International Labour Organization

Methodologies for assessing green jobs

Policy brief

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I. Introduction

"…. and what about jobs?" This key question is often asked by policy makers around the world when considering whether or not prioritizing sustainable economic development strategies. Policies to go green depend in large parts on the perceived positive or negative impact on employment. To help answer this question, economic modeling can inform the potential employment implications of different policy choices.

This policy brief sets out different methodologies available to assess the employment potential that green policies can offer. The purpose of the brief is to guide focused policy decision-making.

Assessing Green Jobs

Various methodologies for the assessment of employment effect of policy scenarios exist; they offer a means for both the identification and quantification of existing jobs and for projecting how effective policies and investment programmes can be in providing new green employment. The selection of which tools are most appropriate for carrying out a study is largely dependent upon the questions that it sets out to answer. For example, will the study set out to estimate current or potential jobs? Will it take only a 'snapshot' or is it intended to take a more dynamic or longer-term view? Should it also analyse occupational and skills needs and income distribution? Not only are different methodologies suited to answering different questions, but their selection is also dependent on other factors such as the available budget and most importantly, the type and quality of data that is available.

A statistical definition for Green Jobs

Policy definitions for green jobs emphasise their capacity for reducing negative environmental impacts, their potential for building more environmentally, economically and socially sustainable enterprises and for providing fair employment. However, projects that set out to calculate the number of sustainable jobs in an economy or region, or the impact of policies designed to boost employment in sustainable sectors, require a clear statistical definition for *green jobs*. Various empirically measurable definitions have already been developed - for example, Eurostat has published a data collection handbook in conjunction with the OECD (Eurostat Data Collection Handbook on Environmental Goods and Services Sector, 2009). However, the application of such definitions is constrained by the quantity, quality and consistency of data available. New studies must consider whether available data is sufficiently detailed that jobs may be assessed for their green credentials on an individual basis, or whether there is only enough detail for certain industries or companies, in their entirety, to be treated as *green*. Even if there is sufficient information to attempt a classification of green jobs within industries, there is still the problem of determining which criteria to use in identifying green jobs. For example, should working as a bus driver be identified as a green job because travel by bus is more sustainable than travel by car? Should a bus driver's work only be considered green if the bus is running on bio-fuel?

Direct, Indirect and Induced Employment Effects

Investment in sustainable sectors will result in an expansion of production and the generation of a number of *direct jobs*. Expanded production invariably leads to a higher demand for inputs, resulting in an increase in *indirect jobs* in supplier industries. The increased consumer spending of those in these newly created direct and indirect jobs will also create a number of *induced jobs*.

Employment effects

Any study wanting to estimate the potential employment generated by a policy investing in the sustainable economy must also consider what employment effects it will measure. For example, will it seek only to quantify the creation of direct jobs or will it also seek to gauge indirect and induced job creation too? (*See text box, right*) Employees of a geothermal energy plant, for example, may be considered to have green jobs. However, a study might also want to take into account the indirect jobs in businesses that supply the computers and stationery for the plant and the induced employment resulting from these direct and indirect jobs.

It is also important to consider whether gross or net employment effects will be calculated. A study that measures the potential new jobs resulting from a policy or project calculates the *gross employment* effects. However, investment in sustainable energy sectors may also have negative indirect or induced employment effects on other sectors; for example, investment in new renewable energies may also have some negative effects on employment in traditional fossil energy sectors. For the *net employment* effect to be calculated, both the new jobs generated and the potential job losses must be taken into account. Data availability and the methodology or methodologies chosen for the study determine the different employment effects that can be measured.

II. Methodologies for assessing Green Jobs

Various methodologies exist for assessing green jobs on a regional, national or global basis. In the following section the methodologies are presented as general types, though in practice studies often employ multiple methodologies in combination.

