the activities of IEA Bioenergy Task 29 were targeted on preparing a 'toolbox' of existing models and methods for using in participating countries and for application to selected study communities [2].

Through the Task 29 activities it became very clear that the technique likely to yield the best match was highly dependent on the state of development of bioenergy/ renewables in that region. For example, in Croatia and Slovenia there are very few if any reference plants for the study and so some very basic modelling is needed in order to facilitate project build (addressing both the technical and political requirements). By contrast, in Sweden and Austria there are numerous fine examples of projects, which are ready for enhanced consideration. Hence, it is unlikely that one model only can be used for all countries. The other significant difference is source of biomass for energy production. Like in no other country, in Slovenia and Croatia, wood fuels, or biomass in general, originate mostly from natural forests. Finally, Croatia and Slovenia belong to so-called *transition countries* (countries in central, eastern and southern Europe which changed their political and economic systems in the 1990's towards a market oriented democracy) and consequently have some specific economic and social characteristics.

Having all this in mind, researchers from two scientific institutions in both countries, Slovenian Forestry Institute and Energy Institute 'Hrvoje Požar', started to develop a new model for regional based analysis of socio-economic benefits of biomass utilization. This action was based on previous successful and fruitful cooperation [3] with the objective to capture the socio-economic impacts (mainly employment and additional income, but also few others) in the regional economy. The user must supply information on the bioenergy sources and projects in region and economic and energy data on the region. The model uses calculation of costs and normal cash flow analysis to establish the net impact of bioenergy projects on the chosen region and it is based on a traditional *Keynesian Income Multiplier* methodology with a strong regional approach. The model is MS Excel based with 6 connected sheets as follows:

- Sheet 1: the "scene setter", all the regional and plant input data (the only interactive sheet)
- Sheet 2: biomass production (sources, flow, costs, viability,…)
- Sheet 3: bioenergy plants (sources of goods and services, cash flow, costs and revenues,…)
- Sheet 4: Results (Quantification of different socio-economical variables, visual presentation of results)
- Sheet 5: Comments (help for developers)Sheet 6: Calculating sheet (hidden)

The version presented at the workshop is still in an early demonstration phase and a lot of improvements are still to be done. In the future a lot of work should be done to identify different indicators of biomass use in selected region. The main point of future development is not only to calculate the aspects but also to make model more user friendly and to present resultants in such way that they will be easy to understand and that they can be used as a strong tool for biomass promotion in local communities.

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WOOD EN MAN – Forest energy project in Scandinavian and the Baltic states

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Objectives

The project partners in the WOOD-EN-MAN (WEM) consisting of The Danish Forest and Landscape Research Institute (DLFRI), Swedish University of Agricultural Sciences (SLU), Finnish Forest Research Institute (METLA), Norwegian Forest Research Institute (Skogforsk), Forest Research Institute Estonian Agricultural University (FRI), Latvian Forestry Research Institute (SILAVA) and Lithuanian Forest Research Institute (LFRI). The number of participants is approximately 60 persons.

The objectives and the expected achievements of WEM is to 1) develop operational level management guidelines for sustainable utilisation of wood-based biomass from conventional forests for energy, and subsequently, 2) to provide national as well as regional policy recommendations for the further development of sustainable forest management in Europe and for achieving wanted goals on the use of wood-based biomass for energy.

The operational level management guidelines and policy recommendations will be based on analyses of present knowledge as well as new research as described below in five key-topics and eleven workpackages (WP):

a. **Ecosystem nutrient vulnerability**
   1. Nutrient balances
   2. Soil nutrient release capability
b. **Ecological consequences of wood ash recycling**
   3. Wood ash recycling and ecotoxic components
   4. Integrated field experiments
c. **Biodiversity and insect pests**
   5. Biodiversity
   6. Insect pests
d. **Socio-Economics**
   7. Forest management level economy
   8. Policy analysis
e. **Management and policy**
   9. Operational level guidelines
   10. Policy recommendations
   11. Dissemination

Description of work

Nutrient balances will be set-up and compared to soil nutrient release capacity. Biomass equations and nutrient concentration models for calculation of nutrient removal with biomass will be developed. Existing data and models on deposition and leaching will be used. Pedo-transfer functions based on easily observable field characteristics will be developed for assessing soil nutrient release capability. The system should be able to classify individual sites at least into states of not vulnerable, intermediate, or vulnerable.

