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# Green Jobs Assessment Institutions Network (GAIN) 3rd International Conference: just Transition

## Report and Country Cases

Geneva, 6-7 December 2017

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# Introduction

The third International Conference of the Green Jobs Assessment Institutions Network (GAIN) took place in December 2017. The conference was structured in the format of a workshop with three sessions and its participants were invited to reflect on the subject of “just transition” by asking the following question: while a just transition towards green societies has the potential to create millions of jobs, what are the key needs in relation to employment losses, skills and social protection in regions falling into long-term unemployment and economic decline?

The conference offered GAIN the opportunity to present both positive and negative social- and employment-related outcomes of green economy and climate change policies through quantitative and qualitative focused international research.

In this framework the GAIN Training Guidebook: “How to Measure and Model Social and Employment Outcomes of Climate and Sustainable Development Policies (2017)” was launched at the conference. The main intended audiences of the training guidebook are policy-makers, statisticians, analysts and researchers based in ministries, national statistics offices, employers’ and workers’ organizations, research institutions and universities, and international organizations. Through the GAIN network and the training guidebook, countries can establish, in partnership with the ILO, national technical working groups capable of guiding the building of the models and the analysis of alternative policy scenarios.

This summary of the conference aims as a first stage to highlight its main results, and as a second stage to present the submitted papers on Just Transition following GAIN’s call for papers in partnership with the Input-Output Association (IOA).

# GAIN in today’s context: The role of assessments in the implementation of the Paris Agreement on climate change, SDGs, and ILO Centenary & Future of Work

The GAIN Network is a means of helping countries identify the many opportunities for green jobs. By enhancing the capacity of their research and national institutions, countries will acquire the ability to develop statistical databases, economic models and the knowledge necessary to use their own employment projections for national development planning centred on promoting decent work. Furthermore Sangheon Lee, the ILO Acting Director of the Research Department, said that the GAIN Training Guidebook can be used in parallel with the upcoming ILO World Employment and Social Outlook (WESO) flagship report on greening jobs (May 2018), which will show how green policies impact on the labour market in the framework of the ILO Centenary Green and Future of Work Initiatives.

Assessing the impact of climate policies on jobs is essential in order to define the future actions required, explained William Kojo Agyemang-Bonsu, Manager, Mitigation and Transparency Support, Mitigation, Data and Analysis Programme, UNFCCC, pointing out that to advance such work many countries might need assistance.

Ulrike Lehr, chair of GAIN and Senior Economist at the Institute of Economic Structures Research in Germany (GWS), said GAIN could be understood as a group of economists who think that numbers and empirical results matter in the decision-making process with a view to ensuring a transition towards greener economies. Each estimate or model should be solidly grounded in a method relating to the economic theory used to conduct the application of the theory. The guidebook provides methodologies for a variety of assessments and different modelling approaches. Indeed, assessment tools should clearly indicate their data requirements, assumptions used and limitations. The launching of the guidebook is also especially relevant as this year GAIN has established a new partnership with the International Inputs-Outputs Association (IOA).

# Session One: Launch of GAIN Training Guidebook – Assessing labour market outcomes of climate and sustainable development policies

During the first session Marek Harsdorff, Economist, ILO Green Jobs Programme, introduced the guidebook and explained its structure. While the first module is geared to policy-makers and social partners, the rest of the guidebook focuses on statistics and economic models based on input-output tables and a social accounting matrix. It is therefore designed primarily for statisticians, researchers and economic modellers.

## A) Modules 1-2: Policy and Statistics

Module 1 introduces the concepts and definitions of green economy and green jobs and the rationale for a transition to greener economies, along with the nature and scale of the major structural, macroeconomic and labour-market implications of the greening of economies, in its discussion of country strategies and policies. It also considers the implications of greener economy policies for employment, the use of assessments to inform policy decisions, and reviews the assessment tools and methods. A green economy is one equipped with the tools for achieving sustainable social, economic and environmental development. Finally it also stresses the importance of quantitative assessment in relation to green economy policies and outlines the use of assessment tools and methods to inform policy decisions. To better understand the concept and definitions of a green economy and a low-carbon economy, it is essential to ask some guiding questions, for example what are the impacts and implications of mitigation and adaptation response policies? Moustapha Kamal Gueye, Coordinator, Green Jobs Programme, ILO, explained that green jobs are one of the tools for achieving sustainable social development and referred to the SDGs in a broader context. In fact green jobs not only contribute to preserving or restoring environmental quality but must also offer decent work based on the four pillars of the Decent Work Agenda of the ILO.

A number of economic, social and environmental factors act as drivers in the shift to greener economies. These drivers include changing consumer preferences that reflect a growing awareness of environmental sustainability and protection, the degradation of the environment and ecosystems, and changes in public and private investments, among others. Yet those policies for greening economies will not produce adequate jobs by default but rather by being part of the design, taking into consideration the employment and social dimensions of green jobs. Modelling tools make it possible to better understand and anticipate the impacts of greener economies over a wide spectrum of areas. However, quantitative analysis does not answer everything, and other methodologies remain necessary.

Module 2 of the guidebook introduces statistical definitions and measurement of employment in environmental sectors and green jobs, and describes different sources of data on greening. Valentina Stoevska, Senior Statistician, ILO Statistics, emphasised the need to translate the policy definition of green jobs into statistical concepts that are measurable. She pointed out that green jobs may exists in all industries, including the very brown industries such as mining industries; and that environmental activities can be carried out by all economic units as main, secondary or ancillary activities. On one hand, there are units that produce environmental goods and services for the market as their main or secondary activity - for example collecting used appliances and preparing them for recycling. On the other hand there are units that do not produce environmental goods and services for the market but use environmentally-friendly technologies and processes that make their production processes more environmentally friendly or make more efficient use of natural resources.

## B) Modules 3-4: Green Input Output and Social Accounting Matrix

To introduce Module 3 Margaret Chitiga, Professor at the University of Pretoria, and Marek Harsdorff debated on how to expand conventional Input-Output Tables (IOT), which do not feature in most green activities, so than green industries can be distinguished. The module introduces the method of building simple Employment Projection Models (Green EPM), and of classifying green industries according to the System of Environmental and Economic Accounts

(SEEA). A basic IOT shows inter-industry transactions, with an equal number of industries in the columns and rows. It features the following four major entry blocks: first, intermediate demand, industry-by-industry; second, gross value added; third, imports; and fourth, total final demand.

Subsequently Massimiliano La Marca, Economist, Multilaterals ILO, noted that Supply and Use Tables (SUTS) and Social Accounting Matrices (SAMS) represent the economy and provide the basis for multiplier analysis and more complex simulation modelling. The SUTS framework can include “green industries” and “green goods and services”. A green SUT can be transformed into a “green IOT” following standard SUTS-to-IOT transformation methods. The model is aimed at helping countries understand their Nationally Determined Contributions and see the cross-border effects.

## Session Two: Presentation of conference papers

The second session of the conference offered a tribune for GAIN and other researchers to present their studies and results on the subject of just transition towards greener economies and societies for all.

### A) Country studies

A paper on the Philippine Employment Projection Model (Green PEPM) was presented by Danica Aisa Ortiz, Research Specialist for the Philippine Institute for Development Studies. The paper projects the demand for green jobs, sectors and outputs. It also highlights the importance of dialogue and consultation, by presenting in terms of policy the Philippine Green Jobs Act of 2016 as a springboard and regulatory mechanism for facilitating the promotion of and shift to green activities. To avoid displacement of jobs, guiding and assessing businesses and industries is needed.

From his side, Mwala Lubinda, Namibia University of Science and Technology, noted in his paper titled “Green Jobs and Green Economy Assessment – Namibia”, that the country has a population of 2.1 million, while youth unemployment stands at 47%, unemployment at 29.5%, and poverty at 19.5%. Furthermore he pointed out that quantitative statistics and more general data on the green economy, which are vital to crafting, integrating and evaluating “Going Green” policies, did not previously exist in Namibia. He outlined the need for the country also to focus on the creation of quality jobs following decent work standards, as there is a danger of transitioning to green economy without addressing the impact on poverty.

The case of Just transition in Argentina was introduced by Christoph Ernst, ILO Employment and Productive Development Specialist. His paper showcases the reality of climate change in Argentina, as phenomena such as flooding, storms, extreme temperature and fires have occurred with increasing frequency. The transition to a green economy in Argentina can generate net positive impacts on the economy, employment and society as long as inclusiveness is promoted and social costs are limited. Yet the challenge remains social in Argentina, where there is 33% informality rate, with many people trapped in non-decent jobs. Without a national strategy and a comprehensive and integrated policy package, the potential of such a shift may not be reached and social adjustment costs could be high. Policy packages have to be framed at both macro and micro levels.

Kirsten Svenja Wiebe, Norwegian University of Science and Technology, presented a global model estimating the impact on the labour market up to 2030 of the transition to a green economy, a process involving significant changes in the structure of economic production. Not only are energy-intensive industries affected, but other industries with close relationships to the natural environment, such as agriculture, also have to undergo significant changes. The results on the impact of a transition to a green economy on the labour market are presented using the newly developed projection of a Multi-Regional Input-Output System (MRIO). The model is driven by exogenous GDP growth rates and exogenous technological change according to the scenario specification.

### B) Sector studies

For the first presentation on sector studies, Guillermo Montt, Work Income and Equity Unit, Research Department, ILO, presented a paper on “Employment in the electricity sector: Evidence of an employment friendly transition”. This paper analyses the employment effects on a global scale of electricity generation by different sources since 2000. It finds that the additional generation from renewable, non-hydro energy sources has been linked to higher job creation in the electricity sector compared to other energy sources, notably fossil-fuel-based technologies. As predicted, renewable energy also helps reduce greenhouse gas (GHG) emissions. In addition, estimating the economy-wide effects through employment multipliers provides more evidence that developing renewable energy has positive environmental and employment impacts on the entire economy.

In his paper titled Mobility - modelling the economic impact of decarbonizing car travel, Richard Lewney, Cambridge Econometrics, explained that Europe could improve its growth prospects and increase overall employment by supporting auto-sector innovation to curb its dependence on imported oil. There are currently concerns that the transition to a low-carbon economy will be too costly to embark on during the economic crisis. But improving auto-efficiency and switching to domestic energy sources for vehicles could contribute to Europe’s key objectives of stimulating economic growth and mitigating climate change.

