BIOMASS & BIOENERGY

Volume 28, Issue 2, Pages 95-266 (February 2005), p 97-106

SOCIO-ECONOMIC DRIVERS IN IMPLEMENTING BIOENERGY PROJECTS

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Abstract
Within the international community there is considerable interest in the socio-economic implications of moving society towards the more widespread use of renewable energy resources. Such change is seen to be very necessary but is often poorly communicated to people and communities who need to accept such changes. There are pockets of activity across the world looking at various approaches to understanding this fundamental matter. Typically, socio-economic 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, institutional, and environmental issues. The extremely complex nature of bioenergy, many different technologies involved and a number of different, associated aspects (socio-economics, greenhouse gas mitigation potential, environment, …) make this whole topic a complex subject. This paper is primarily a descriptive research and review of literature on employment and other socio-economic aspects of bioenergy systems as drivers for implementing bioenergy projects. Due to the limited information, this paper does not provide absolute quantification on the multiplier effects of local and or national incomes of any particular country or region. The paper intends to trigger a more in-depth discussion of data gaps, potentials, opportunities and challenges. An encouraging trend is that in many countries policy makers are beginning to perceive the potential economic benefits of commercial biomass e.g. employment/earnings, regional economic gain, contribution to security of energy supply and all others.

Key words: Bioenergy; Socio-economics; Employment; Earnings.

1. Introduction

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.
Bioenergy has provided millions of households with incomes, livelihood activities and employment. The essence of sustainability of bioenergy projects from a social aspect is how are they is perceived by society, and how different societies benefit from this activity. Avoiding Carbon emissions, environment protection, security of energy supply on a national level or other 'big issues' are for local communities an added bonus, but the primary driving force are much more likely employment or job creation, contribution to regional economy and income improvement. Consequently, such benefits will result in increased social cohesion and stability that stem from the introduction of an employment and income-generating source (table 1).

Table 1. Benefits associated with local bioenergy production [1]

Employment-creation in the sector of bioenergy in particular, is a challenge. Millions depend upon bioenergy as their main source of fuel not only for cooking and heating but more importantly, a source of employment and incomes. Various regions throughout the globe have documented various experiences. The cases have mostly been site-specific and situation-specific. This is particularly true in the case of traditional use vis-à-vis modern uses.
A closer look at the role of employment in the bioenergy sector in general (without any reference to any specific country) revealed the ambiguity of terminologies and operational definitions (i.e. full time employment vs. part time employment; direct employment vs. indirect employment). Employment in

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bioenergy sector is better understood when fundamental assumptions are clarified. These could pertain to: Element in the system (process flows); type of system (conversion process use hence type of system); units of measure (energy units); scale (number of households or people involved) and total number of employment created per energy unit, per amount of land, per GDP measures. The last one is particularly true when bioenergy is for traditional uses. Add to these, employment creation was distinct and different for: traditional and modern bioenergy systems, skilled or unskilled labour, direct or indirect labour, formal or informal sector and direct impact or indirect impact, to mention only few cases.

Apart from uncertainties and lack of precise definitions mentioned above, it is clear that bioenergy can significantly contribute to employment at local, regional and national level. The exact numbers vary and depend on methodology used and input data constraints. Some examples like country case studies for Brazil showed the job potentials in tree plantation for charcoal/steel production and sugarcane cane/bioethanol industry. Similar findings also come from studies done for the Netherlands, Ireland, Croatia, Nicaragua, the European Union, and some Asian countries [2, 3, 4, 5, 6, 7]. The results of all these studies provided evidence in support of the notion that bioenergy provide ample employment opportunities. However this is not true for all countries at all time periods and there are certain conditions to be met and distinctions to be made prior to concluding that bioenergy may or may not be successful for this or that country in question.

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.

The 1990s have seen a substantial diffusion of many renewable energy technologies, often showing two-digit growth rates. In most cases, however, this growth is not self-sustained. Apart from a lack of cost competitiveness, for which policy-makers try to compensate by means of subsidies or quota targets, there are numerous socio-economic and institutional barriers that need to be identified and tackled. In addition, there are a plethora of external net benefits that are not accounted for in the decision-making process. As this paper will show, gaps still exist in our understanding of the socio-economic aspects of bioenergy system. Many assumptions will have to be made, distinctions to be clarified, definitions to be outlined, regional scenarios to be understood, experiences and lessons to be learned.