A *wood ash* experiment will be established in Lithuania and integrated investigations carried out. Existing experiments in the Nordic countries will host selected investigations and previous measurements will be included. Wood ash data (dioxin, PAHs and heavy metals) as well as nutrient and physiological data will be analysed and modelled to describe effects of wood ash on soil and seepage water, soil acidity, tree nutrient status and physiological variables, fine roots, mychorrhiza, nitrification and release of heavy metals to the forest ecosystem.

Insect biodiversity and pests as an effect of storage of woody material in the forest will be studied by annual sampling of insects, mainly long horn beetles (biodiversity) and bark beetles (insect pests). Population sizes will be compared for different storage periods and for different types of woody material.

End-users of the results of WEM will be invited to a workshop in the project period where they will be asked for input to the research of the project. Literature in the fields will be reviewed. Knowledge provided by the project will be transformed and integrated into *operational guidelines and policy recommendations.*

Socio-economics effects of wood-based biomass usage: the market and policy failures will be analysed. The gap between theoretical resources and supply, the competitiveness of wood-based energy to conventional energy systems, effects for employment, and monetary values of environmental effects and mitigation measures will be researched. A simple decision model to support decisions on supplying wood for energy will be developed for forest owners and managers. Collection of new data will primarily be carried out in the Baltic countries. In the Nordic countries existing data will mainly be used. WP7 will study the gap between the theoretically available amount of wood-based resources and the real supply. It will include minimum reservation prices and other decision measure like silvicultural and environmental effects. WP8 will perform financial and economic analyses of market and policy failures in the countries of the consortium for wood-based energy to be competitive compared to other energy systems. WP8 will include a comparison and an evaluation of public fiscal measures like green taxes, levies and other public policy measures in support of energy, climate, environment and forest policies as well as a review of relevant innovative financial and incentive mechanisms. This will be the foundation for recommendations to national Governments and the European Union on implementation of their policies on increased use of biomass for energy production. Based on the modelling of monetary value of adverse environmental effects in WP7, WP8 will also model economic (benefit-cost) effects of utilising wood-based resources for energy (employment, value-added) taking environmental and other societal effects into consideration. Regional effects will be modelled for chosen regions.

Milestones and expected results

The main expected outputs are: 1) A book with operational management guidelines on the ecologically and socioeconomically sustainable production of wood for energy, 2) web pages and publications with countrywise guidelines, 3) a report on policy recommendations at national, EU and Pan-European levels for further development of sustainable forest management and for achieving wanted goals on the use of wood-based biomass for energy in an ecologically and socioeconomically sustainable way, 4) a web page for information and communication with end-users and for internal flow within the project, 5) a tool for personal computers for assessing ecosystem nutrient vulnerability, wood ash compensation and supply of ecotoxic components, 6) a database on wood ash properties, 7) end-user workshops and meetings, and 8) several scientific papers.

STUDENT PAPERS

Left to Right: Mirela Susa (Croatia), Giorgia Franco (UK), Irmgard Herold (Austria)

The Task recently sponsored students from participating countries to gather and analyze data and apply socio-economic models to the regions. This initiative provided an excellent opportunity for the students to exchange ideas and their work will provide data for their final or M Sc. theses. The three students pictured gave interesting presentations at the final Task workshop.

Applying BIOSEM (Biomass Socio-Economic Multiplier): Conclusions from the Styrian (Austrian) Case Study

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Abstract

This paper reports on a case study undertaken for biomass-fired district heating plants in the Austrian province of Styria, and in which the BIOSEM model has been employed. Because it would have been very difficult to collect reliable data for the whole case study region, we have restricted ourselves to an investigation of three biomass district heating plants: Passail, Pischelsdorf, and Kirchberg.