Joaquim Bento de Souza Ferreira Filho, University of São Paulo, examined in his paper on the economic impacts of deforestation in Brazil the employment and income impacts of deforestation control in Brazil. Deforestation reduction is a principal target for Brazil, and is probably the most important green policy under discussion in the country. While it shows that the Brazilian economy would not suffer much from stopping of deforestation, people should however be protected from the collateral impacts of the transition, which would disproportionately hurt poorer workers.

Ulrike Lehr talked about Egypt’s challenges in the energy sector resulting from rising energy demand, decreasing domestic shares and energy subsidies. In her paper titled “The socio-economic impacts of renewable energy and energy efficiency in Egypt”, she further explained that population growth in the country has put a strain on the jobs market, in particular from young adults seeking to enter the labour market for the first time. Renewable and energy efficiency expansion can help mitigate both these challenges. Scenarios for future expansion could lead to almost 40,000 jobs in Egypt in renewable and energy-efficient sectors. Ms Lehr outlined that Egypt has the opportunities and the capacity for extensive green development, and could become a regional hub for renewable energy and energy efficiency.

## C) Methods and models

Litia Simbangala, Senior Statistician & Head National Accounts Branch, Central Statistical Office of Zambia, presented Supply and Use Tables. The SUTS is a key framework in national economic accounting. Mr Simbangala explained that SUTS show how goods and services are made available in the economy and how they are used. The environmental (green) activities are defined as economic activities, the primary purpose of which is to reduce or eliminate pressures on the environment or make more efficient use of natural resources. He noted that challenges faced during compilation included a lack of data, inadequate data, classification mix-matches, poor data quality and vertically-integrated industries, mining being an example.

A paper on “Assessing employment impacts of deep decarbonization: an alternative method between input-output analysis and CGE modelling”, was presented by Boris Thurm, Doctoral Assistant, EPFL, who introduced the European Calculator modelling approach. This approach aims to provide decision-makers with a user-friendly solution to quantifying sectoral energy demand, GHG trajectories, and the social implications of lifestyles and energy technology choices in Europe. The model relates emission reductions to human lifestyles, exploitation or conservation of natural resources, job creation, energy production, agriculture, costs, and so forth, in a single approach and tool.

Massimiliano La Marca talked about the paper on Green growth in Zambia: from SUT to green employment model. He introduced supply and use tables for Zambia which are expanded to include green industries in addition to the standard conventional industries. Building on the Green SUT and Social Accounting Matrix, an employment projection model was presented comparing a conventional and a green growth scenario. The employment projection model will facilitate the comparison of conventional and green growth policies and identify their employment impact over time. Such policy tools have not been available to date and have been expressly requested by the Zambian Government to support its economic planning activity.

Ronal Gainza, Programme Officer, Economic and Fiscal Policy Unit, Economy Division, UN Environment, concluded with a paper titled “Do green investments boost climate change mitigation and adaptation benefits while delivering positive social and employment related outcomes?”, a meta-analysis of 17 green economy country studies. Top-priority green investments aim at reducing GHG emissions and increasing their sequestration and storage, followed by climate-oriented investments relating to adaptation and increased country readiness to address more severe climate change scenarios. A green economy is a vehicle for building climate resilience as well as country development priority issues such as energy and food security. Investments within green economy are climate-oriented (i.e. climate-oriented green investment) and deliver sustainable development benefits such as a positive balance in economic growth and in the most important social indicators including employment creation. Finally Mr Gainza emphasised the importance of going to the local think-tank to explain how they can use the data. You need to have good local networks, for example, with the Minister of Economy. Two years is required for a good assessment if every stakeholder is involved. This is why it is important to promote development in in the country.

## Session Three: Way forward: connect research to policy - How can GAIN support country needs in climate policy making?

Tomasz Chruszczow, Special Envoy for Climate Change, Poland’s High-Level Champion for COP24, said there is a growing understanding of the social impact of climate change, which should be taken into account when negotiating policies. However, more awareness among negotiators and governments is required.

It was noted by Angelina Ama Tutuah Mensah, Director, Environmental Protection Agency, Ghana, that there is more quantitative than qualitative data, and there is a need for bridging. GAIN should link to national statistical offices and include a scenario analysis based on climate policies as stipulated by National Determined Contributions and The Paris Climate Agreement. Countries need to acquire the capacity to build their own models but need capacity-building and financial support.

Furthermore, south-south cooperation in climate change has an important role. Vicente Yu, Deputy Executive Director, South Centre, underlined that research institutions are trying to make progress in this regard by using holistic reality-based approaches. Capacity-building is important but assistance in building institutions in developing countries is essential. The science community must understand the specific and respective context in which new policies are applied. There are often misunderstandings due to a developed country, European-North- America-based approach. In consequence a one–size–fits–all approach to modelling is a challenge in researching adequately.

Mr Gueye underlined the need to build capacity locally in order to allow countries to do the work autonomously. It is also important to develop a compelling narrative that politicians and the public can understand.

It was suggested by Ms Chitiga that implementing the training guidebook content should be done step-by-step with people involved in policy-making. South Africa could be one of the training hubs in this regard.

The conference was concluded by Alice Vozza, ITCILO Green Jobs, who stressed that capacity-building demand is evolving and requires a multi-faceted approach. Indeed, knowledge is increasingly coming from participants and not only from trainers.

# Appendix

## Social and Employment Impacts of Green Restructuring: what does it mean for Just Transition policies?

## Country Case 1

# Economic impacts of deforestation reduction scenarios in Brazil[1]

*Joaquim Bento de Souza Ferreira Filho*[2]

## 1. Introduction

Accomplishment of the planned Brazilian Nationally Determined Contribution (iNDC) relies heavily on deforestation reduction. Brazil has made enormous progress in curbing deforestation in tropical Amazonia, mostly as result of years of investment in surveillance methods and of command and control policies. Although deforestation has increased again recently, its control is high on the country´s policy agenda. Deforestation control, however, restricts agricultural and livestock expansion possibilities in the frontier states, which still account for a large share of the population and some of the worst welfare indicators in Brazil.

In this study, the potential effects of several deforestation reduction scenarios in Brazil will be analyzed, with a focus on the distributive impacts, with the aid of a Brazilian general equilibrium model, the TERM-BR. This model was designed specially for land use change (LUC) analysis, and is based on previous work by Ferreira Filho and Horridge (2014).

## 2. Methodology

The TERM-BR model is a recursive, bottom-up, dynamic computable general equilibrium model that includes a detailed regional representation of Brazil, covering 27 regions (26 states plus the Federal District), 110 products, 110 productive activities, ten types of family (classified by family income bracket) and 10 types of work (classified by salary range).

The model allows the design of a baseline for a given economy, that is an inertial growth trajectory with which a second trajectory (policy trajectory), which differs from the first only in terms of the economic policy to be implemented, can be compared. The difference between the two trajectories can be interpreted as the effect of the policy being studied. The TERM-BR model has a particular module designed for land use change analysis, which is described in more detail below. Various alternative deforestation scenarios will be part of the policy scenarios to be analyzed.

## 3. The land use module in the TERM-BR model

The model’s land use module is based on the concept of transition matrices. The transition matrix shows, for example, how many hectares of the Cerrado biome in the state of Mato Grosso, which consisted of natural vegetation in 1994, came under crops in 2002, or remained as natural vegetation. Therefore the model has for each biome in every state a complete transition matrix. The data observed during the period mentioned above was processed to show the probability that each hectare, with given use in each year, will be used differently in the following year.

These transitions are also influenced by relative prices. The transition from pastures or forests to crops, for example, is accelerated by the growth of the relative prices of agricultural products. Moreover, as in the case of this study, the level of deforestation can be projected exogenously in accordance with desired patterns. In this case the Transition Matrix ensures consistency of the information, that is, the increases in the pasture, crop and reforestation areas in a given year have to take account of the increase in the available areas provided by deforestation in the previous year.

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[1] This research was funded by Instituto Escolhas (http://escolhas.org/).

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## 4. The simulation strategy

The model´s database is from year 2005, updated to 2015 through a historical simulation of the database, up until the current period, which is achieved by imposing on the model the observed trajectory of the Brazilian economy during the period in terms of its macroeconomic components. Deforestation in three biomes (Amazonia, Cerrado and Mata Atlântica) up to 2015 was imposed on the model, as well as the trend in the total area of crops and reforestation (silviculture).The period of the projections, therefore, begins in the year 2016 and continues until the year 2030, generating the baseline for the Brazilian economy. The main features of this baseline are described below:

- Projections of population growth by state (IBGE).
- Projected growth of real GDP in Brazil of 2.5% per year.

Deforestation projections per biome, based on the last 5-year average for Amazonia and Mata Atlantica, and 3-year average for Cerrado. This leads to total deforestation at the baseline of 13.7 million hectares (Mha) by 2030, of which 7.4 Mha will take place in the Amazonia biome, 6 Mha in the Cerrado biome, and 0.3 Mha in the Mata Atlantica biome.

Crop area growth projections, according to the observed five-year (2011-2015) average, with an annual increase of approximately 2.5 Mha per year.

Projected growth of reforestation area (eucalyptus and pinus plantations, or commercial forests) of 0.49 Mha per year, by 2030.

The projections described above are consistent with a reduction of 31.1Mha in the area of pasture at the baseline between 2016 and 2030. The choice of pasture area as the adjustment variable is based on the idea that agricultural activities have, in general, higher rates of return than livestock in their current configuration. With faster growth of crops and forestry relative to grassland in the base year, projected deforestation is consistent with that decline.

Three scenarios were simulated:

- Scenario 1 (DZabs): absolute zero deforestation.
- Scenario 2 (DZ2): the rate of deforestation on public lands and in private lands in the Mata Atlantica biome will follow the current trend until 2020, when it will start to diminish until it stops in 2030. Deforestation in private lands in the Amazonia and Cerrado biomes will follow the current trend, but only over non-protected natural vegetation (i.e. legal deforestation), and only on stocks in areas of high agricultural suitability.
- Scenario 3 (DZ3): the rate of deforestation on public lands and in private lands in the Mata Atlantica biome will follow the current trend until 2020, when it will start to diminish until it stops in 2030. Deforestation in private lands in the Amazonia and Cerrado biomes will follow the current trend on existing stocks, irrespective of agricultural suitability.