The objective of the paper is to review the most important socio-economic aspects of bioenergy systems and to discuss them as drivers for implementing bioenergy projects. This paper is a product of consultative and collaborative efforts among many individuals and institutions involved in activities of IEA Bioenergy Task 29 (www.ieabioenergy.com; www.iea-bioenergy-task29.hr).

The term *bioenergy sector* is used throughout this paper as a concept and as a collective phrase to connote all types of bioenergy[1] related activities encompassing production, consumption and distribution by peoples and institutions regardless of geographical coverage. It is meant to be an aggregation of bioenergy as a "sector" similar to the way one would refer to other sectors such as - the energy sector, the household sector, the public sector or the business sector.

2. Review of Socio-economic Aspects of Bioenergy Systems

2.1. The Social Dimension of Bioenergy Systems

In many ways the social implications arising from local bioenergy investment represents the '*woolly*' end of impact studies, nevertheless they can be broken down into two categories: those relating to an increased standard of living and those that contribute to increased social cohesion and stability.

In economic terms the 'standard of living' refers to a household's consumption level, or its level of monetary income. However, other factors contribute to a person's standard of living but which have no immediate economic value. These include such factors as education, employment opportunities, the surrounding environment and healthcare, and, accordingly, they should be given equal consideration.

1 Bioenergy covers all energy forms derived from organic fuels of biological origins that are used for energy production. It comprises all purposely grown energy crops, multi-purpose plantations and by-products (residues, wastes). By-products include solid, liquid and gaseous biological by-products derived from human activities. Wood is presently the most widely used form of bioenergy.

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Moreover, the introduction of a net employment and income-generating source, such as bioenergy production, could help to stem adverse social and cohesion trends (e.g., high levels of unemployment, rural depopulation, etc.). It is evident that rural areas in some countries are suffering from significant levels of outward migration, which mitigates against population stability. Consequently, given bioenergy's propensity for rural locations, the deployment of bioenergy plants may have positive effects upon rural labour markets by, firstly, introducing direct employment and, secondly, by supporting related industries and the employment therein (e.g., the farming community and local/regional renewable energy technology providers, installers and service providers).
Finally, it is often possible to achieve significant and sustained development of local initiatives given genuine local involvement of key stakeholders. The emergence and cultivation of local champions is an essential area for study.

2.2. Macro-economic and Supply Security/ Diversity Effects

Bioenergy contribute to all important elements of country or region development: economic growth through business expansion (earnings) and employment; import substitution (direct and indirect economic effects on GDP and trade balance); security of energy supply and diversification. For energy importing states, biomass use translates into important local economic and employment multipliers. In general terms, biomass is better for national and local economies because the fossil fuel and utility alternatives are very capital intensive, in comparison.
The increased use of bioenergy, which exhibits both a broad geographical distribution, and diversity of feedstock, could secure long-run access to energy supplies at relatively constant costs for the foreseeable future. According to some authors, one of the main obstacles to the expansion and acceptance of bioenergy into world energy markets is that the markets do not acknowledge the real costs and risks connected with the usage of fossil and nuclear fuels. The costs of maintaining channels to fossil fuel sources through military means, should also to be taken into consideration.
The security of energy supply, together with import/export balance is obviousely one of the most important macroeconomic and strategic issue for any country. The growing import dependence ratio in European Union (estimated on 70% before 2030, 90 % for oil), influenced several legislative initiatives (Directives) intended to faciliate development of biofuels market in Europe.
The recently published EC Green Paper: 'Towards a European strategy for the security of energy supply' emphasise the importance of energy indepedence and the possible role of bioenergy and other renewable energy source in overcoming increasing external dependence. Among other solutions and proposed action, the paper proposes to adapt existing fiscal framework for renewable energies. This should enable renewables to benefit from preferential conditions in order to be competitive with other energy sources. Other recognised mechanisms include compensation funds, tax incentives, fixed prices, aid for R&D, priority rights to access electricity networks, development and operating subsidies, a contribution from other sources which are now profitable, etc [8].
On the European market economic 'disruptions' caused by the erratic fluctuations in the price of energy products have been seen several times so far. The tripling of the price of crude oil in 1999 and its effect on the price of natural gas would have a significant impact on the energy bill and the Member States' economies, were prices to remain at the level. The increase in the price of crude oil led to a net transfer from the European Union of nearly an extra EUR 22.7 billion between January and May 2000. The spectacular rise in oil prices since 1999, combined with the fall of the euro has already increased the Union's inflation rate by one percentage point. Economic growth seems to be feeling the effects but growth in GDP remains around 3%. The current situation is leading to a drop in growth rate: 0.3% in 2000 and 0.5% in 2001 [8]. Loss of confidence among market operaters and consumers would aggravate the situation. Current events show that increases in fuel prices can also cause serious social disruption. The strike in autumn 2000 by those particularly affected by the rise in oil prices, notably truck drivers, is an example of this.

