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Bioenergy and Job Generation

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Introduction

Biomass utilisation, bioenergy technologies, their market share, and research interests in these issues vary considerably between different countries. Nevertheless, in most 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 creation of regional employment 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 they are perceived by society, and how different societies benefit from this activity. Avoiding carbon emissions, protection of the environment, security of energy supply on a national level, and other 'big issues' are an added bonus for local communities, but the primary driving forces are much more likely to be employment or job creation, contribution to the regional economy, and income improvement. Such benefits result in increased social cohesion and stability stemming from the introduction of an employment and income-generating source. Employment-creation in the sector of bioenergy, in particular, is a challenge. Millions depend upon bioenergy not only as their main source of fuel for cooking and heating but, more importantly, as a source of employment and incomes. Various regions throughout the globe have documented their experiences. The cases have mostly been site-specific and situation-specific.

Task 29 of the Bioenergy Implementing Agreement[1] of the International Energy Agency accordingly focuses its activities specifically on the 'Socio-Economic Drivers in Implementing Bioenergy Projects'. The overall aim of Task 29 is to promote use of biomass for energy over fossil-based competitor fuels in participating countries and world wide by gaining a better understanding of the social and economic drivers and impacts of bioenergy systems at the local, regional, national, and international levels. From its start in 2000, employment or job creation has always been one of the key issues for Task 29. The Task works also to improve the overall assessment of socio-economic impacts of biomass production and utilisation in order to increase uptake of bioenergy and provide better guidance to policy makers.

Task 29 started its activities in January 2000 with the following participating countries: Austria, Canada, Croatia, Japan, Sweden, and the United Kingdom. Ireland and Norway subsequently joined the Task, bringing the total to eight countries.

Issues and Definition

The first questions facing Task 29 when its work started were – 'What does the term employment mean? From the perspective of the bioenergy sector, how is the concept of 'employment' typically addressed?'

1 IEA Bioenergy is one of some 40 energy technology R&D and information dissemination programmes established by the International Energy Agency and its Committee on Energy Research and Technology (CERT). They operate within the IEA's Framework for International Energy Technology Collaboration.

ILO (International Labour Organisation) refers to the 'employed' as all persons above a certain age who during a specified brief period, either one week or one day, were in the categories 'paid employment' (at work, or with a job but not at work) or 'self-employment' (at work, or with an enterprise but not at work) [1].

Faaij [2], considering electricity production from biomass in the Netherlands, views employment in a biomass fuel cycle as two-fold: direct employment and indirect employment. Direct employment results from operation and construction of power plants and fuel production. This includes the total labour necessary for crop production, construction, operation, and maintenance of conversion plant and for transporting biomass. Indirect employment refers to jobs generated as a result of expenditure related to the fuel cycles. Input-output analysis is used to derive indirect employment estimates from multiplier impacts.

The European Commission (EC) ALTENER Programme classified employment in terms of seasonal differences, so that employment effects could be measured with more precision. Employment is categorised according to time periods and is referred to as Full Time Equivalents[2] (FTEs). FTEs include full time, part time, and seasonal workers as defined by their specific tasks, duration of work, and wage modes [3].

The RIOT model (as used in Eufores 2000) offers the concept of net impacts i.e., taking account of employment displaced in conventional energy technologies. The study mentions direct, indirect, and subsidy impacts. Direct impacts are defined as effects within the energy industry (for the renewable and conventional power and heat technologies) or in the agriculture industry (for the renewable fuel technologies). Indirect effects are impacts elsewhere in the economy induced by changes in the purchasing activities of the renewable and conventional energy technologies. Subsidy impacts arise when Government or price subsidies artificially support the renewable energy technology. As a result consumers have less to spend elsewhere in the economy. The final outcomes thus were expressed as the ratios of net additional employment per unit of capacity, for different renewable technologies – in this case, bioenergy [4].

A paper prepared for Task 29 delineates 'job creation' as a term found in the political vocabulary, whereas 'income formation' and 'employment' are words economists and planners would use, but are not clearly distinguishable from each other. Emphasis was put on two ways to measure employment and earnings – the direct method (when data are available) and the indirect method (when data are not sufficient) [5].

More sophisticated approaches to measuring employment and multiplier impacts of bioenergy systems were developed and empirically tested by Task 29 participants in past years. After 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, activities were targeted towards preparing a 'toolbox' of existing models and methods for use in participating countries and for application to selected study communities [6, 7, 8].