- ***Inventories and surveys***

Surveys and inventories can provide a simple and effective way of assessing how many green jobs exist in specific sectors, regions or countries. A survey is usually carried out in the form of a questionnaire sent out to relevant companies, government departments or analysts, whilst an inventory commonly draws on a national or regional database to provide employment statistics. Some such studies are comprehensive, whilst others offer only a snapshot, or 'scale-up' a more limited review so that it can provide an estimate of green jobs for a whole country or region. Inventories and surveys, if repeated consistently over a prolonged period, can also provide a useful measure of the extent of the new employment realised by policies aimed at developing employment in sustainable sectors.

Green jobs in Spain in 2009

Sector	No. of Jobs
Waste water treatment and purification	58,264
Management and treatment of waste	140,343
Renewable energy	109,368
Forest management	32,400
Environmental services to business	26,354
Environmental education	7,871
Organic agriculture and stock breeding	49,867
Management of green spaces	10,935
Industry and services	20,004
Public Sector	53,072
Environmental research & development	21,929
Services	540
Total	530,947

Source: Green Jobs in a Sustainable Economy

Green jobs in Spain (2009)

A study carried out by the Spanish government estimated the number of green jobs in Spain to be 530,947 in 2009, equivalent to 2.6% of Spain's working population. The extensive research employed a combination of both interview and survey techniques to identify and quantify green jobs, and to calculate totals on a sector basis. The approach chosen meant that only direct green employment was included in the total number of green jobs, though the depth of analysis was also able to provide some information as to the potential within each sector for the generation of new employment.

Solar electrification in rural Uganda (2009)

A survey was carried out to ascertain the effects of a project to provide financial and business support for Ugandan companies providing solar home systems (SHS) to households in rural Uganda. The survey examined the activities of three companies and their regional business activities. It found that the companies supported were able to expand their business and that over 30 direct jobs were created because of an increase in sales of SHS devices, and a further 5 indirect jobs were generated as a result of market expansion. The study was also able to conclude that no jobs were 'crowded out' by this expansion and therefore these were 'net' increases resulting from the ability of SHS businesses to target a previously untapped market.

Brazilian inventory of Green Jobs (2009)

Inventory of Green Jobs in Brazil			
	2006	**2007**	**2008**
Total Green Jobs	2,293,505	2,484,799	2,653,059
Total formal jobs	35,155,249	37,607,430	39,411,566

Source: Adapted from the ILO Study: 'Green Jobs in Brazil: How many are there? Where are they? How will they evolve over the coming years?'[1]

The Brazilian government has made green jobs a central part of its national development policy, with the ILO providing technical support for the implementation of green jobs strategy at both federal and state level. Many of Brazils green jobs have been created by extensive development of its renewable energy sector - with many jobs in wind, solar thermal power and solar photovoltaic (PV) power. Brazil has also invested in innovative projects such as the 'My House, My Life' housing program which orchestrated the construction of 300,000 new homes with solar heating systems (SHS) installed, creating 30,000 new green jobs. The inventory was undertaken using data from the Annual Inventory of Social Statistics compiled by the Ministry of Work and Jobs. The original inventory compiled statistics for formal employment in Brazil and the ILO study then disaggregated these figures so that a specific total for *green jobs* could be reached.