The net results of the above scenarios, in terms of deforestation deviation from the baseline, can be seen in Table 1.

**Table 1. Deforestation, percentage variation from the baseline, by region. Million hectares.**

| REGIONS | DZABS | DZ2 | DZ3 |
|---|---|---|---|
| **1 Rondonia** | 0.97 | 0.48 | 0.16 |
| **2 Acre** | 0.41 | 0.25 | 0.05 |
| **3 Amazonas** | 0.76 | 0.14 | 0.09 |
| **4 Roraima** | 0.20 | 0.03 | 0.02 |
| **5 Pará** | 3.15 | 1.90 | 0.31 |
| **6 Amapa** | 0.02 | 0.01 | 0.00 |
| **7 Matopiba** | 4.40 | 2.01 | 0.18 |
| **8 PernAlag** | 0.00 | 0.00 | 0.00 |
| **9 RestNE** | 0.00 | 0.00 | -0.01 |

| | | | |
|---|---|---|---|
| **10 MinasG** | 0.56 | 0.09 | 0.05 |
| **11 SaoPaulo** | 0.00 | -0.01 | -0.02 |
| **12 RestSE** | 0.00 | 0.00 | 0.00 |
| **13 Sul** | 0.00 | -0.02 | -0.02 |
| **14 MtGrSul** | 0.21 | 0.02 | 0.01 |
| **15 MtGrosso** | 2.64 | 0.68 | 0.13 |
| **16 GoiasDF** | 0.38 | 0.04 | 0.01 |
| **TOTAL** | 13.72 | 5.60 | 0.95 |

The data in Table 1 represent the avoided deforestation (or the area of lost pastures) in each scenario, relative to the baseline. As can be seen, the DZabs scenario, which simulates total interruption of deforestation from 2016, would imply a total increase in the area of native forests of 13.7 Mha from the baseline, as accumulated by 2030 (avoided deforestation). In scenario DZ2 the total gain in forest areas (or, as is symmetrical, loss of pasture areas) would be lower, at 5.6 Mha, while in the DZ3 scenario there would be a gain of 0.95 Mha of forests.

## 5. Results

In terms of economic impacts, the total extent of avoided forest losses (or, again, the loss of pasture landings) is not the only variable to be observed. Considering that the economic activity has an uneven distribution in the territory, and that the productivity of pastures lost is not equal in all regions, these impacts are not directly proportional (**Table 2**).

**Table 2.** Model results. Macroeconomic variables. Percent variation, aggregated in 2030.

| | DZABS | DZ2 | DZ3 |
|---|---|---|---|
| Household consumption | -0.58 | -0.21 | -0.03 |
| Real investment | -3.32 | -1.35 | -0.22 |
| Real government consumption | -0.58 | -0.20 | -0.03 |
| Exports volume index | 1.94 | 0.76 | 0.13 |
| Imports volume index | -0.85 | -0.36 | -0.06 |
| GDP (real) | -0.62 | -0.22 | -0.03 |
| Wages (real) | -1.23 | -0.48 | -0.08 |

*Source: model results.*

The accumulated GDP loss by 2030 is small in relative terms. The largest loss observed would be in the DZabs scenario, a fall of 0.62% of GDP by 2030. This is the social cost of avoided deforestation (or lost pastures), once all associated economic losses in the economic system are computed. In monetary terms GDP losses, accumulated up to 2030 and expressed in 2016 values, are estimated at R$46 billion (R$3.1 billion per year) for the DZabs scenario, R$ 16.9 billion (R$1.1 billion per year) for the DZ2 scenario and R$2.3 billion (R$153.4 million per year) for the DZ3[3] scenario. Only as a reference for the orders of magnitude involved, the total rural credit volume made available in 2016 in Brazil was R$162 billion (Central Bank of Brazil, 2017).

As can be seen, this value is small and is associated with the small share of livestock in total Gross Value Added of

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[3] Values deflated using a consumer price index (IPCA).

the Brazilian economy, which was approximately 1.5% in the base year (2005). Considering that the grassland area in the base year was approximately 160 Mha, the simulated loss of pasture area accounts for less than 10% of the total area in the base year.

Losses in pasture areas lead to a general reallocation of livestock production in the territory where the largest relative fall occurs in the production of livestock activities, which directly use pasture. Not all products are negatively affected by the policy. Products with a significant exported share, either directly as a primary product or indirectly through their processed products, or even imported, have their domestic production increased. This is because the policy shock generates a real exchange rate devaluation, with an equivalent loss in the terms of trade, benefiting the exported products (soy, coffee and forest products mainly), as well as those with high imports if prices are high). These products tend to benefit from policies by expanding their production to the detriment of others.

The results relating to social losses (GDP) can be seen in regional terms. In this case the GDP fall, which is quite small when considered against the Brazilian aggregate, shows significantly higher values in some states. In all scenarios the states in the agricultural frontier would typically lose more than those in the southeastern region, since at the baseline deforestation takes place mainly at the frontier. The states of Rondonia, Acre, Pará and Mato Grosso would in general be the most affected states.

The distribution of social costs between regions is a crucial element in the political economy of any policy. Deforestation reduction policies should take into account these asymmetric losses in order to obtain the political support of different actors in the process. In this context discussions on compensation mechanisms for loser states may be important for the success of policies to contain deforestation.

The reduction of economic activity, expressed by the fall in GDP, generates uneven effects in the economy for workers with different types of qualification (Table 3). In this table workers are classified in ten different types according to their wages, as a “proxy” for skills; for example the OCC1 category is the least qualified and OCC10 is that with the highest qualification.

**Table 3.** Model results. Percentage changes in real wages, by type of work occupation, accumulated in 2030.

| OCCUPATION TYPE | DZABS | DZ2 | DZ3 |
|---|---:|---:|---:|
| 1 OCC1 | -2.61 | -1.08 | -0.15 |
| 2 OCC2 | -2.60 | -1.12 | -0.16 |
| 3 OCC3 | -1.70 | -0.67 | -0.11 |
| 4 OCC4 | -1.63 | -0.64 | -0.09 |
| 5 OCC5 | -1.73 | -0.70 | -0.11 |
| 6 OCC6 | -1.59 | -0.62 | -0.10 |
| 7 OCC7 | -1.48 | -0.58 | -0.09 |
| 8 OCC8 | -1.36 | -0.53 | -0.09 |
| 9 OCC9 | -1.09 | -0.41 | -0.07 |
| 10 OCC10 | -1.06 | -0.40 | -0.06 |

The wages of the least skilled workers would show a greater fall than those with higher qualifications. Agriculture is relatively more intensive in low-skilled labour than in the wider economy, which explains the result. As the policy shock (reduction of deforestation) primarily affects agriculture and livestock, less skilled workers (OCC1) tend to experience a larger decline in real wages than do higher-skilled workers (OCC10).

The lowest wage-earners are concentrated in lower-income families, and *vice versa*. Thus the greater fall in the salary of the less-skilled workers tends to affect more negatively the incomes of the poorest families, and their consumption. One must also add the effect of the composition of the consumption baskets of the different income-level families. Poorer households carry a greater weight of food in their consumption basket than the richer ones. The latter, on the other hand, have a relatively greater weight of services in their consumer baskets than the poorer ones. The combined result of these effects can be seen in Table 4, where families classified as POF1 are those with the lowest income and those classified as POF10 the richest: real consumption falls more in the poorest families. The richest families (POF10) would even increase consumption (in real terms) in scenarios DZ2 and DZ3. This is associated with the composition of their consumption basket: in the richest families (POF10), consumption of services represents about 32% of total expenditure in the base year, whereas for the poorest (POF1) the equivalent figure is only 2.2%.

The service-producing sector, however, is also an important low-skilled employer, in which the salaries have fallen, as seen before. Thus while food products tend to increase their price in simulations, service prices tend to fall, benefiting relatively more households that have a larger share of services in their consumer basket (the richest).

**Table 4.** Percentage changes in real household consumption. Accumulated in 2030.

| | DZABS | DZ2 | DZ3 |
|---|---|---|---|
| 1 POF1 | -1.80 | -0.72 | -0.10 |
| 2 POF2 | -1.59 | -0.63 | -0.09 |
| 3 POF3 | -1.24 | -0.48 | -0.07 |
| 4 POF4 | -1.11 | -0.42 | -0.06 |
| 5 POF5 | -0.82 | -0.30 | -0.05 |
| 6 POF6 | -0.64 | -0.23 | -0.03 |
| 7 POF7 | -0.44 | -0.15 | -0.02 |
| 8 POF8 | -0.28 | -0.08 | -0.01 |
| 9 POF9 | -0.10 | -0.01 | 0.00 |
| 10 POF10 | -0.03 | 0.02 | 0.01 |

Therefore reducing deforestation, by reducing livestock activity would tend to affect the poorest of the economy more negatively. As discussed previously in terms of regional losses, this is also an important result. All economic policy produces winners and losers, a consequence of the limited resources in any economy. The identification of these agents is an important policy consideration, as it allows the design, if necessary, of adequate compensatory policies.

## 6. Final remarks

Model results show that the reduction, or even the total interruption, of deforestation in Brazil would not bring about high social losses. These losses, however, are not uniform geographically. Likewise, this policy also affects asymmetrically the welfare of economic agents, as measured by their consumption. As shown here, this policy has regressive potential, penalizing the poorest families of the economy from both income and expenditure sides. This phenomenon is even more intense when one considers the frontier states, where deforestation is still high and where there is still potential for considerable deforestation on private lands and in unprotected areas.

Recognizing these asymmetries is important for the discussion of policies to reduce deforestation in Brazil, especially given the still high level of poverty in the country. As seen in this study, the relatively higher share of agriculture and livestock in the regional GDP of the agricultural frontier states makes them more dependent on expansion of those activities. Anticipating these results may be important in the design of compensatory policies aimed at their adherence to efforts to reduce deforestation.

Technological progress could compensate, in terms of livestock supply, for the losses of simulated pasture areas. Model results (not presented here) suggest that moderate to small incremental gains in productivity would in most cases compensate for the effect of reduced pasture caused by reduced deforestation. Historical observed rates show that these gains would be possible, and are probably ongoing. Although reduced availability of land for pasture can itself induce technological progress, there would certainly be room for public policies that may facilitate the adoption of existing technology. This is much more a question of relative prices than of technology availability.