Through the Task activities it also became very clear that the technique likely to yield the best result was highly dependent on the state of development of bioenergy renewables in that region. For example, in Croatia or the United Kingdom there are very few reference plants for study and so some very basic modelling is needed (addressing both the technical and political requirements). By contrast, in Sweden and Austria there are numerous good examples of projects for consideration. Hence, it is unlikely that one model can be used for all countries. Basically, the models reviewed to date are seen as most appropriate for 'top-down' assessments, but emphasis should also be given to management/business-type approaches with a summary made of the differences. A report setting

2 FTE means Full time employment equivalent. In EC – ALTENER – SAFIRE definition, employment effects are measured in FTE. The number of FTE working in the economy is calculated from adding full time workers to part time and seasonal workers weighing the latter two according to how many hours a year they work. The definition of a full time worker is usually someone that works more than 30 hours a week all year round.

out the possibilities for using such approaches either alongside more conventional methods employed for case study areas, or using hybridised methods was seen as an important contribution to the Task activities [9].

The Task agreed that, for this analysis, employment in the bioenergy sector should be categorised in FTEs as defined by the EC ALTENER Programme. Additionally, three different forms of employment are recognised:

- Direct employment results from operation and construction of plants and fuel production. This refers to total labour necessary for crop production, construction, operation, and maintenance of conversion plant, transporting biomass, etc.
- Indirect employment is FTEs generated within the economy as a result of expenditure related to the biomass cycles.
- Induced employment is caused by spending additional wages and profits from both biomass production and bioenergy plant activities.

A Review of Bioenergy Sector Employment

Within the international community there is considerable interest in biomass-based employment. Typically, socio-economic implications are measured in terms of economic indices, such as employment and monetary gains, but the analysis includes social, cultural, institutional, and environmental issues. The problem lies in the fact that these latter elements are not always amenable 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. The literature pertaining to bioenergy technology is huge. However, this is not the case when it comes to topics such as employment, connected socio-economics of bioenergy, and other related themes.

Table 1 gives the estimated bioenergy sector employment in various developing countries. The figures are approximations of employment in production and distribution of bioenergy resources. These extremely aggregated figures do not usually include information about seasonality, nature of work, full time or part time work, period and duration of work, and other work-associated details.

Table 1: Estimated employment figures from various source documents [10]

Pakistan	600,000 FTE	Wholesalers, retailers in the wood fuel 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 FTE	The wood fuel 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 FTE (800,000 FTE) 200,000 FTE (120,000 FTE)	Ethanol industry alone (Ethanol industry) Charcoal industry (charcoal production)
Kenya and Cameroon	30,000 FTE	Charcoal production only
Ivory Coast	90.000 FTE	Charcoal production only

Experts participating in Task 29 have provided more detailed accounts of job creation, earnings, and employment in bioenergy projects. One analysis compared three types of systems: intensive production in marginal lands, wood fuel production with intensive inter-cropping, and large-scale wood fuel production on previously forested lands. Another synthesis that considered multiplier effects (indirect and induced) is given in Table 2. In previous examples, employment and earnings were held constant. In the real world wood fuel production generates other activities (indirect/induced) that further translate into more earnings and more opportunities.

In 1997-98, a European Union (EU) sponsored study known as the Biomass Socio-economic Multiplier (BIOSEM) project was carried out in several European countries. Salient points include:

- Large projects tended to have lower impact on employment and earnings than small projects (may be due to diseconomy of scale).
- Multiplier effects appear to be slightly lower than can be found in the general literature and could be caused by the methodology used.
- Detailed calculations were extremely difficult to perform due to the quality of data and the complexities of the variables to be considered.

It was also observed that projects based on agricultural crops generated much more earnings and employment. The key element in that success was the fact that the projects were subsidised under the Common Agricultural Policy (CAP) and performed on set-aside land. The projects included in the study also varied enough in size and type for general comparisons and conclusions to be made. More importantly, the number of jobs and the net earnings are influenced by the type of organisation and the production methods used. Hence, the complexities make it difficult for simple standard methods to be applied for the general appraisal of employment and earnings. Further, the lack of relevant data hinders detailed analyses, especially when applying sophisticated tools such as multiplier impacts. Considering this, it seems more realistic to apply case-specific models based on whatever data are available with a focus on relevant issues rather than to develop a common or standard methodology.