Keywords: BIOSEM, biomass district heating, Austria

Compared to many other countries, Austria is densely wooded, and Styria is the province with the greatest share of forest-covered area of all the nine federal provinces, that is about 60%. This is certainly one explanation why Biomass already accounts for a remarkable 14% of total energy consumption in Styria. Moreover, over the last two decades Styrian energy policy-makers have also significantly fostered the use of Bioenergy systems. After Finland and Sweden Austria has the largest Biomass share in the European Union. The declared potential of Biomass for energy is about 24% in Austria. But the availability of Biomass is not the limiting factor; the actual use depends strongly on the prices of competing fossil fuels (esp. oil and gas), comfort levels, image, market information, and other factors. In fact Styria's share of Biomass energy did not increase in the last years. This is because quite a lot of households replace their old wood-fired heating system with one fired by natural gas or oil. In recent years policy-makers and other actors involved have managed to slow down this trend towards fossil-based systems, and therefore the decrease is not as high as in other countries. Biomass district heating is very important in this respect, because comfort is a crucial aspect in the choice of a heating system. The installation cost of oil or gas heating systems are still considerably lower than those for the installation of Biomass heating systems, although things are improving, as the market, the technologies, and the accompanying services are further developed and manufacturers, installers, builders, architects, and other actors involved learn more about bioenergy systems. On the other hand, the costs for the fuel Biomass in many cases is already lower than for fossil fuels.

In recent years it has been an important aim of the policy-makers to support Bioenergy plants. Today there are almost 200(!) bioenergy (heating) plants installed in Styria, with a capacity of about 190 MW (these are April 2001 figures). Styria has the largest number of Bioenergy plants in Austria. Austria and Styria have been subsidizing biomass district heating plants since the year 1984. Until 1995 plant operators received subsidies up to approximately 55% of the total investment costs! However, this was not necessarily an advantage. Some plants were completely oversized, mainly because of overly optimistic assumptions, and could not work economically because they had a much lower number of district heat recipients than calculated for. Today the subsidies are restricted to 45% for agricultural cooperative societies and to 30% for commercial enterprises.

Most of the Biomass district heating plants in Austria are run by cooperatives, and their members are mainly farmers who buy stakes in the plant, and in turn obtain the right to deliver wood chips. A precondition for obtaining the increased subsidy of 45% is that at least 51% of the cooperative´s shares are held by farmers. Often wood processing firms are stakeholders, too. The stakes held by communities have been diminished because they tend to reduce the subsidies that can be obtained. Only few plants are operated by energy supply companies. The plants are commonly fuelled with bark, wood chips, and sometimes also sawdust. Other feedstock is not very common. In general the farmers are interested in Bioenergy plants, because they can supply the plant with their own Biomass resources and thus earn some additional income. The agricultural sector still plays an important role in the East of Styria. In Weiz about 19% of all jobs are in this sector, in Feldbach even 27%. The agricultural sector is facing an increasingly difficult market environment, and the number of jobs has been declining steadily in the past. Hence farmers are usually very happy about this additional source of income and employment creation.

Bioenergy plants generally do not produce any electricity because of (a) a lack of advanced technologies (e.g. Stirling engines) and (b) cost-competitiveness (in a now fully liberalised market). Production of electricity takes place in the pulp and paper industry, which utilises black liquor for co-generating heat and power. On the basis of the Austrian Electricity Act 'ElWOG' (Elektrizitätswirtschafts- und –organisationsgesetz 2000), the production of electricity from bioenergy is favoured and has made the production of biomass more interesting. Nevertheless there are no producers of electricity from biomass in Weiz so far. Because of numerous uncertainties, especially with regard to the development of the guaranteed feed-in-tariffs in the next years, investment has been sluggish. There are some CHP demonstration projects that make use of the Stirling engine technology and gasification, with the goal to demonstrate technical feasibility and to further bring down costs for small plants as well. An important fact in this respect is that the ElWOG contains percentage targets for the production of electricity from small hydropower (8%) as well as other renewables (e.g. 4% by 2007). Bioenergy will have to contribute the major part in order to achieve the latter target. Besides, there is one coal-fired power station in Styria (Zeltweg), where part of the coal use has been replaced by the use of Biomass (co-firing).