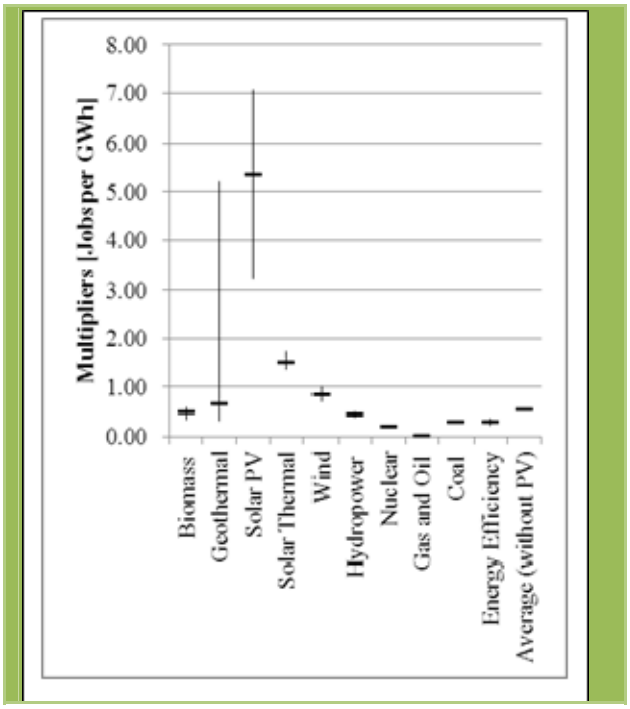
- ***Employment Factors***

Employment factors measure the number of jobs created per unit of produced product or service. It is often used for employment in the energy sector. It calculates installed capacity expressed per megawatt for electricity-generating technologies (MW) or heat-producing technologies (MWth). For renewable energy fuels they may be expressed in jobs per million liters of production or in jobs per petajoule (i.e., by unit of energy content). The data for calculating employment factors can in principle be derived from a number of sources. These might include data from a broad industry survey; from specific enterprises or projects; from feasibility studies and technical literature specifications.

[1] Original publication: Empregos Verdes no Brasil: Quantos são, onde estão e como evouirão nos próximos anos?

German employment in Renewable Energy (2012)

A study from Germany shows that compared to conventional energy sources, most renewable energy sources have a higher labor input per GWh in construction, installation and manufacturing (CIM) as well as in operation and maintenance (O&M). To get an idea of overall employment per GWh, multipliers for O&M and CIM (over the lifetime of the facility) are aggregated. Most jobs per GWh are created in PV (5,36), followed by solar thermal (1,5), wind (0,84), geothermal energy (0,65), biomass (0,49) and hydropower (0,84). Of all the conventional energy sources, coal has the highest labor intensity (0,3) followed by nuclear power (0,22) and finally oil and gas (0,03). Price and income effects are not part of this analysis but need to be incorporated to get the net employment effect.



- ***Input-output analysis and Social Accounting Matrices***

Input-output (I-O) analysis and Social Accounting Matrices (SAMs)[2] are empirical tools that rely on the construction of a matrix or table listing all subsectors in an economy and detailing how outputs from one sector are used as inputs in others. These models draw on information from the national accounts and are the most widely employed methodology for assessing green jobs.

On the table above, the rows show the total output of an industry that is consumed by either other sectors or through final demand (e.g. household consumption). The columns show the share of inputs a sector uses in order to reach its final output. The basic input-output model measures how much additional output is needed from each sector to meet an increase in final demand. If information on the labour intensity of the different sectors in an economy can be obtained, then the matrix can be used to estimate the effect on employment of an increase in demand for a green service or product. Thus, these models can be used to answer questions such as "How many jobs might result from a given program of investment in sustainable economic areas?" or "For a given level of investment, which sector or sectors

Simplified Input-output table

	Agriculture	Food & Beverages	Land Transport	Final Demand	Total Output
Agriculture	1323	2290	6	1911	6467
Food and Beverages	333	1390	17	8074	11670
Land Transport	34	261	480	5794	10775

Source: Adapted from GHK's forthcoming guide: 'Exploring the links between the environment, economy and employment in developing countries: A practitioner's guide'

[2] The difference between I-Os and SAMs: Whilst I-O tables provide a disaggregation of the system of production and can illustrate the interactions within it, SAMs go further by describing the interrelationships of income and transfer flows between different institutional units.

would yield the greatest number of jobs?" I-O models and SAMs are usually used to provide short to medium term projections for policies.

South Korea's Green New Deal (2009)

In January 2009, the Republic of Korea announced its 'Green New Deal'. Under the initiative, South Korea will invest heavily in energy conservation, recycling, clean energy development, green transportation and infrastructure, clean water supply and technology development. National input-output tables were used as the basis for calculating the number of jobs likely to be created for each element of the investment program. The study concluded that the initiative has the potential to create nearly one million new green jobs.