As reported by the US Department of Energy, in the USA economic activities associated with biomass currently support about 66,000 jobs, most of which are in rural regions. It is predicted that by the year 2020, over 30,000 MW of biomass power could be installed, with about 60% of the fuel supplied from over 10 million acres of energy crops and the remainder from biomass residues. This would support over 260,000 USA jobs and would substantially revitalise rural economies.

Table 2: Employment and earnings per PJ annual fuel consumption among selected Central European projects [11]

Project	MWth	Direct jobs	Indirect jobs	Induced jobs	Total jobs	Labour Earning in 000 euro	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

Employment Potentials in the Bioenergy Sector

Global projections of the potential of the bioenergy sector in terms of employment generation differ. Most developing countries continue to use bioenergy in the traditional way, and population growth adds 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, creates many challenges and opportunities.

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. Member States encourage the deployment of renewables as an alternative, indigenous, energy source with low environmental impacts. Although biomass-based employment has an impact primarily in rural areas of developing countries, it is also important in cities and in developed countries, as demonstrated in Stockholm (Sweden), Vienna (Austria), Bracknell (United Kingdom) and some other European cities.

A study was 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 EC 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 [12]. The study took a two-stage approach in calculating the effects of bioenergy on employment: using the SAFIRE (Strategic

Table 3: Predicted capacity and output of bioenergy technology up to 2020 for the European Union [12]

Capacity GW	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Biofuel liquid GW eq.	0.15	0.75	3.88	7.68	11.23	13.42
Biofuel anaerobic	8.12	10.19	16.08	21.58	24.66	26.77
Biofuel combustion	170.09	181.58	204.27	221.28	232.97	236.33
Biofuel gasification	1.64	1.86	3.92	5.38	6.15	6.36
Total	**180.00**	**194.38**	**228.15**	**255.92**	**275.01**	**282.88**
Output TWh						
Biofuel liquid	1.21	5.93	30.00	58.40	85.53	102.14
Biogas	19.43	30.01	57.15	82.94	97.32	106.92
Biofuel combustion	367.51	412.76	496.33	562.90	611.22	630.61
Biofuel gasification	6.56	8.14	20.95	30.20	35.03	36.37
Total	**394.71**	**456.84**	**604.43**	**734.44**	**829.10**	**876.04**

Assessment Framework for Rational Use of Energy) model, energy predictions were made for three time periods using the following scenarios:

- Short-term (to 2005) – Renewables still needing investment support (subsidies).
- Medium-term (to 2010) – By which time carbon or energy taxes will be implemented.
- Long-term (to 2020) – By which time there is convergence of renewable energy prices with conventional energy prices.

'Will an investment in renewables lead to more jobs and economic growth?' was the single question that challenged the commissioned study. 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 (Tables 3 and 4).

Highlights from the conclusions of the study were:

- The use of renewable energy technologies will more than double by 2020. This increase[3] will lead to creation of about 900,000 jobs by 2020 of which approximately 500,000 jobs will be in the agricultural industry to provide the primary biomass fuels.
- Job gains are greatest from biomass technologies, both in the biomass energy industry and in fuel supply.

By 2020, biomass use for power, heat, or biofuels is predicted from SAFIRE to have the potential to create 323,000 jobs, together with a further 515,000 jobs for the provision of fuel as energy crops, forestry or agricultural wastes (Table 5). Interestingly, the analysis assumed that expansion of biological fuel sources occurs *without* displacing employment in conventional agriculture and forestry[4].

Table 4: Impact on employment (net new FTEs relative to base in 1995) in renewable technologies for European Union [12]

Technology	**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**

3 The study clearly cited the fact that renewable energy is more labour intensive than conventional energy technologies in delivering the same amount of energy.
4 The rationale for this, according to the report is that, there is still widespread overproduction of many agricultural products due to price subsidies from consumers and export subsidies from the CAP even though significant areas of land are in set-aside. The political reality of how an increase in energy crop production can be brought about within the framework of CAP and international agreements has not been considered within the commissioned research.

Table 5: Impact on employment in bioenergy technology for European Union (net new FTEs relative to base in 1995) [12]

Technology	2005	2010	2020
Biofuel anaerobic	37,223	70,168	120,285
Biofuel combustion	15,640	27,582	37,271
Biofuel gasification	78,524	96,026	117,151
Liquid biofuels	10,900	32,369	48,709
Energy crops	33,527	56,472	79,223
Forest residues	133,291	139,421	147,170
Agricultural waste	140,823	220,645	288,971
Total	**449,928**	**642,683**	**838,780**

Discussion and Conclusions

Bioenergy continues to provide a significant amount of energy for global consumers. 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. It is encouraging 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 others. This represents a significant policy shift from the old view that biomass was a non-commercial rural source, or poor man's fuel.