The first bioenergy district heating plants in Styria were erected in 1980, and the late 1980s have seen a remarkable boom for these plants. During that time regional energy advisors („regionale Energiebetreuer") went into the communities as change agents, in order to promote the idea of using bioenergy. Typically, the most important people to convince in local rural communities include the mayor, the council, teachers, physicians, priests, and other influential persons. The first biomass district heating plants erected in Styria were quite heterogeneous, also with regard to the managers installed (a mayor, a teacher, a farmer, a sawmill operator), which has been considered advantageous for the further diffusion of plants because it allowed many potential innovators and opinion leaders to seek interpersonal communication with somebody with a similar background.

The idea to build the Biomass plant in **Pischelsdorf** came from the local community itself, which wanted to replace oil by Biomass in their heating system. To provide all public buildings with bioenergy, they decided to build a district heating system and searched for operators. Today, the cooperative consists mainly of farmers (85%), a sawmill operator, and the community which holds the rest of the shares. For the plant an old building was adapted, and in the year 1989 the first boiler was put into operation. Several years later a second one was installed. Meanwhile the plant operates at full capacity and even more capacity would be needed than is currently available. Also the farmers are satisfied with their revenue (€ 81/odt) and prepared to supply more Biomass in the future.

The plants have been investigated with the BIOSEM Model, which identifies and quantifies the effects of Bioenergy production on the economic environment. Using a Keynesian Income Multiplier approach, the BIOSEM technique makes predictions not only about direct income and employment effects, but also about indirect and induced income and jobs.

Table 1. Total Net Impact (Pischelsdorf)

Total Net Impact Pischelsdorf	
Net Additional Labour Income	€ 21,236
Net Additional Profit	€ 14,179
Net Additional Income/Profit	€ 35,415
Share of Net Additional Income/Profit spent in the Region	47%
Multiplier	1.89
Total Additional retained expenditure from additional Income/Profit	€ 66,934
Average Turnover/Labour Ratio incl. Unemployment pay	€ 122,956
Induced Jobs	0.5
Net Additional Direct Jobs	1.0
Net Additional Indirect Jobs	0.2
Total Net Additional Jobs	1.7

The estimated impacts on income and employment of the Bioenergy plant in **Pischelsdorf** are shown in this table. In Pischelsdorf one direct job has been created, 70% of which is created in the feedstock production and 30% in the conversion process. The 0.2 indirect jobs come from the conversion process. Including the 0.5 jobs induced there is altogether a plus of 1.7 jobs. The additional labour income and profit is very satisfying in Pischelsdorf, even if it appears to be not very much. However, farmers and saw mill owners participate in the plant and get money for the fuel as well. This means that the participants have their important returns from the sale of fuel and not directly from the plant itself, which has also some additional fiscal advantages. Moreover, there is not much sense in separating labour income from agricultural profit because hardly any farmer has employees.

Table 2. Total Net Impact (Kirchberg)

Total Net Impact Kirchberg	
Net Additional Labour Income	€ 19,704
Net Additional Profit	€ 8,275
Net Additional Income/Profit	€ 27,979
Share of Net Additional Income/Profit spent in the Region	47%
Multiplier	1.9
Total Additional retained expenditure from additional Income/Profit	€ 53,160
Average Turnover/Labour Ratio incl. Unemployment pay	€ 122,956
Induced Jobs	0.4
Net Additional Direct Jobs	1.0
Net Additional Indirect Jobs	0.2
Total Net Additional Jobs	**1.6**

In **Kirchberg** the situation is nearly the same as in Pischelsdorf. It was erected in 1988 (in only four month time!) and actually the grid was built too small. As a consequence, a circular grid has been built to further increase the number of recipients. 50 farmers and one company deliver the Biomass, for which they currently get € 76/odt. Most of the time all fuel comes from the participants, and only in years with cold winters some extra biomass from outside sources had to be bought (up to 11%). The financial situation in Kirchberg is similar to Pischelsdorf, which means it is quite satisfying. Because the plant is smaller, the income, profit, and additional jobs generated are slightly lower. Just like in Pischelsdorf there is one direct job created, which is divided in 0.7 jobs in the feedstock production and 0.3 in the conversion process. In total there are 1.6 extra jobs.