2.3. Supply Side Effects

Supply side effects are rather subjective in regional impact studies, as they are commonly deemed to be those impacts, which are the result of improvements in the competitive position of the region, including its attractiveness to inward investment. These effects are likely to differ in kind and will depend upon the development, but generally such 'economies of speculation' relate to changes and improvements in regional productivity, enhanced competitiveness, as well as any investment in resources to accommodate any inward migration that may result from the development.
Taken together, these effects may result in the establishment of complementary economic activity, where related (and often local) industries mushroom in response to increases in local demand. Accordingly,

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supply side effects have a much broader scope, and as such quantitative assessments are much more speculative. Despite this caveat, some projects have been justified purely on the grounds that they may have significant long-term supply side effects, even if they are difficult to quantify with any confidence prior to the development.

2.4. Demand Side Effects

Demand side effects constitute the focal point of the majority of socio-economic impact studies, and are concentrated upon for several reasons. Most notably, they are relatively easy to define and the scale of the investment's impact can be quantified with reasonable accuracy. Moreover, it is the economic impact that is most important to regional developers and decision makers.

Demand side effects are primarily quoted in terms of employment and regional income. They can be categorised accordingly into:

- Direct Effects
- Indirect Effects
- Induced Effects
- Displacement Effects.

The derivation of the above should form the basis of socio-economic analyses. However, the extent to which these effects can be totally captured at a local level will depend crucially on the quality of the information available.

Considerable effort should be made to determine the extent and direction of capital flows both within the region under analysis and, more importantly, out of the specified region. If this 'leakage' element is ignored, then it gives rise to misleading spurious predictions about future employment and income gains. Furthermore, consideration should be given to the duration of the impacts, and only then can a tentative evaluation of the wider effects pertaining to some, or all, of the other factors be attempted.

3. Bioenergy and its employment-creation function

What can the bioenergy sector offer in terms of employment generation? Global scenarios differ. Most developing countries continue to use bioenergy in the traditional way. As this trend remains, unprecedented population growth add more pressure to existing resources. Developed countries, on the other hand, continue to invest in RD&D in furthering advancement in bioenergy technology. International commitments to cut carbon emissions push frontiers and encourage the use of better and environmentally appropriate fuels in the years to come. Global climate change coupled with the convoluting realities of social, political, economic and environment issues make way for many challenges and opportunities.

Approximately 10% of the world's primary energy is presently biomass used in developing countries. It is used very inefficiently, and in very polluting ways exposing hundreds of millions of women and children to indoor air pollution levels from cooking and heating. In addition they spend many hours a day collecting and carrying fuel, instead spending this time in more productive ways. One option to improve the situation of these people is to provide them with access to cleaner fuels and to electricity, in the first place for cooking and water pumping, and also for income generation (employment). The term 'modern biomass' refers to its conversion into such energy carriers.

Modern biomass systems are clean, efficient and safe. Application of such a systems can also facilitate changes in biomass-based employment in developing countries. It is obviously very different to work as a wood-energy producer in a poor developing country than a wood-energy producer in Europe or USA. Employment in the biomass sector can be of low-wage/training/capacity. The fact that more people are needed per energy unit is not necessarily a positive thing. Many biomass energy workers in developing countries would like to have other opportunities of employment to move up in the economic ladder. A comparison of the wages in both developing and developed countries would show that in developed countries the wood-energy worker earns the equivalent to many other technically qualified jobs and can have a average lifestyle. In developing countries the wood-energy worker will probably earn well below an average wage, being left in the lowest economic levels. Therefore, this paper approach is to modernize bioenergy systems in developing countries, maybe loosing some jobs but raising economic level.