Finally it should be pointed out that the environmental gains from reduced deforestation have not been analyzed here. As noted earlier, these gains are not captured by the circular flow of income in the economy, and are probably very high when calculated in all their dimensions. Indeed, this is a frontier area in applied economic research, and represents a high priority in future methodological development efforts.

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## Country Case 2

# Estimating the labor market impact of the transition to a green economy

*Kirsten S. Wiebe, Guillermo Montt and Marek Harsdorff* [1]

## 1. Introduction

The transition to a green economy is a transition that “results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (UNEP 2011). This transition involves significant changes in the structure of economic production. Not only are energy-intensive industries affected, but other industries with a close relationship to the natural environment, such as agriculture or waste management and recycling, also have to undergo significant changes.

One of the main approaches for modelling economy-wide changes is input-output analysis. Input-output tables report the interlinkages between final consumption, the flows of intermediate and final goods, and the flows of factor inputs into production. Global multi-regional input-output (MRIO) tables add the dimension of bilateral trade between countries to these flows and are therefore predestined for an analysis of the impacts of a global transition to a green economy. The environmental and socio-economic extensions to these databases allow an analysis of the corresponding impacts along global value chains resulting from changes in global production networks.

Analyzing the transition to a green economy requires a forward-looking approach. To this end an MRIO is projected to 2030 based on the International Energy Agency’s Energy Technology Perspectives (IEA 2015). The IEA ETP six-degree scenario serves as a business-as-usual scenario, while the IEA ETP two-degree scenario is the alternative scenario covering the green energy, transport and construction transitions. The other alternative scenarios are concerned with green agriculture and the circular economy.

The next section briefly introduces MRIO analysis and projecting an MRIO table into the future. Section 3 briefly describes the scenario specification, followed by a presentation of the results in Section 4.

## 2. Methodology

Few global MRIO databases are currently available (in alphabetical order): EORA, EXIOBASE, GTAP, OECD ICIO and WIOD. EXIOBASE has been selected as a basis for the analyses in this project owing to its balance between sectoral detail and country coverage. The sectoral detail in EXIOBASE, with 163 industries and 200 products in the supply-and-use tables, is far better than in any other MRIO database. Tukker et al. (2013) and Wood et al. (2014) there is a need for databases to encompass the global dimension of societal metabolism. In this paper, we focus on the latest effort to construct a global multi-regional input\u2212output database (EXIOBASE provide more information on EXIOBASE and its potential uses.

EXIOBASE constructs labour inputs from national labour force surveys gathered from ILOStat, and from a combination of labour force and industrial surveys in national accounts, obtained from the OECD’s STAN Database (Simas et al. 2014). Labour data from ILO consist of 39 economic sectors, whereas STAN’s data covers up to 60 industries, which provide better allocation to economic output in the MRIO sectors. Labour inputs were disaggregated from broad economic sectors into industries in the MRIO in accordance with the compensation of employees from the model. The disaggregation was made under the assumption that, inside a broad economic sector industry, average wages and hours worked would be similar for all workers.

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[1] December 2017, Geneva.

Labour inputs in the MRIO model are divided into three skill levels (low, medium and high). ILO's sectoral data on occupations for all countries in EXIOBASE are used to construct the number of workers in each skill level in each sector. For the rest of the world's regions, each industry has a weighted average distribution of skill levels in total employment for three broad sectors: agriculture, industry and services.

## 2.1 Direct and indirect employment by green activities

The virtue of input-output analysis is its ability to capture indirect effects, that is effects on other industries, in addition to the direct effects on industries that are the focus of the analysis. This is achieved by considering the interlinkages with other industries through recording the flows of intermediate goods and services between the industries.

If, for example, 10% of the inputs into the car industry are provided by the steel industry and the steel industry needs 10 employees to produce one unit of output, we could conclude that one employee (= 10% of 10 employees) from the steel industry is employed owing to production in the car industry.

Using the common input-output notation the indirect employment effect of one unit of production of industry is calculated as , where is a vector direct employment per unit of output for all industries, is the Leontief inverse, is a vector where all but the entry corresponding industry , which is one, are zero, and is the direct employment per unit of output of industry .

## 2.2 Projecting an MRIO into the future

Applying IO data in a scenario framework requires a consideration of many factors. Basic IO scenarios imply a series of direct and exogenous changes in final demand and the production structure, that is technological change (Wiebe 2016). The results must be understood as a comparison between the *status quo* and a result in which the scenario, *ceteris paribus*, has been achieved. Results from MRIO scenarios are first-order impacts devoid of the effects of assumptions about substitution elasticities, utility and profit maximization, price equilibrium, and so forth. Some key assumptions include:

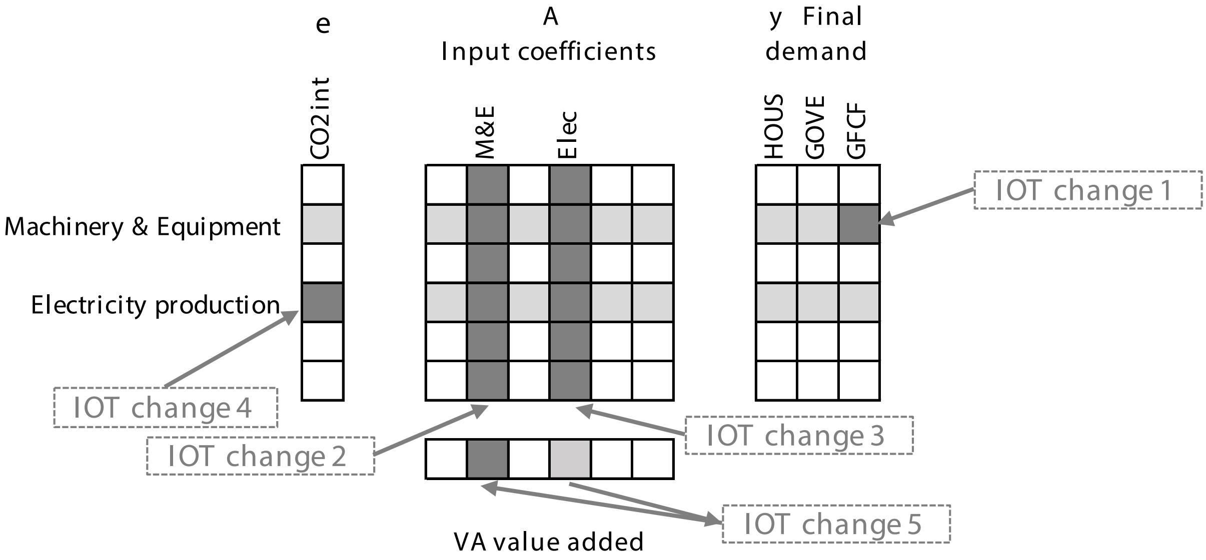
EXIOBASE v3 mapped the world economy in 2011 but was then updated to 2014 (Stadler et al. 2017). This 2014 table serves as a basis for the projections to 2030 that combine the GDP projections from the IMF (IMF, 2017) and IEA ETP with employment projections from the ILO. Except for the changes modelled in the scenarios – as described below – the basic trade and country-specific sectoral structure of the world economy remains constant.

In an input-output framework, both the economic structure and technology is represented as the intermediate input coefficients. But modelling technological change in an economy through changing the input coefficients alone is not sufficient. Wiebe (2018) explains how to model technological change consistently in a forward-looking multi-regional input-output model. Five types of changes are differentiated, relating to different parts of the input-output system:

1. Gross fixed capital formation, investment in the new technology
2. Input coefficients of technology production
3. Input coefficients of technology use
4. Emission intensity of production (or any other relevant environmental or socio-economic extension)
5. Value added shares, including compensation of employees.

These changes are visualized in Figure 1 and explained based on the example of increasing electricity production through the use of wind turbines (Wiebe 2018).

**Figure 1.** Technology diffusion related changes in an environmentally extended input-output framework



*Source: based on Wiebe (2018)*

*Note: Wind turbines are produced by the "Machinery & Equipment" industry (M&E). Thus an increased diffusion of wind turbines is reflected through a change in the investment in M&E (IOT change 1), changing intermediate input coefficients due to the increased share of wind turbines in the total production of the M&E industry (IOT change 2). Then, more wind turbines are used for electricity production (Elec), thus less coal and gas is needed, changing the input coefficients of the electricity industry (IOT change 3). This in turn reduces the CO2 intensity (CO2int) of the electricity industry.*

Note that the focus in Wiebe (2018) was on emissions. However, the extended IO methodology is also applicable to any other kind of environmental and socio-economic extension. When estimating the impact of other environmental or socio-economic factors, the corresponding stressors (e.g. the number of employees per unit of output) need to be changed as well. That is, if we assume more labour is necessary for the maintenance of renewable energy production and we model an increased VA share for compensation of employees, we need to consider an increase in the number of employees or a productivity increase that is reflected through increased wages. If compensation of employees increases, but the number of employees remains the same, employees earn a higher average wage.