South Korea's Green New Deal Initiatives	
Project	**Predicted Jobs Created**
Eco-friendly transportation networks	200,000
National green information infrastructure	138,100
Water resource facilities & management	3,100
Green cars and clean energy	16,100
Recycling resources	14,300
Forest restoration	16,200
Energy conservation	133,600
Environmentally-friendly living space	170,700
Revitalization of four major rivers	10,800
Other related projects	257,100
Total	960,000
Source: Ministry of Strategy and Finance	

South Africa's Green Jobs Potential (2012)

The 'New Growth Path of South Africa' spelled out in 2011 highlights the Green Economy as one of the ten 'job drivers'. The South African Industrial Development Corporation (IDC) was requested to assess the net direct job creation potential in key sectors of the formal economy. Based on the constructed Input-Output model, it is estimated that by 2025 a total of nearly half a million new/additional jobs can be created. The analysed sectors include energy generation and efficiency as well as pollution control with the highest potential being in natural resource management.

Net direct jobs	Short term (2012)	Medium term (2017)	Long term (2025)
Total	**98,000**	**255,000**	**462,000**
Energy generation	13,565	57,142	130,023
Energy efficiency	31,569	70,193	67,979
Pollution control	8,434	13,189	31,641
Nat. resources	44,512	114,842	232,926

Mauritius' Green Jobs potential (2012)

Green Jobs for Mauritius stands at around 35,000 which is 6.3% of total employment estimated at 558,100. To assess the impacts of different investment scenarios the employment and output multiplier has been calculated using the *input-output* model. The *input-output* table 2009 from the Statistic Office, Mauritius, has been disaggregated into sub-sectors such as green agriculture, sustainable fishing, green textile, recycling, green hotel, sustainable transport, renewable energy among others. Thereby the production linkages for these sectors and sub-sectors have been adjusted.

The output multiplier shows the resulting rise in demand and output in the sector which increases investment as well as in the other supplying sectors. These other sectors produce inputs which are needed in the production process of the sector which increase final output. Similarly, employment multipliers show the generation of employment in the sector itself as well as the other sectors which supply input to the final output sector.

For the purpose of informing policy choices a simple comparison can be made between a green and a conventional growth scenario, using the calculated output and employment multipliers. Assuming a

conservative 2.5% growth in total industrial output per year – which is roughly around Rs. 10 billion – the model allows for a short term simulation between scenarios.

The four main sectors – agriculture (sugar), manufacturing (textile), tourism (hotel) and energy (renewable versus fossil fuel) – have been selected for simulation. An increase in industrial output in those sectors by a combined total of 10 billion Rs. would lead to an increase of 21,600 jobs in the green scenario as opposed to 15, 250 jobs when following a conventional growth path (See table for sector multipliers).

Table 1: One million Rupee increase in final demand and its effects on output, direct and indirect jobs on selected sectors

	Contribution to GDP as % of total	Employment per sector as % of total and % of green and conventional sector shares		Output multi-plier	Direct jobs created by an 1 million Rupee increase in final demand	Indirect jobs created by an 1 million Rupee increase in final demand	Total jobs created by an increase of 1 million Rupee increase in final demand
Agriculture (sugar)	**4%**	**8%**					
Conventional			88%	1.21	2.28	0.29	2.57
Green			12%	1.30	2.28	0.41	**2.69**
Manufacturing (textile)	**18%**	**21%**					
Conventional			95%	1.58	0.7	0.8	1.5
Green			5%	1.54	1.7	0.8	**2,5**
Services (hotel)	**7%**	**7%**					
Conventional			97%	1.37	0.67	0.55	1.23
Green			3%	1.37	1.49	0.55	**2.05**
Energy	**2%**	**1%**					
Fossil fuel			77%	1.6	0.2	0.6	0.8
Renewable			23%	2.5	0.2	1.2	**1.4**
Other sectors	**69%**	**63%**					
Total	**100%**	**100%**	**6.3%**				

Green Jobs in China (2010)

This study employed input-output analysis to examine the potential for employment in renewable energy between 2005 and 2020. China's thermal, wind and solar power industries were all included, with figures calculated using both direct and indirect jobs. The study found that China has the potential to generate millions of jobs in the renewable energy industry over the coming years.