Passail was erected in 1996, with a capacity of just above 5 MW. It supplies 102 households and is fuelled by sawdust and wood chips. Passail was one of the plants which were built in a big scale and which at the moment struggles with economic problems. This is the reason why the farmers get only € 29 per odt for their Biomass delivered to the plant. For that price it is impossible to make a profit and thus the farmers have stopped supplies. Therefore, Passail buys all fuel from a firm (Weitzer Parkett) nearby. The most important task in Passail is to get more buildings connected to the district heating grid. A joinery holds 49% of the shares and has planned (already before the plant was built) to erect a subsidiary joinery next to the plant, where it could burn its wood wastes. This project has not been realized yet, however, because the market demand for such products is still insufficient. The possibility still exists that the subsidiary, which would require about 1 MW of heat, will eventually be built. For the joinery the situation of the plant is not seen as a major problem, because it is considered a long-term investment, and they still believe that the investment will eventually pay off some time in the future and that the farmers will sooner or later get fair prices again for the wood chips they deliver. On the other hand, and quite understandably, the farmers are not satisfied with the current situation and would like to start supply again as soon as possible.

Table 3. Total Net Impact (Passail)

Total Net Impact Passail	
Net Additional Labour Income	€ 100,055
Net Additional Profit	€ -232,476
Net Additional Income/Profit	€ -132,421
Net Additional Direct Jobs	4.7
Net Additional Indirect Jobs	1.5
Total Net Additional Jobs	**6.2**

The operating losses of the Passail plant are currently even larger than the labour income that accrue if the farmers delivered their biomass at the offered lower price of €29/odt (i.e. the overall income multiplier is equal to unity). As mentioned before there is no supply from farmers in Passail; thus at the moment no jobs are created. Theoretically there would be 3.4 additional jobs created in the agricultural sector, and 1.3 direct and 1.5 indirect jobs in the conversion process. Unfortunately, BIOSEM does not provide valid results for a plant that is economically not viable such as Passail. Income and jobs are higher in Passail because the plant has a higher capacity and the area of energy crops grown is also larger. Probably the numbers are not that accurate because not all the fuel for the plants comes from farmers and not all their firewood is used for the plants. In Passail usually 20% and in Pischelsdorf 70% comes from local farmers.

Conclusions

In conclusion I would like to say that there are still many elements of uncertainty in such a modelling exercise. It seemed that the BIOSEM model is best adapted to the Bioenergy situation in the UK. For applications in other countries, we suggest that BIOSEM should be better adapted for the particular local or regional situation, and all the data included in the spreadsheets should be carefully verified (e.g. working hours, not all the fuel for the plants comes from farmers, not all their firewood is used for the plant, separating agricultural income and profit, taxes, …).

The final output of the model should be taken as a rough estimate only, and not as a definitive answer. The results are very dependent on the region chosen and the input data used. BIOSEM calculates only jobs that are created in the region. For the case of the three plants studied, the chosen region is quite small and there are no local companies, e.g., for the delivery of plant equipment. If there is an investigation in a district where such a company is located, the multiplier and with it profits and jobs would be higher. Thus some studies (where "a region" is not considered) have found more jobs created with regard to biomass plants than the present study. As a comparison, for example, Steinmüller (you will find the reference in our case study report which is going to be completed in the next couple of weeks), has estimated that one MWh sold requires an input of 4.56 working hours, which would result in approximately 3 jobs/year for a 1 MW plant.