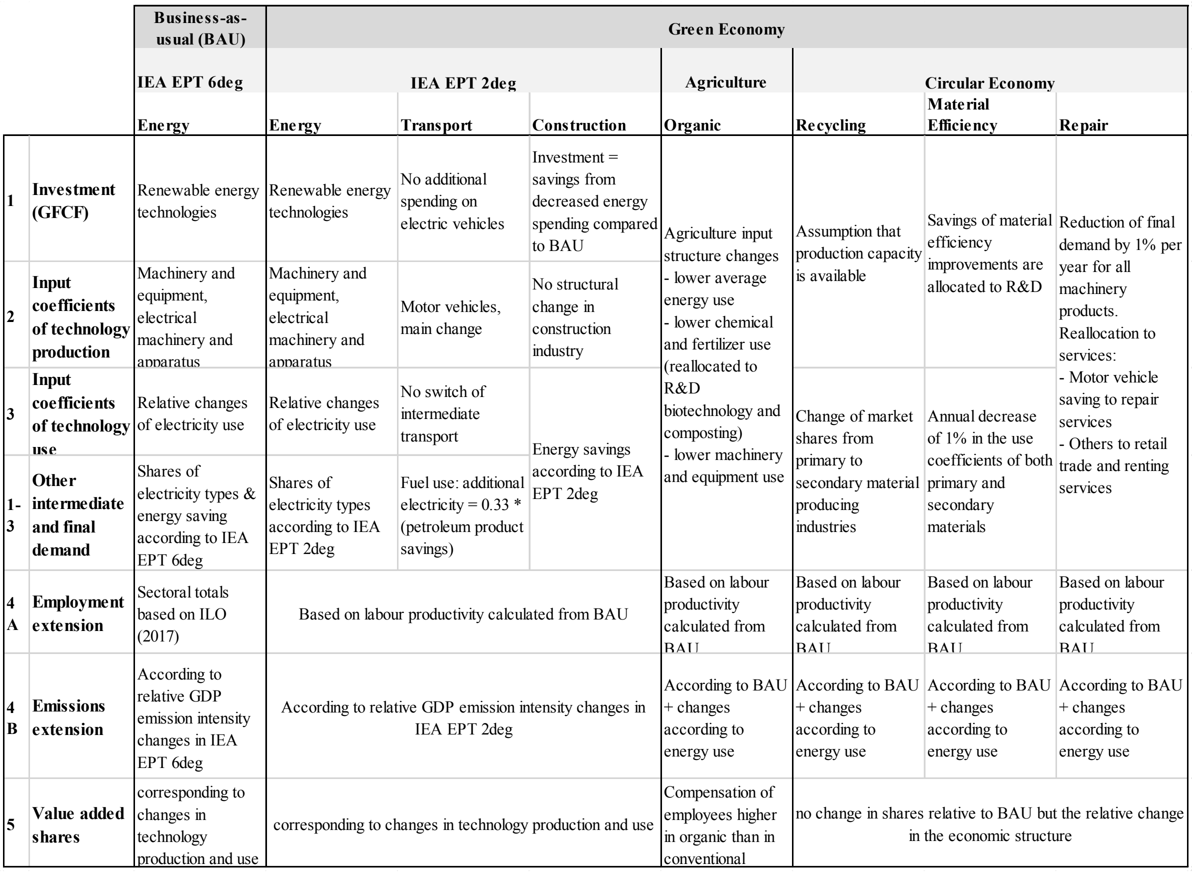
This directly leads to IOT change 5, changes in value-added shares, that is to say taxes and subsidies, compensation of employees and consumption of fixed capital. These value-added shares may need to be updated for both the technology-producing industry and the technology-using industry. This is done using the same approach as updating the intermediate input coefficients: e.g. for the "machinery and equipment" (M&E) industry, where reflects the share of wind turbine production in total production of the M&E industry in a given year .

The transition to a green economy affects several industries at the same time in different ways: changes in individual intermediate input coefficients, capital formation, intermediate and final demand, value-added shares and emission or employment intensities. When implementing these individual changes one needs to keep in mind that the changes need to be consistent. If the use of fossil fuels as intermediate inputs is reduced in an industry, the corresponding emission coefficient also needs to be reduced. If a new technology is used it needs to be produced (some capital needs to be invested). If one input coefficient of an industry is increased, another input coefficient or value-added share needs to be decreased or *vice versa*, because the sum of input coefficients plus value-added component shares always add up to one.

# 3. Scenario specifications

The baseline scenario for the MRIO system to 2030 is calibrated to the economic and energy technology specifications of the IEA ETP's six-degree scenario. We present three alternative scenarios that cover five different topics regarding transition to a green economy. First, we analyze the IEA ETP two-degree scenario, which affects the transition to renewable energies, energy-efficiency improvements and a switch of transport fuels from oil to electricity. Second and third, we consider the increasing penetration of organic agriculture by assuming that 30% of agricultural production in high-income countries and 5% of agriculture in developing and emerging economies is organic in 2030. The last scenario specifies an increasingly circular economy: that is, in 2030 95% of metals and non-metallic mineral products are produced from recycled material, material efficiency increases by 1% annually and goods are repaired and shared. These exogenous changes are summarized in Table 1.

**Table 1:** Scenario specifications of business-as-usual and alternative scenarios



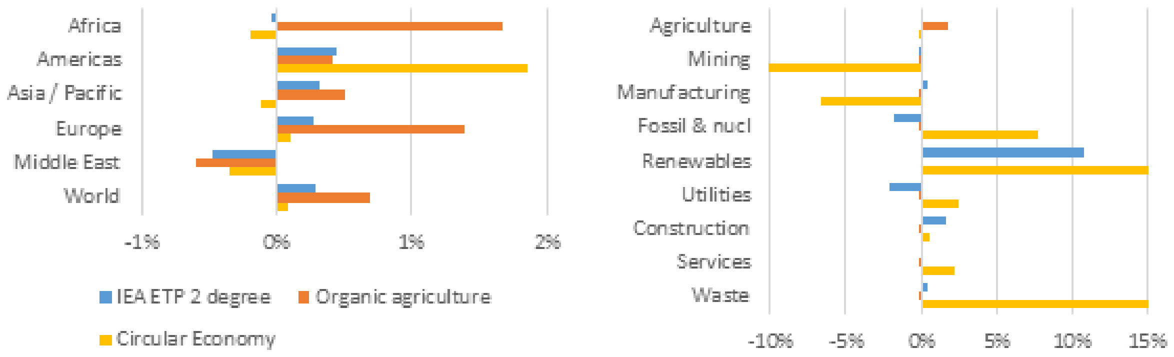
| | | **Business-as-usual (BAU)** | **Green Economy** | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **IEA EPT 6deg** | **IEA EPT 2deg** | | | **Agriculture** | **Circular Economy** | | |
| | | **Energy** | **Energy** | **Transport** | **Construction** | **Organic** | **Recycling** | **Material Efficiency** | **Repair** |
| 1 | **Investment (GFCF)** | Renewable energy technologies | Renewable energy technologies | No additional spending on electric vehicles | Investment = savings from decreased energy spending compared to BAU | Agriculture input structure changes<br>- lower average energy use<br>- lower chemical and fertilizer use (reallocated to R&D biotechnology and composting)<br>- lower machinery and equipment use | Assumption that production capacity is available | Savings of material efficiency improvements are allocated to R&D | Reduction of final demand by 1% per year for all machinery products.<br>Reallocation to services:<br>- Motor vehicle saving to repair services<br>- Others to retail trade and renting services |
| 2 | **Input coefficients of technology production** | Machinery and equipment, electrical machinery and apparatus | Machinery and equipment, electrical machinery and apparatus | Motor vehicles, main change | No structural change in construction industry | | | | |
| 3 | **Input coefficients of technology use** | Relative changes of electricity use | Relative changes of electricity use | No switch of intermediate transport | Energy savings according to IEA EPT 2deg | | Change of market shares from primary to secondary material producing industries | Annual decrease of 1% in the use coefficients of both primary and secondary materials | |
| 1-3 | **Other intermediate and final demand** | Shares of electricity types & energy saving according to IEA EPT 6deg | Shares of electricity types according to IEA EPT 2deg | Fuel use: additional electricity = 0.33 * (petroleum product savings) | | | | | |
| 4 A | **Employment extension** | Sectoral totals based on ILO (2017) | Based on labour productivity calculated from BAU | | | Based on labour productivity calculated from BAU | Based on labour productivity calculated from BAU | Based on labour productivity calculated from BAU | Based on labour productivity calculated from BAU |
| 4 B | **Emissions extension** | According to relative GDP emission intensity changes in IEA EPT 6deg | According to relative GDP emission intensity changes in IEA EPT 2deg | | | According to BAU + changes according to energy use | According to BAU + changes according to energy use | According to BAU + changes according to energy use | According to BAU + changes according to energy use |
| 5 | **Value added shares** | corresponding to changes in technology production and use | corresponding to changes in technology production and use | | | Compensation of employees higher in organic than in conventional | no change in shares relative to BAU but the relative change in the economic structure | | |

# 4. Results

## 4.1 Employment

The results show a global employment increase of 0.3%-0.7% compared to the baseline, depending on the scenario. The agricultural scenario has the largest positive employment impact driven by increased employment in agriculture, especially in Africa and Asia and the Pacific. The employment impact of increased use of recycled materials, where the additional jobs in services and waste industries slightly outweigh the job losses in mining and manufacturing, is largest in the Americas. In the two-degree scenario, the oil exporting countries in the Middle-East as well as Russia are likely to experience job losses, but of less than 0.5%, while all other countries benefit from the increased demand for manufactured products and from higher employment intensities of renewable electricity production and related services.

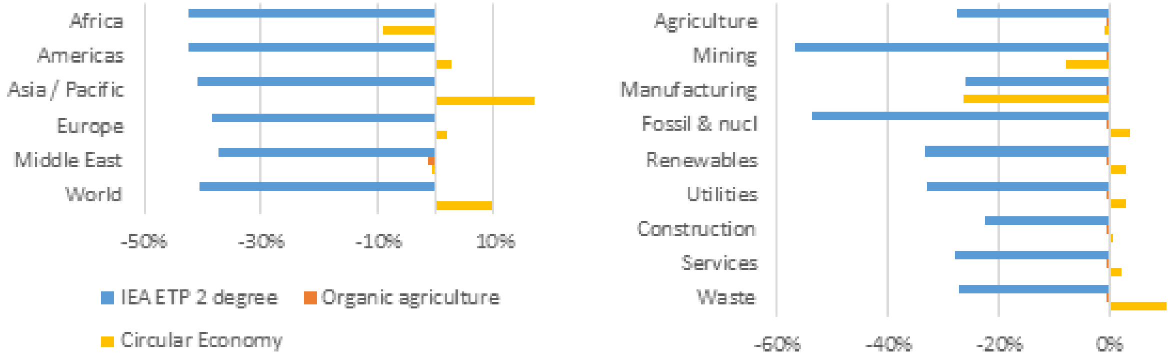
**Figure 2.** Employment differences compared to IEA ETP 6 degree scenario in 2030 by region and by industry



## 4.2 $CO_2$ emissions

The $CO_2$ emission differences are naturally largest in the two-degree scenario. Global emissions in the model are reduced by 40.5%, while in the IEA report the reduction is 39%. This is due to consideration of the indirect effects. In the agricultural scenario, the change in emissions is small, but negative, due to decreased use of energy and chemical inputs in organic agriculture. The circular economy scenario has diverse impacts on emissions. The switch to metal production from scrap increases emissions in the waste industries. This becomes especially apparent in China, where the largest shift from primary to secondary production takes place.