There are many promising experiences of modern biomass in developed countries and some promising experiences in developing countries. One of them is the ethanol programme in Brazil, partly described in this study. The programme has desirable general characteristics of sustainability-the raw material is renewable and it is locally produced reducing transport and foreign exchange spending on oil imports; ethanol is superior to leaded gasoline from an environmental perspective and the production of sugar cane-derived ethanol provides rural development benefits, e.g. 700 000 jobs were created.

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In Europe, policy makers recognise that there are added economic benefits from renewables (in this case bioenergy), especially in terms of the potential for employment creation and the development of a strong **export industry**. The renewable energy industry is one of Europe's fastest growing sectors. The Member States encourage the deployment of renewables as an alternative, indigenous energy source with low environmental impacts.

What does the term employment from the perspective of bioenergy projects mean? **Direct employment** results from operation, construction and production. In case of bioenergy systems, this refers to total labour necessary for crop production, construction, operation and maintenance of conversion plant and for transporting biomass. **Indirect employment** is jobs generated within the economy as a result of expenditures related to said fuel cycles. Indirect employment results from all activities connected, but not directly related, like supporting industries, services and similar. The higher purchasing power, due to increased earnings from direct and indirect jobs may also create opportunities for new secondary jobs, which may attract people to stay or even to move in. These latter effects are referred to as **induced employment**. The main issue is: will the bioenergy project provide earnings that are high enough to make it worthwhile to mobilise local resources for implementation?

Table 2 lists estimated figures of bioenergy sector employment among various developing countries. The figures are approximations of employment in production and distribution of bioenergy resources. Hektor [9], has provided a more detailed account of job creation, earnings and employment in bioenergy projects (Table 3). Three types of systems are shown here: Intensive production in marginal lands, woodfuel production with intensive inter-cropping, and large-scale woodfuel production on previously forested lands. Total employment per unit of energy in person-years were derived for the activities of establishment, weeding, harvesting, chipping and administration.

Table 2: Estimated employment figures among various countries [2]

Table 3: Employment and earnings from selected studies among developing/tropical countries (partial) biofuel production [9]

Another synthesis is offered in Table 4, which consideres indirect and induced effects. In previous examples, employment and earnings are held constant. In the real world, woodfuel production effectively catalyses other activities (indirect/induced) and this further translates into more earnings and more opportunties.

Table 4: Employment and earnings per PJ annual fuel consumption among selected Central European projects [10]

"Will an investment in renewables lead to more jobs and economic growth?" was the single question that challenged the study carried out in 1998-99 to evaluate and quantify the employment and economic benefits of renewable energy in the EU. The study funded by the European Commission through the ALTENER Programme was initiated by the European Forum for Renewable Energy Sources (EUFORES) and carried out by a consortium of organisations led by ECOTEC Research and Consulting Ltd. The study provided a complete analysis of employment impacts from renewable energy (more importantly bioenergy) taking into account jobs created both directly and indirectly as more renewable plants are manufactured, installed and operated. It also considered jobs displaced in conventional (fossil or nuclear) energy plants, or jobs lost because of subsidies provided to renewables that could otherwise fund employment in other sectors of the economy. Key highlights derived from the conclusions are that the use of renewable energy technologies will more than double by 2020 and will lead to the creation of about 900,000 jobs by 2020. Approximately 500,000 of these jobs will be in the agricultural industry in order to provide the primary biomass fuels (table 5).