Employment and low-carbon development in China 2005 to 2020			
Sector	**Direct jobs**	**Indirect jobs**	**Sub-total**
Renewable energy	1,149,000	3,575,000	4,724,000
Data Source: Low Carbon Development and Green Employment in China			

The Green Stimulus Program in the United States of America (2008)

A study carried out by PERI (Political Economy Research Institute) set out to estimate the green jobs potential of the Green Stimulus Program in the USA. The study utilized survey figures provided by the U.S. Department of Commerce in the form of I-O tables combined with a series of economic equations to capture indirect and induced employment effects. The model's results indicated that the stimulus program had the potential to create almost two million green jobs. PERI now support the U.S. Department of Energy's work in estimating the employment potential of investment programs.

Total Job Creation through $100 Billion Green Stimulus Program	
Direct jobs	935,200
Indirect jobs	586,000
Induced jobs	496,000
Total job creation	1,999,200

Source: PERI Green Recovery – A program to create Good Jobs and Start Building a Low Carbon Economy

- ***Computable General Equilibrium (CGE) models and System Dynamics***

These models take the work of I-O analysis and SAMs a step further by simulating full economy responses to exogenous changes. Typically they combine empirical data, usually in the form of I-O tables or SAMs, with a series of economic equations designed to comprehensively capture the dynamism and complexity of an entire economy. In this way, they can explore the effects of policies over time on a variety of different macroeconomic parameters, including future employment scenarios. These models allow policy-makers the opportunity to calculate the long-term impacts of policies. OECD's Environmental Linkages Model and the Millennium Institute's Threshold21 (T21)model, which is used by UNEP's Green Economy work, are such CGE models.

Employment shift of climate policy in OECD countries (2012)

An OECD study using the Environmental Linkages Model illustrated a policy scenario of an emission trading scheme (ETS) which, over the period 2013-2050, progressively reduces greenhouse gas (GHG) emissions in all OECD countries combined by 50% in 2050 as compared to their 1990 levels. Assessing the labour market implications the model showed that, up to 2030, there will be quite dynamic expansions and contractions but that these do not translate into a large overall reallocation of jobs. This is because the heavily impacted industries represent only a small share of total employment. By 2030, the change in the sectoral composition of employment induced by the mitigation policy would affect less than 1% of all jobs in the OECD. As national labour markets are assumed to be fully flexible in the model, job destruction and creation are equalised at the aggregate level, hence total employment is not affected by the mitigation policy. The simulation also suggests that by 2030 employment in solar and wind electricity sector in the OECD could be 25% and 40% higher than it would have been in the absence of the climate mitigation policy. By contrast, employment in the fossil fuel and coal mining sectors in the OECD could contract with more than 35%. Important as they are, these are still relatively small numbers as compared to the cross-sectoral employment shifts that were observed over the last decade when the Information and Communication Technology (ICT) transition occurred. Indeed, over the period 1995-2005, total job reallocation between economic sectors –*i.e.* the sum of sectoral job creation and destruction– accounted for 20% of total employment on average in the OECD area.

Global Employment and GDP scenarios of a Green Economy (2011)

The UNEP-led Green Economy Report used a modelling approach to test the hypothesis that investing in the environment delivers positive macroeconomic results, in addition to improving the environment. The modelling tool used is the Threshold 21 World model (T21-World), a system dynamics approach, which comprises several sectoral models integrated into a global model.

The modelling traces the effects of investing various amounts of GDP in green – as opposed to business-as-usual (BAU) – economic activities in terms of stimulating the economy, improving resource efficiency, lowering carbon intensity, and creating jobs. The assumptions underlying the various scenarios are:

- a BAU scenario with no additional investment
- two BAU scenarios with increased levels of investment, but no change in energy and environmental policies (BAU1 and BAU2)
- two green scenarios which combine the higher levels of investment with improved environmental polices (G1 and G2).

The main findings related to employment are that economic development in a green economy pushes total global employment up to 4.8-4.9 billion in the G1 and G2 scenarios (3 per cent to 5 per cent above BAU). Depending on the investment simulated, and its timing, the total net direct employment in green sectors may decline in the short-term (primarily due to a decline in the fishery and forestry sector), to then converge or rise above BAU employment in the medium to long run.