The majority of jobs which are created on the feedstock side are hardly new jobs, but will nonetheless help the farmers to earn some additional income. However, the exact number of jobs preserved cannot be fully identified and their quantification is beyond the scope of the underlying modelling technique.

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Impressions from the IEA Bioenergy International Workshop – Cavtat, Croatia 19-21 September 2002

Giorgia Franco

At the end of my work for Thames Valley Energy on modelling the socio-economic aspects of bioenergy systems in the Thames Valley I was given the opportunity to attend the IEA Bioenergy International Workshop in Croatia in September 2002. At this event I presented to an international audience the results of my research and I also learned about various other fields of research within the Task 29 of IEA Bioenergy.

Research Results

The first objective of my work was to use the computer model BIOSEM (Biomass Socio-Economic Multiplier) to simulate the socio-economic effects that a 5MW biomass plant based in Buckinghamshire (North of the Thames Valley region) would have on the local community.

I looked at three scenarios using the following feedstock for the plant:

- forest residues only
- short rotation coppice (SRC) only
- a combination of both residues and SRC

After some difficulties, the following results were obtained from the model:

Total net impact	residues only	SRC only	SRC+residues	units
Net additional labour income	484,724	274,604	287,731	€
Net additional profit	- 177,957	203,370	203,619	€
Net additional direct jobs	17.2	4.9	5.6	jobs
Net additional indirect jobs	1.1	4.6	4.6	jobs
Net additional induced jobs	4.3	8.2	8.5	jobs
Total net additional jobs	22.7	17.6	18.6	jobs

Table 1. Total net impact of the bioenergy plant

The residues only case appears to produce the greatest net additional labour income and total net additional jobs. This can be explained by the fact that a residues only plant would not displace any existing agricultural activity (as in both cases involving SRC), but would be a completely new industry therefore creating more new jobs. However, the model also showed that the net additional profit in this case would be negative. This result is due to negative values throughout the model calculations and it does not mean that there is a negative profit but rather that the project would not be undertaken in the first place because not economically viable.

The SRC only and SRC and residues cases are not significantly different. This is due to the fact that in the latter case, the SRC is by far the most significant component of the feedstock purely because of its amount and therefore the results are very similar to the SRC only case. However, the number of jobs and profit and labour income are all slightly higher in the latter case because the residues increase the overall feedstock and therefore the plant requirements.

My impressions on the BIOSEM model

The second objective of my work for TV Energy was to assess how easy it is to use the BIOSEM model for someone with no background in economics. This was done in order to asses the possibility of using such model with local communities (e.g. Local Councils).

During this research I found that BIOSEM is not very straightforward to use for someone with no background in economics. A lot of the captions for the data that needs to be inputted are not very explanatory and when an error occurs in the calculations, it is very difficult to track it back to the inputted data to try and solve the problem. Also the User Manual currently available is not very helpful in addressing the issues stated above. As a consequence of this, the results that I have found during my research are not very reliable because a lot of the input data had to be left by default in order to avoid errors.

In order to address these issues, it would be very useful to supply a handbook that clearly explains what data needs to be inputted in the model. Also it would be helpful to incorporate more than one default option to choose from in case the data for the case study considered is not available. Finally it would be helpful if there were more information on why error might occur and how they can be addressed. Such measures would also make the model more interactive and therefore more interesting to use for people from local communities.

My impressions on my work experience with Task 29

The third objective of my work for TV Energy was for me (a university student) to gain some work experience.

The experience of working on the BIOSEM model was very interesting because as well as allowing me to learn skills in data analysis and collection, it also gave me the opportunity to learn more about the socio-economic aspects of developing a biomass plant. More importantly it was an opportunity for me to learn, in practice, about international bioenergy initiatives such as Task 29 as well as good experience in the renewable energy field for me to add to my CV, which I am sure has been very useful in helping me obtain my current position as a trainee in a renewable energy consultancy.