Application of modern biomass systems can facilitate changes in biomass-based employment in developing countries. Working as a wood-energy producer in a poor developing country is obviously very different from working in Europe or USA. Many biomass energy workers in developing countries would like to have other opportunities of employment to move up the economic ladder. A comparison of the wages in developing and developed countries would show that in developed countries the wood-energy worker's earnings are the equivalent to many other technically qualified jobs and can support an average lifestyle. In developing countries the wood-energy worker will probably earn well below an average wage, being left at the lowest economic level. This report, as well as all Task 29 findings so far, clearly shows the significant contribution of bioenergy as a labour-intensive technology to local, regional, and national employment. In particular, the following conclusions can be drawn:

1. The task of reviewing bioenergy employment is complex. Bioenergy covers different biomass sources (forests, agriculture, industrial residues, communal waste, urban biomass, etc) various conversion systems (combustion, gasification, etc), a wide range of processes (engines, turbines, fuel cells), and many other institutional and political aspects.

2. Employment is a function of bioenergy. The quantity and quality of 'employment' depends, but not solely, on:

   - the stage or stages in the overall bioenergy system cycle (i.e., production, conversion, end use);

- the conversion process and stage of the process (i.e., tree plantations for electricity production)
- which setting is being referred to (developing country/traditional/informal vs. developed country/modernised/subsidised or formalised); and
- labour-intensive or mechanised systems.

3. In every respect, there is a huge difference in the understanding of bioenergy between developing and developed countries, but one conclusion is common: among other renewables, bioenergy has the greatest potential for 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 current practices, however, are unsustainable. It is said that modernising traditional bioenergy may turn it into a more sustainable venture but it is imperative to understand the implications of this from the socio-economic point of view as it touches way of life, gender, health, environment, poverty, and rural development. Among other renewables, bioenergy is the most promising for the developing countries as it can provide large employment generation schemes, can be linked to ecosystem conservation, and even to rehabilitation; furthermore, investment in biomass energy can be an effective tool to combat desertification, can have a significant impact on global climate change, and can become valuable in promoting gender equity in the management of associated natural resources.

   Among *developed countries*, bioenergy is being promoted because of its potential contribution to energy security and environmental appropriateness. Moreover, there is the realisation that deployment of bioenergy can assist with job creation, improved industrial competitiveness, regional development and the development of a strong export industry. Experiences in employment generation among EU member countries should therefore be disseminated not only within the energy group but also to a larger audience in terms of lessons learned and techniques derived.

4. Since the concept of employment in bioenergy covers a broad range of topics, it is essential to develop precise definitions, agree on standard units, and elaborate a standard methodology to measure and quantify more accurately bioenergy-based employment. Units of measure such as man-years, man-hours per energy unit (PJ, GWh, etc) although found in some work, still need to be incorporated into the analysis in order to be consistent and comparable with reports about other energy sources. Other important issues are the formal connotation of the term employment (i.e., existence of a contract with specified wage rates and other work-related conditions), scale of enterprise, and sociology framework for any analysis which requires public involvement.

5. This report proposes that employment in the bioenergy sector should be categorised according to time periods and referred to as FTEs. FTEs include full time, part time, and seasonal workers as defined by their specific tasks, duration of work, and wage modes. Additionally, three different forms of employment should be recognised:

   - direct employment resulting from operation and construction of plants and fuel production. This refers to total labour necessary for crop production, construction, operation and maintenance of conversion plant, for transporting biomass, etc;
   - indirect employment – FTEs generated within the economy as a result of expenditure related to biomass cycles; and
   - induced employment caused by the spending of additional wages and profits from both biomass production and bioenergy plant activities.

6. Despite the uncertainties and lack of precise definitions mentioned above, it is clear that bioenergy can significantly contribute to employment at local, regional, and national levels. Among other renewables, bioenergy is the most labour-intensive technology and has the highest employment-creation potential. The exact numbers vary and depend on methodology used and input data constraints. However, studies conducted for countries participating in Task 29, EU, USA, and numerous developing countries, as presented in this report, confirm this conclusion.

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