**Figure 3.** $CO_2$ differences compared to IEA ETP 6 degree scenario in 2030 by region and by industry



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## Country Case 3

# Economics of Just Transition

***Heidi Garrett-Peltier*** [1]

## Introduction

Investments in low-carbon energy and energy efficiency – what we will call here “Clean Energy” – create job opportunities. Time and again, both research and experience have shown that for every dollar shifted from fossil fuels into clean energy, there is a net gain in employment. This holds true primarily because clean energy industries are more labour-intensive than coal, oil, or gas industries. However, while a net gain in employment is good for the economy as a whole, and very good for the people who newly acquire jobs, it is not without its costs. As the fossil fuel sector shrinks, and as demand for coal, oil, and gas falls because of increased energy efficiency and a shift to renewables, there are workers in the fossil fuel sector who will lose their jobs. For this reason, we must consider not only the macroeconomic benefits of clean energy investments, but also what policies and practices should be put into place to protect or lessen the hardships of fossil fuel workers who will lose their jobs. This is what we call a “Just Transition,” the policies and practices to assist workers and communities who will be adversely affected by a transition to clean energy.

At the Political Economy Research Institute (PERI), we have explored the concept of a Just Transition for the U.S. as a whole, as well as for a few specific States. Most recently, we published a paper on this topic regarding the state of New York, “Clean Energy Investments for New York State: An Economic Framework for Promoting Climate Stabilization and Expanding Good Job Opportunities.” I was a co-author of the paper, along with economists Robert Pollin and Jeannette Wicks-Lim. Below, I summarize the important questions we address in that paper, along with our findings. In 2016 PERI also published a working paper on this same topic that addresses the U.S. as a whole. However, for this conference I am presenting the work on New York because it has a slightly more refined methodology than the earlier paper and, as we shall see below, New York’s GDP is about $1.5 trillion, making it comparable to, or even larger than, many national economies.

The study examines the benefits of large-scale clean energy investment for New York State – in both clean renewable energy and energy efficiency. It takes as a starting point the goal of reducing carbon emissions by 50% from 1990 levels by 2030, which translates into a $CO_2$ emissions level of 100 million tons by 2030. This requires a 40% reduction from the current level of 170 million tons.

A clean energy programme includes both public and private investments in energy efficiency and renewable energy. In this study, energy efficiency investments include efficiency upgrades in buildings and vehicles, in industrial processes, and in an expanded system of public transportation. Renewable energy investments are focused primarily on wind and solar energy, as well as geothermal energy in some cases, all of which are priced competitively with fossil fuel energy in New York State.

Targeted public and private investments toward these areas of clean energy will create approximately 150,000 jobs per year while reaching the emissions target noted above. New job opportunities will be in a wide array of occupations, including construction, sales, management, electrical work, engineering, and office support.

The fossil fuel sector in New York State is primarily composed of petroleum and natural gas. Consumption of these will fall by about 40% from current levels in order to meet the 2030 climate stabilization target. Job losses will be occur primarily in nine fossil-fuel and related industries, which currently employ about 13,400 workers combined. While up to 40% of these workers could be vulnerable to job loss, many of these are in fact close to the retirement age of 65, and over the course of the next 13 years, the majority of the job losses from a clean energy transition will be handled simply through natural attrition. For these workers, Just Transition policies need only ensure that their pensions will be protected even as the fossil fuel industries contract. Beyond natural attrition through retirement, about 67 workers

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[1] December 2017, Geneva.

per year will lose their jobs between now and 2030 owing solely to the effects of a clean energy transition. For these workers, a Just Transition programme should guarantee reemployment as well as income, retraining, and relocation support. The costs of this would be about $300,000 per worker, or about $18 million per year. Since certain communities are also heavily dependent on fossil fuel workers for their local economic vitality, these communities will be more severely impacted by a clean energy transition. For this reason we propose targeting clean energy investments on these hardest-hit communities in order to create job opportunities and economic health where there would otherwise be losses.

Combining the investments in clean energy along with both individual and community-level Just Transition programmes, we estimate the overall level of public and private investments to be in the range of $30-35 billion per year until 2030. This is about five times the current level of clean energy investments in New York State. About $5 billion of this total should be publicly financed, and will leverage an additional $25-30 billion in private funding. If the State charged a polluter fee of $35 per ton of $CO_2$, rising to $75 per ton by 2030, this would raise an average of $7.1 billion per year, fully covering the public expenditures on the clean energy programme.

## New York State: Emissions, Energy, and Prospects for Clean Energy and a Just Transition

New York State is home to nearly 20 million people and its gross domestic product (GDP) is approximately $1.5 trillion. As of 2014, New York produced 170 million tons of $CO_2$ per year. This is 18% below 1990 levels. In order to reach the target of 100 million tons by 2030, which is 50% below 1990 levels, $CO_2$ emissions must fall another 40% from current levels. Emissions currently result primarily from petroleum (53%) and natural gas (43%), with a smattering from other sources. Total energy consumption as of 2014 was approximately 3.7 quadrillion BTUs (Q-BTUs, also known as “quads”), of which 2.75 quads were from fossil fuels.

New York is already one of the “cleanest” states in the United States, with emissions of 8.6 tons of $CO_2$ *per capita* in comparison to the U.S. national average of about 17.0. New York has this status because it has a high level of energy efficiency as well as a relatively clean energy mix that relies heavily on natural gas, hydropower, and nuclear power. New York also has a significant percentage of its population, about 40%, in New York City. The high population density, relatively small apartments, and vast public transportation system are all factors in bringing down the energy use per person to a level below the U.S. average.

Since New York is already a relatively energy efficient state, additional improvements may prove challenging. However, the study focuses on the efficiency potential in buildings and private automobiles. According to findings from the U.S. National Academy of Sciences, improvements in the range of 30-40% are possible with relatively low upfront investments. The cost, on average, of saving one Q-BTU of energy is approximately $35 billion.[2]

Using these estimates for energy efficiency, along with cost estimates from the U.S. Energy Information Administration (EIA), we estimate the combined costs of energy efficiency investments along with investments in wind, solar, and geothermal energy necessary to reach the 2030 targets of 100 million tons of $CO_2$ and 1.6 Q-BTUs of fossil fuel energy (down from 2.75). We assume that there will be a 3-year start-up period for planning, securing financing for projects, and setting up the expansion of clean energy. Therefore, the period from 2021 to 2030 is when the majority of the investments and job creation will occur. During this period we estimate that total clean energy investments will average about $31 billion per year, which is approximately 1.8% of the State’s projected GDP over that period if we assume continued growth of 2.6% per year over the period.

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[2] Note that this cost is higher than the cost per Q-BTU of energy efficiency investments that we have found in other areas, particularly in other countries. See “Global Green Growth” (Pollin et al., 2015) for comparison.

**Figure A:** Table 12 from Pollin, Garrett-Peltier, and Wicks-Lim (2017), p. 39.

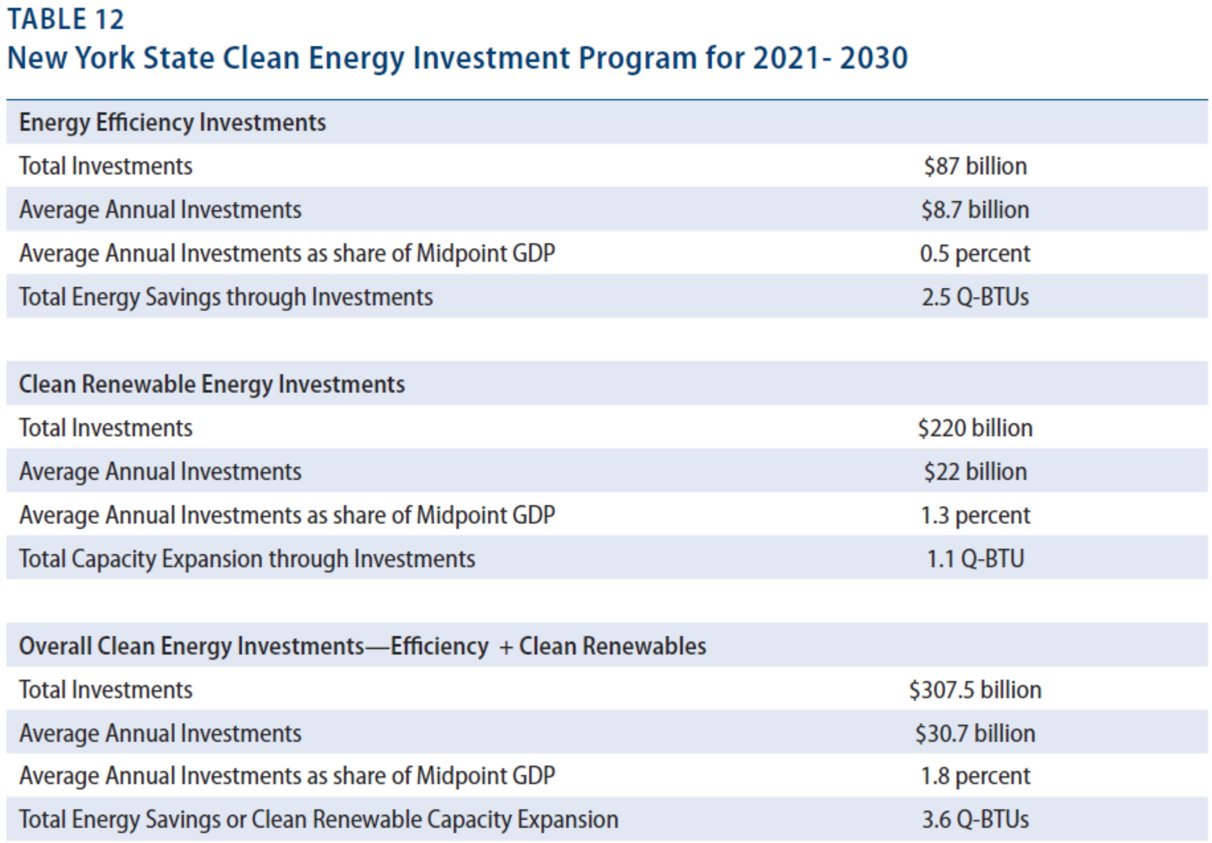

TABLE 12
New York State Clean Energy Investment Program for 2021- 2030

| | |
|---|---|
| **Energy Efficiency Investments** | |
| Total Investments | $87 billion |
| Average Annual Investments | $8.7 billion |
| Average Annual Investments as share of Midpoint GDP | 0.5 percent |
| Total Energy Savings through Investments | 2.5 Q-BTUs |
| **Clean Renewable Energy Investments** | |
| Total Investments | $220 billion |
| Average Annual Investments | $22 billion |
| Average Annual Investments as share of Midpoint GDP | 1.3 percent |
| Total Capacity Expansion through Investments | 1.1 Q-BTU |
| **Overall Clean Energy Investments—Efficiency + Clean Renewables** | |
| Total Investments | $307.5 billion |
| Average Annual Investments | $30.7 billion |
| Average Annual Investments as share of Midpoint GDP | 1.8 percent |
| Total Energy Savings or Clean Renewable Capacity Expansion | 3.6 Q-BTUs |

## Job Creation through Clean Energy Investments

New jobs will be created as the clean energy industry expands. From 2021 to 2030 we estimate that approximately 160,000 jobs per year will be created. If we assume that labour productivity will continue to increase at a rate of 1% per year, then job creation will average about 145,000 jobs per year over the period 2021-2030. Since the majority of these jobs are likely to be held by white men (historically prevalent in the fields likely to expand), we propose that policies should be considered to increase the inclusion of women and people of colour in these fields.