Most importantly of all however, this work experience and especially the workshop in Croatia has been a great opportunity for me to make international contacts in the renewable energy field. During the Workshop, as well as hearing interesting presentations on the work that is being carried out in Task 29, I had the chance to meet many interesting people. The socialising during meals and sightseeing trips has been a perfect opportunity to get to know people on a more informal level and make contacts that I am sure will be very useful in the future, given that it is much easier to work with people that you have met face to face beforehand.

On top of all this I also had the bonus of visiting Croatia, which is a really nice country that I had never had the chance of visiting before.

In conclusion, working on IEA Bioenergy Task 29 has been a great experience for me, very useful in terms of my chances of getting a good job in the renewable energy field and also very interesting and enjoyable throughout.

APPENDIX

IEA Bioenergy

Task 29 – Socio-Economic Aspects of Bioenergy Systems

Final Announcement

for the International Workshop

Socio-economic Aspect of Bioenergy Systems: Issues Ahead

19 – 21 September 2002

Cavtat-Dubrovnik, Croatia

Hosted by Energy Institute 'Hrvoje Požar' Ltd., Zagreb, Croatia

Energy Institute
"Hrvoje Pozar" Ltd
Zagreb, Croatia

Patronage

Ministry of Science and Technology

HGK 1852

Croatian Chamber of Commerce

Task 29 Website: www.iea-bioenergy-task29.hr

Background

IEA Bioenergy is an international, collaborative research programme on Bioenergy (www.ieabioenergy.com). The primary goal of IEA Bioenergy Task 29 ("Socio-Economic Aspects of Bioenergy Systems") is to promote the use of biomass for energy over fossil based competitor fuels in the participating countries through achieving a better understanding of the social and economic impact of bioenergy systems at the local, regional, national and international level. Participating countries are Austria, Canada, Croatia, Japan, Sweden and the United Kingdom.

The Task 29 workshop in Croatia, is part of a series of workshops within Task 29 taking place on a regular basis, but also represents a final event at the end of first three year period of the project. For more detailed information on the Task, its output, and on previous workshops, see www.iea-bioenergy-task29.hr

Workshop Aims and Objectives

The workshop represents the culmination of effort for the task partnership and will provide the opportunity for specialists and non-specialists alike to learn and participate in an action focused on understanding the complex social and economic interactions of bioenergy and community. In particular to:

- Compare and contrast approaches taken to the Task in partner countries
- Learn from Best Practice (including invited papers)
- Hear reports from student and community participants
- Plan and agree future actions and priorities (next 3 year programme)
- Link and learn about related international projects and programmes

Preliminary workshop programme; events

Altogether, the workshop consists of several technical sessions, meetings and excursion as follows:

Tuesday, September 17 – Wednesday, September 18 Arrival in Cavtat (Dubrovnik airport)

Wednesday, September 18 – *Hotel Croatia, Cavtat, Room SIPUN*
16:00 - Meeting of National Team Leaders/Task 29 business session

Thursday, September 19, 9:30- 12:30, *Hotel Croatia, Cavtat, Room SIPUN*
Technical Session I: Country actions and progress reports: Methods, tools and modelling

Roberto Franzosi (UK): **Applying sociological methods and tools to analysing the prospects for community renewable energy projects**
Reinhard Madlener and Leif Gustavsson (Austria/Sweden): **Socio-economics of the diffusion of innovative bioenergy technologies**
Jian Gan & Tat Smith (USA): **Comparative welfare analysis of biomass and fossil energy**
Nike Krajnc and Julije Domac (Slovenia/Croatia): **Modelling socio-economic aspects in cases where wood fuels originate mostly from nature forests**
Keith Richards (UK): **Establishing community based wood heat supply clusters in the Thames Valley**

Thursday, September 19, 16:00-18:00, *Hotel Croatia, Cavtat, Room SIPUN*
Technical Session II: Country progress: Communities and public sector