Table 5: Impact on employment in renewable technologies for European Union (new net jobs FTE employment relative to base in 1995) [11]

4. Conclusions

Bioenergy continues to provide a significant amount of global consumer energy. Modern biomass is developing rapidly. Many new and improved bioenergy technologies are reaching the market and, in some cases, are successfully competing with fossil fuels even without government incentives. Bioenergy in its traditional forms, is still the main source of energy in many developing countries, and will continue to be so in the foreseeable future. Bioenergy has often been associated with poor environment and health

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hazards but these attributes are not inherent to bioenergy but the consequence of underdevelopment, cultural factors and so forth. In fact, modern biomass use systems usually results with local health benefits, whether as a result of better wood stove design for people living in rural areas, as a consequence of avoided emission of sulphur dioxide or particles when biomass replacing coal in modern power plant, or even more, as a result of reduced pollution by using biofuels for those living in the many urban centres. Amongst *developing countries*, bioenergy is a source of fuel for people surviving at the subsistence level. It is also a source of income of particular importance during the off-harvest season. Many of the practices currently used by these countries are, however, unsustainable due to a variety of factors. It is sometimes suggested that modernising traditional bioenergy may turn it into a more sustainable venture. This hypothesis needs further research and investigation to prove it one way or the other. Certainly the potential for generating employment opportunities in modern bioenergy applications among developing countries is a topic worthy of serious study. It is imperative to understand the implications (and impacts) of these claims specifically from the socio-economic point of view as it touches on very fundamental aspects of the ways in which people live, gender, health, environment, poverty and rural development issues. Among *developed countries*, particularly in the EU, bioenergy (together with the other renewable energy technologies) is being promoted due to its potential contribution to energy security and environmental benefit (both local and global). Moreover, there is the realisation that deployment of bioenergy has the potential for job creation, improved industrial competitiveness, regional development and the development of a strong export industry. Experiences gained amongst EU member countries relating to employment generation in particular should be disseminated not only within the energy group but to a much larger audience in terms of lessons learned, techniques derived, and case study experiences.

An encouraging trend is that in many countries policy makers are beginning to perceive the potential economic benefits of commercial biomass e.g. employment/earnings, regional economic gain, contribution to security of energy supply and all others. This represents a significant policy shift with regards to the old view in which biomass was viewed as an non-commercial rural source, or poor man's fuel.

This paper clearly shows significant contribution of bioenergy, as a labour intensive technology, to local, regional and national employment. In particular, the following can be concluded:

0. **Employment is a function of bioenergy**. The quantity and quality of "employment" depends upon but not solely on:
   - stage or stages in the overall bioenergy system cycle (i.e. production, conversion, end use);
   - conversion process and stage of conversion process (i.e. tree plantation for electricity production);
   - which setting is being referred to (developing country/traditional/informal vs. developed country/modernized/subsidized or formalized);
   - is it labour-intensive or mechanized.
1. **In every respect, there is a huge difference in the understanding and interpretation of bioenergy as a sector between developing and developed countries, but one conclusion is common: among other renewables, bioenergy has the greatest potential in job creation.**

   Among *developing countries*, bioenergy is a source of fuel for subsistence. It is also a source of income particularly during off-harvest seasons. Many of the current practices however are unsustainable due to many factors. It is said that modernizing traditional bioenergy may turn it into a more sustainable venture. It is imperative to understand the implications of these claims specifically from the socio-economic point of view as it touches way of live, gender, health, environment, poverty and rural development. Among other renewables, bioenergy is the most promising for the developing countries as its mobilization can provide large employment generation schemes, can be linked to ecosystem conservation, and even rehabilitation; furthermore, investments in biomass energy can be an effective tool to combat desertification, can have a significant impact on global climate change and can become a valuable tool in promoting gender equity within the associated natural resources management activities.

   Among *developed countries*, particularly in the EU, bioenergy (together with the other renewable energy technologies) is being promoted due to its potential contribution to energy security and environmental appropriateness. Moreover, there is the realization that deployment of bioenergy has the potential for job creation, improved industrial competitiveness, regional development and the development of a strong export industry. Experiences among EU member countries therefore in terms of employment generation should be disseminated not only within the energy group but also to a larger audience in terms of lessons learned, techniques derived, experiences acquired, among others.