To capture the full extent of employment opportunities created through clean energy investments, we use an input-output (I-O) model. The I-O model captures the linkages throughout the economy – the supply chains of goods and services that are used to produce clean energy, as well as the consumption patterns of households, businesses, governments, and foreign markets. Using the I-O model, we estimate the direct jobs that are created in industries with increased demand, such as the energy efficiency and renewable energy industries where we are targeting investments. Likewise, we can estimate the results of a fall in demand for fossil fuel production. The I-O model can estimate three levels of employment: direct jobs (those in clean energy); indirect jobs (those in the supply chains); and induced jobs (those created through the multiplier effect as workers in the direct and indirect industries spend their earnings). While the I-O model can capture all three of these effects, for this study we focus mainly on the direct and indirect effects.

The differences in job creation by industry are a result of three factors – labour intensity, domestic content, and wages. Since the fossil fuel sector is one of the most capital-intensive industries in the U.S. economy, a shift away from fossil fuels and towards just about any other industry will create jobs. In the case of clean energy, the differential is significant, since clean energy is fairly labour-intensive. This is true particularly in the energy efficiency (EE) industries, since they involve a significant amount of construction, which is a relatively labour-intensive sector. Renewable energy (RE) industries are more labour-intensive than fossil fuel industries, but the mixture of manufacturing and construction means that their level of labour-intensity is not quite as high as energy efficiency industries. Nonetheless, a shift from fossil fuels to either EE or RE will entail a shift to greater labour-intensity and therefore higher employment for the same level of investment. Domestic content is also higher in clean energy than in fossil fuels, particularly because of the construction sector. And, on average, wages are lower in clean energy than in fossil fuels, and therefore a greater number of people can be hired for the same total amount of spending.

Using the I-O model, we estimate the direct and indirect jobs for each of the energy efficiency industries and renewable energy industries in our clean energy investment programme. Having previously estimated the energy needs and costs, we can estimate the employment impacts of $8.7 billion per year in efficiency investments and $22 billion per year in wind, solar, and geothermal energy. The detailed results are below. These tables show that EE investments create about 60,000 direct and indirect jobs per year and RE creates about 100,000. Therefore, combined, a programme with an annual investment of about $31 billion creates a yearly average of 160,000 jobs within the State.

**Figure B:** Table 14 from page 46 of Pollin, Garrett-Peltier, and Wicks-Lim (2017)

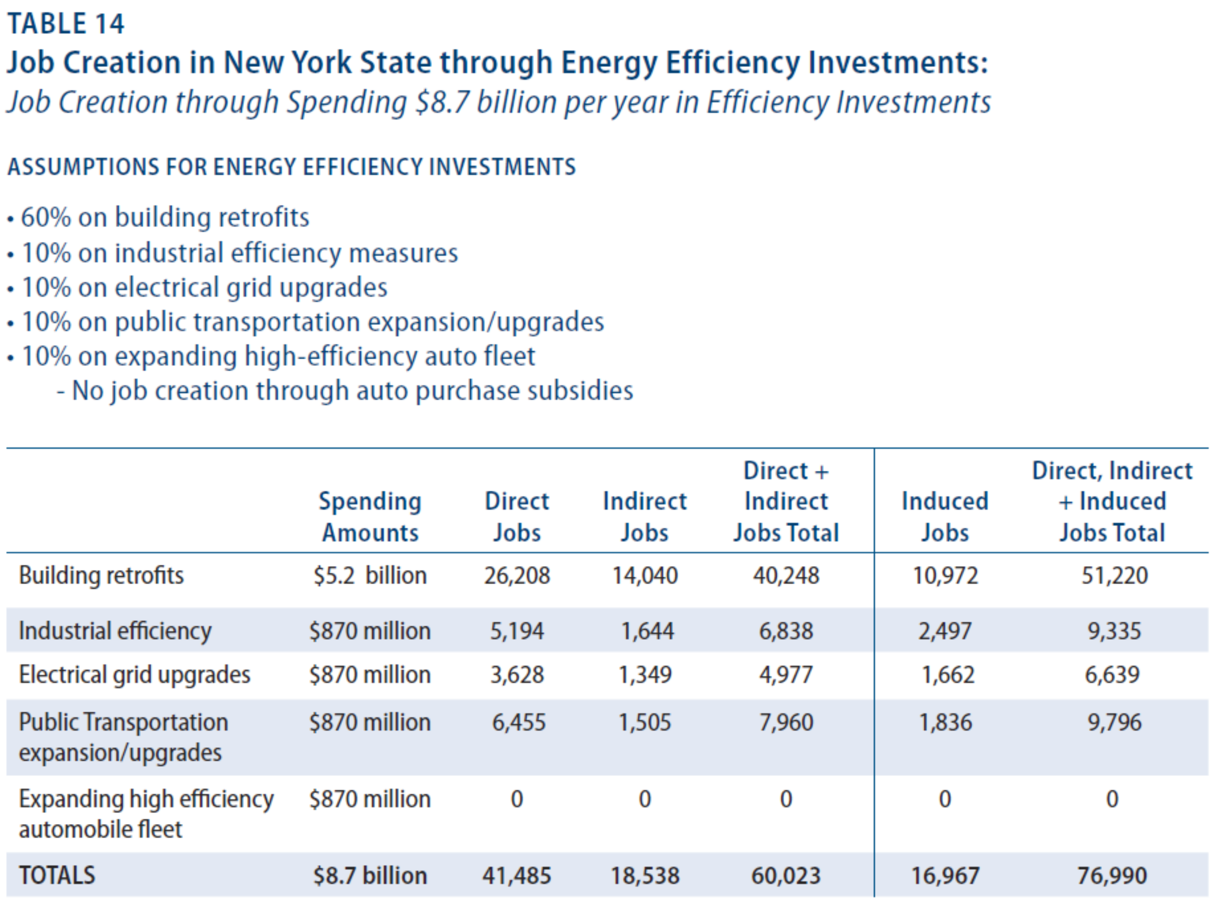

**TABLE 14**

**Job Creation in New York State through Energy Efficiency Investments:**

*Job Creation through Spending $8.7 billion per year in Efficiency Investments*

ASSUMPTIONS FOR ENERGY EFFICIENCY INVESTMENTS

- 60% on building retrofits
- 10% on industrial efficiency measures
- 10% on electrical grid upgrades
- 10% on public transportation expansion/upgrades
- 10% on expanding high-efficiency auto fleet
    - No job creation through auto purchase subsidies

| | Spending Amounts | Direct Jobs | Indirect Jobs | Direct + Indirect Jobs Total | Induced Jobs | Direct, Indirect + Induced Jobs Total |
|---|---|---|---|---|---|---|
| Building retrofits | $5.2 billion | 26,208 | 14,040 | 40,248 | 10,972 | 51,220 |
| Industrial efficiency | $870 million | 5,194 | 1,644 | 6,838 | 2,497 | 9,335 |
| Electrical grid upgrades | $870 million | 3,628 | 1,349 | 4,977 | 1,662 | 6,639 |
| Public Transportation expansion/upgrades | $870 million | 6,455 | 1,505 | 7,960 | 1,836 | 9,796 |
| Expanding high efficiency automobile fleet | $870 million | 0 | 0 | 0 | 0 | 0 |
| **TOTALS** | **$8.7 billion** | **41,485** | **18,538** | **60,023** | **16,967** | **76,990** |

**Figure C:** Table 16 from page 47 of Pollin, Garrett-Peltier, and Wicks-Lim (2017)

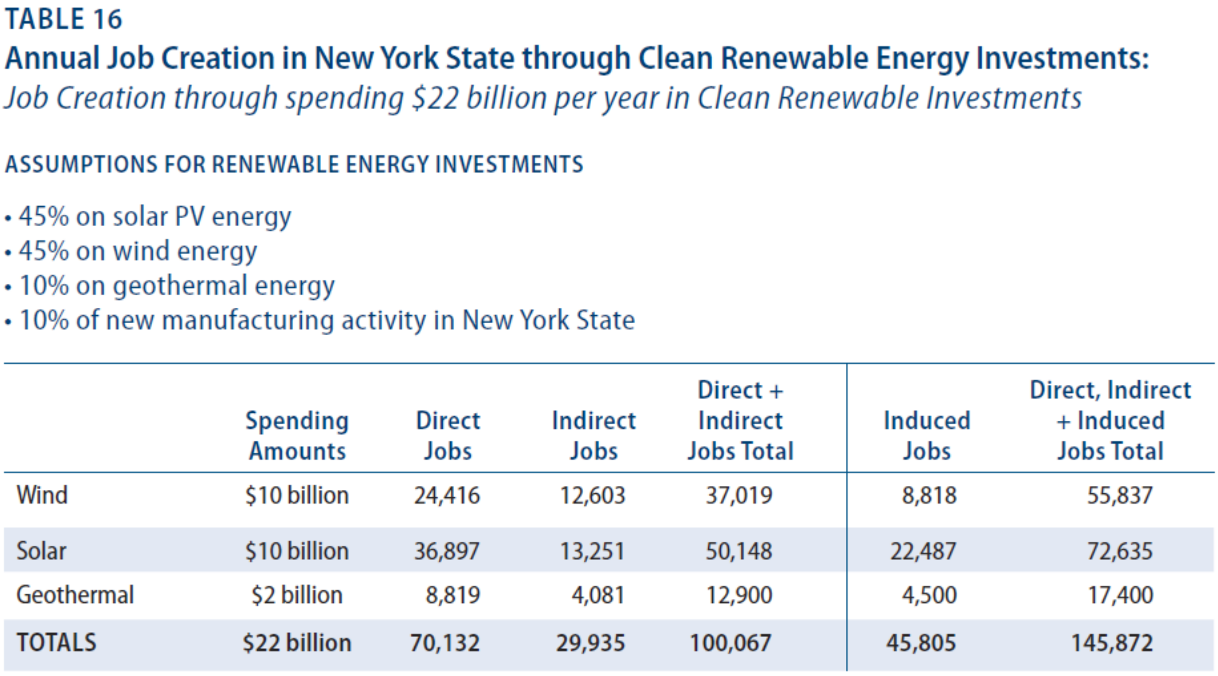

**TABLE 16**

**Annual Job Creation in New York State through Clean Renewable Energy Investments:**

*Job Creation through spending $22 billion per year in Clean Renewable Investments*