Kjell Mårtensson and Karin Westerberg (Sweden): **Entrepreneurship and political legitimacy: strategies for implementing renewable energy policies in the public sector**
Tatsuo Yagishita (Japan): **Trends of bioenergy introduction to rural areas in Japan**
Biljana Kulisic, Ranko Tadic (Croatia**): Results and findings of the summer research camp
on energy and climate – Kupa 2001**
Daniel García Alminana & Julije Domac (Spain/Croatia): **Biomass based efficient energy alternatives in Korcula**

Evening programme (informal): City walk – Cavtat, dinner at the Leut restaurant

Friday, September 20, 9:30- 12:30, *Hotel Croatia, Cavtat, Room SIPUN*
Technical Session III: International experiences, related programmes and projects

Miguel Trossero (FAO, Rome): **Socio-economic aspects of wood energy systems in developing countries: A focus on employment**
Jorn Lileng (Norway): **WOODENMAN-joint project**
Elizabeth M. Remedio (Philippines): **Woodfuel use, production, distribution and trade among Southeast Asian countries: The case study of Cebu province, Philippines**
Andreas Grübl (Austria): **EBEEX – The European Biofuel Exhange – A chance for the future**

Friday, September 20, 16:00-18:00, *Hotel Croatia, Cavtat, Room SIPUN*
Technical Session IV: Task work programme for next period

Facilitated discussion

Evening programme: Task 29 dinner at the hotel (local live music)

Saturday, September 21 – Dubrovnik
Social day/Excursion

Instructions for preparation of papers

Papers presented during workshop will be reviewed and published in a set of workshop proceedings.
Papers must be written in English and the complete paper should not exceed six A4 pages. The title of the paper should be informative and concise. It should be followed by the author(s) name(s), organisation, address, telephone, fax and email address.
The body of paper should be predeced with an abstract of 100 to 200 words and list the three most relevant keywords.
Font size: Times New Roman, 10 pt. Line spacing: single. Text alignment: justified left and right.
Figures should not exceed 50% of the whole paper, should be placed near their citation, and should be numbered. Photos and illustrations should be black and white and in enough resolution to enable a quality printing.
References should not appear as footnotes but should be gathered together at the end of the text. When referring to them in the text, type the corresponding reference number in brackets. References should be numbered.
The deadline for papers is: OCTOBER 15, 2002
Please send the complete papers to Julije Domac (jdomac@eihp.hr).

Presentations

Oral presentations will be 20 minutes plus 10 minutes for questions and discussion. There will be further discussion time at the end of each session. Slide and Powerpoint presentation equipment will be available for oral presentations. Please let the organisers know what you intend to use for your presentation If it is Powerpoint, please either email the presentation file itself to Julije Domac before **MONDAY, SEPTEMBER 9, 2002**, or bring your own CD.

Accommodation and Transport

The workshop will be held in Hotel Croatia, Cavtat, Croatia. Participant should arrive at Dubrovnik international airport from where free transport will be provided to the hotel (10 minutes travel time) **Participants need to**

make their own hotel reservations. Please, advise both the hotel and workshop organiser (see attached response forms) about your arrival and departure time in order to make transportation from airport to hotel possible.

The Dubrovnik international airport can be reached from Zagreb (there are several flights during the day), but also from Vienna, Brussels, London and some others European capitals.

More information and timetables:

http://www.croatiaairlines.hr/ (Croatia Airlines)
http://www.airport-dubrovnik.hr/ (Dubrovnik Airport)

IMPORTANT: Please note that Cavtat/Dubrovnik are very popular destinations in September and book your flight well in advance!

More information about the venue is available at: http://www.hoteli-croatia.hr/

More information about Dubrovnik can be found at:
http://dubrovnik.laus.hr/
http://www.dubrovnik-online.com

Registration

If not already, please complete and return the attached workshop response form **as soon as possible.** There will be a registration fee of **EUR 200 to be paid in cash at the registration**, to cover the cost of bus transportation, meeting facilities, coffee breaks during technical sessions and all breakfast and lunches, excursion and publication of workshop proceedings. All participants are invited to the special dinner on behalf of the organisers, which will take place on Thursday, September 20.

Contact

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