The direct employment gain is projected to range from 134 million to 238 million for the G1 and G2 scenarios, depending on the projected growth of sectors that depend on natural resources. When accounting for the indirect employment effect across the economy as well (jobs created or lost in sectors depending on the ones analysed in more details in this study, e.g. fish distribution), we observe a growth in the range of 126 million to 223 million for BAU1 and BAU2 scenarios and 149 million to 251 million jobs for G1 and G2 scenarios respectively, by 2050. The results highlight the need to confront transition costs of greening, particularly with regard to retraining and preparing the labour force for a lower carbon future.

Scenarios / Employment	BAU1	BAU2	G1	G2
Total employment in 2050 (billion people)	4.7	4.8	4.8	4.9
Employment gains (millions)	97	176	134	238
Indirect employment (millions)	126	223	149	251
Data source: Green Economy Report, Modelling Chapter (UNEP, 2011)				

Renewable energy sources in the European Union (2009)

This study set out to discover the potential impact of renewable energy sources (RES) on economic growth and employment in the EU. Analysis of the historic situation, based on an I-O model, was used to assess the effect that developments in the RES sector have had on other economic sectors.

The I-O tables were constructed using employment data from the EU's Eurostat database, combined with employment coefficients from the EU-KLEMS (Growth and Productivity Accounts) database.

Employment in Germany's renewable energy sector		
2007	2008	2009
277,300	322,100	339,500
Data Source: Renewably Employed! Short and long-term impacts of the expansion of renewable energy on the German labour market		

The study also utilised two separate macro-economic modelling tools, to project potential future economic and employment impacts. The study reached the conclusion that, if renewable energy sources were developed to the point where they provided 20% of the total energy consumption in the EU, there would be a net increase of around 410,000 additional jobs.

Germany's renewable energy sector growth (2010)

Continued investment in Germany's renewable energy sector has meant that employment has grown year-on-year. The empirical basis for this study was a comprehensive survey of companies. This provided the key data for input-output analysis to establish estimates for total employment. By developing a complex macroeconomic model named PANTA RHEI, the long-term net employment impacts in Germany resulting from an expansion of the renewable energy sector could be calculated. The use of PANTA RHEI enabled the study to estimate net employment impacts for various scenarios, depending on electricity prices, the expansion of renewable energy sources and export activity. The highest net employment estimate found that over 300,000 additional jobs will be generated in the renewable energy industry in Germany by 2030.

III. A brief comparison of methodologies

Inventories, surveys and employment factors	Input-output analysis and Social Accounting Matrices	Computable General Equilibrium models
-Relatively simple to carry out, they provide a useful snapshot of the current employment situation and a basis for further assessment using more complex models. - Allow a simple extrapolation from existing employment ratios on short term employment effects of increased activity in one or the other sector	-They are geared to estimating potential employment effects over the short and medium term. -They are relatively fast to construct and both flexible and practical. Their use of data from national accounts means that they also provide a high degree of accuracy on what actually happens in the economy. -Most models offer only a short to mid-term 'snapshot' and cannot provide predictions for a long-term period. Many computable general equilibrium and related models are built upon I-O analysis or SAMs but include additional assumptions to provide more comprehensive, dynamic and long-term analysis of employment effects.	-The detailed level of the models means that they can create a comprehensive picture of an economy and allows the analysis of long-term employment effects. -Building these models requires time, resources and a high level of expertise. -Developing these models requires numerous assumptions and simplifications to be made about how an economy operates over time. Some models assume that markets always clear or do not include unemployment. Such assumptions will ultimately influence model outcomes and limit their explanatory capacity.

The Green Jobs Programme

The ILO addresses the employment opportunities and challenges in a Green Economy and the impacts of climate change and environmental degradation on the *World of Work*. The Green Jobs Programme offers policymakers support in developing national Green jobs assessments and formulate effective policies.

For more information:

Visit the ILO's Green Jobs webpage at: *www.ilo.org/greenjobs*
Contact the Green Jobs Team: *harsdorff@ilo.org*

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