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2. **Among other renewables, bioenergy is the most labour-intensive technology and has the highest employment-creation potential. The level at which it can contribute depends on local demographic and economic conditions. Other conclusions and findings include:**
   - the use of manual systems supplied the local economy with the highest earnings, while the use of mechanized systems gave the local economy only a fraction of the earnings since most of the revenues went to "outside suppliers";
   - large projects tended to give lower impact on employment than small projects;
   - projects based on agricultural crops generated more earnings and employment. In EU, these projects are subsidized and performed on set-aside lands;
   - investment cost per job created in the bioenergy sector is lower than average employment costs of industrial projects, petro-chemical industry and hydro-power;
   - electricity production from bioenergy involve numerous potential external effects such as indirect socio-economic and environmental external impacts of the fuel cycles;
   - the level of direct jobs needed for the operation of bioelectricity systems is about four times higher than the one required for the operation of fossil fuel power plant;
   - bioelectricity production requires several times direct jobs than the production of nuclear electricity;
3. **From a macroeconomic perspective, bioenergy contribute to all important elements of country development:**
   - **economic growth through business expansion (earnings) or employment;**
   - **import substitution (direct and indirect economic effects on GDP);**
   - **efficiency improvement;**
   - **security of energy supply and diversification.**

Acknowledgements

This paper is a product of consultative and collaborative efforts among many individuals and institutions involved in activities of IEA Bioenergy Task 29 (www.ieabioenergy.com; www.iea-bioenergy-task29.hr). Authors wishes to thank many researches from participating countries and especially Bo Hektor, Reinhard Madlener, Joe De Franceschi and Tatsuo Yagishita for successful and fruitful cooperation.

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Tables

Table 1: Benefits associated with local bioenergy production

Dimension	Benefit
Social Aspects	• Increased Standard of Living – Environment – Health – Education • Social Cohesion and Stability – Migration effects (mitigating rural depopulation) – Regional development – Rural diversification
Macro Level	• Security of Supply / Risk Diversification • Regional Growth • Reduced Regional Trade Balance • Export Potential
Supply Side	• Increased Productivity • Enhanced Competitiveness • Labour and Population Mobility (induced effects) • Improved Infrastructure
Demand Side	• Employment • Income and Wealth Creation • Induced Investment • Support of Related Industries

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Table 2: Estimated employment figures among various countries

Name of country	Estimated employment figures	Description and nature of employment
Pakistan	600,000	Wholesalers, retailers in the WF trade. Many are involved in production, conversion, and transportation. About three-quarters are full time, the rest part time. the ratio between traders and gatherers is 1:5
India	3 to 4 million	The woodfuel trade is the largest source of employment in the energy sector
Philippines	700,000 hhs (productions) 140,000 hhs (trade)	Biomass energy production and trade
Brazil	700,000 (800,000) 200,000 (120,000)	Ethanol industry alone Ethanol industry Charcoal industry (Charcoal production)
Kenya and Cameroon	30,000	Charcoal production only
Ivory Coast	90.000	Charcoal production only

Table 3: Employment and earnings from selected studies among developing/tropical countries (partial) biofuel production

(Person years/PJ)	Estab-lishment	Weed-ing	Harves-ting	Trans-port	Chip-ping	Admini-Stration	Total
Intensive production, farmers	112	338	248	70	13	19	799
Intensive inter-cropping	71	196	251	71	13	19	620
Large scale “energy Forestry	34	59	85	51	13	11	252
Earnings $ per PJ	**Estab-lishment**	**Weed-ing**	**Harves-ting**	**Trans-port**	**Chip-ping**	**Admini-stration**	**Total**
Intensive production, farmers	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 “energy forestry”	17 147	27 435	37 723	20576	13 717	34 294	150 892

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Table 4: Employment and earnings per PJ annual fuel consumption among selected Central European projects

	MWth	Direct jobs	Indirect jobs	Induced Jobs	Total jobs	Labour Earning keuro	Country
Forest residues, CHP	8.9	12	7	8	27	348	Croatia
Wood Residues, CHP	6.8	16	4	5	25	974	Slovenia
Wood Residues, CHP	15	40	9	14	65	932	Croatia
Wood Residues, heat	10	52	2	27	81	698	Bosnia and Hercegovina

Table 5: Impact on employment in renewable technologies for European Union (new net jobs FTE employment relative to base in 1995) [EU-ALTENER/EUFORES 2000 study using SAFIRE model]

	2005	2010	2020
Solar thermal heat	4,590	7,390	14, 311
PV	479	-1,769	10,231
Solar thermal electric	593	649	621
Wind onshore	8,690	20,822	35,211
Wind offshore	530	-7,968	-6,584
Small hydro	-11,391	-995	7,977
Bioenergy	449,928	642,683	838,780
TOTAL	453,418	660,812	900,546