**ASSUMPTIONS FOR RENEWABLE ENERGY INVESTMENTS**

- 45% on solar PV energy
- 45% on wind energy
- 10% on geothermal energy
- 10% of new manufacturing activity in New York State

| | Spending Amounts | Direct Jobs | Indirect Jobs | Direct + Indirect Jobs Total | Induced Jobs | Direct, Indirect + Induced Jobs Total |
|---|---|---|---|---|---|---|
| Wind | $10 billion | 24,416 | 12,603 | 37,019 | 8,818 | 55,837 |
| Solar | $10 billion | 36,897 | 13,251 | 50,148 | 22,487 | 72,635 |
| Geothermal | $2 billion | 8,819 | 4,081 | 12,900 | 4,500 | 17,400 |
| **TOTALS** | **$22 billion** | **70,132** | **29,935** | **100,067** | **45,805** | **145,872** |

## Just Transition for Workers and Communities Dependent upon Fossil Fuel Industries

The fossil fuel sector, meanwhile, will lose some jobs. Consumption of fossil fuels, which in New York State are primarily petroleum and natural gas, will have to fall by about 40% by 2030 to meet our climate stabilization targets. Currently about 13,400 workers are employed in the nine fossil-fuel and related industries likely to contract from a clean energy transition. Once natural attrition is taken into account, however, only about 67 workers per year will lose their jobs owing to decreased demand for fossil fuels. For these workers, as well as those who are already expected to retire before 2030, we propose four Just Transition programme elements:

1. guaranteed pensions for the workers in affected industries who retire between now and 2030;
2. guaranteed reemployment for workers facing displacement;
3. income, retraining, and relocation support for workers facing displacement; *and*
4. transition programmes targeted on communities that are currently fossil-fuel dependent.

In order to calculate the number of workers who will need reemployment and retraining *versus* those retiring, the following calculation applies: we use publicly-available data on the ages and employment levels by industry, then multiply this by 40% to estimate total job losses (assuming a 40% reduction in output is matched by a 40% reduction in employment, which however is not necessarily the case). Of the 13,400 workers, then, about 5,400 will face job losses over 10 years, that is about 540 workers per year. In each industry we estimate how many of these workers will reach retirement age (65 years old) over the period 2021-2030. On average in the fossil fuel sector in New York, about 35% of workers fall into this category, or about 4,700 people, that is 470 people per year. Therefore, of the approximately 540 workers per year who face job losses from a clean energy transition, 470 were already going to leave the industry through natural attrition, leaving only about 70 people (67, to be precise) who will need adjustment assistance. The remainder need only regulations to enforce the provision of pensions by their employers.

## Costs of Just Transition Policies

We estimate the costs of the four parts of the programme listed above. The first part, guaranteeing pensions, has minimal cost since it entails only regulation. For instance, a policy can be instituted in which fossil fuel companies are required to fully fund their pension programmes before they are allowed to pay out dividends.

To estimate the costs of guaranteeing reemployment and providing income support, we use the average wage of a state government worker in New York, which is about $87,000 per year, and compare that to the average wages earned by fossil fuel workers, which range from $63,000 to $165,000. While it is likely that many displaced workers will find new jobs in an expanded clean energy sector, or in another industry, we guarantee reemployment through a policy in which the government is the employer of last resort. And while it is most certainly the case that not every one of the 67 workers will need this option, we overestimate the costs of reemployment and income support to be about $15 million per year, which is the cost of providing five years of compensation insurance.

Retraining costs we estimate to be about $1.5 million per year, which is the cost of providing two years of community college education for all 67 workers. Relocation support totals $1.3 million per year, assuming that half of the displaced workers need to relocate and receive generous financial assistance to do so. Again, these are probably overestimates and therefore are essentially a worst-case scenario in terms of assessing the costs of a Just Transition programme. Even so, the total cost of the programme would be about $18 million per year over ten years, which is small compared to the Clean Energy investment programme of about $31 billion per year over this period.

**Figure D:** Table 30 from Pollin, Garrett-Peltier, and Wicks-Lim (2017), p. 62

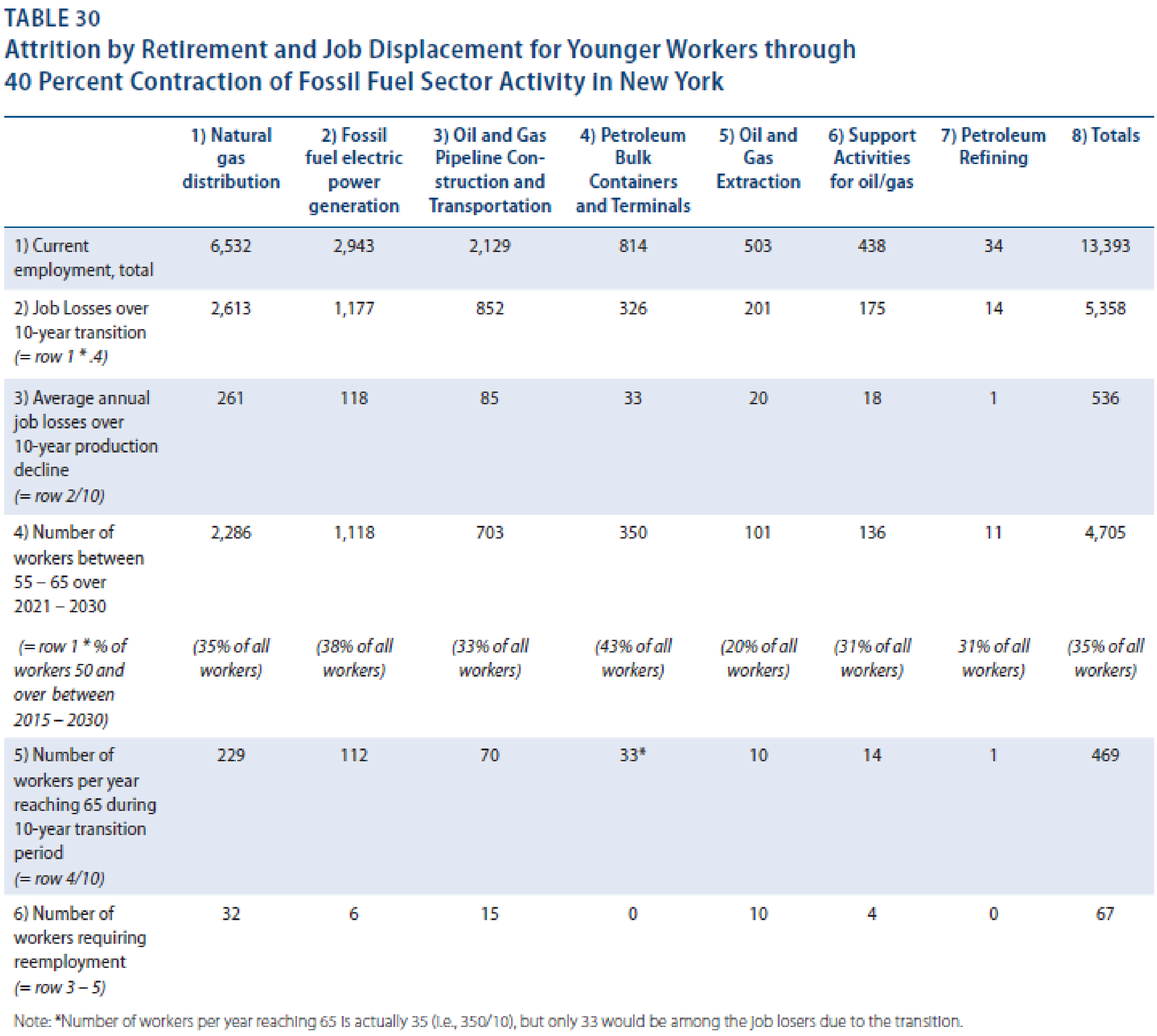

**TABLE 30**
**Attrition by Retirement and Job Displacement for Younger Workers through 40 Percent Contraction of Fossil Fuel Sector Activity in New York**

| | 1) Natural gas distribution | 2) Fossil fuel electric power generation | 3) Oil and Gas Pipeline Construction and Transportation | 4) Petroleum Bulk Containers and Terminals | 5) Oil and Gas Extraction | 6) Support Activities for oil/gas | 7) Petroleum Refining | 8) Totals |
|---|---|---|---|---|---|---|---|---|
| 1) Current employment, total | 6,532 | 2,943 | 2,129 | 814 | 503 | 438 | 34 | 13,393 |
| 2) Job Losses over 10-year transition *(= row 1 * .4)* | 2,613 | 1,177 | 852 | 326 | 201 | 175 | 14 | 5,358 |
| 3) Average annual job losses over 10-year production decline *(= row 2/10)* | 261 | 118 | 85 | 33 | 20 | 18 | 1 | 536 |
| 4) Number of workers between 55 – 65 over 2021 – 2030 | 2,286 | 1,118 | 703 | 350 | 101 | 136 | 11 | 4,705 |
| *(= row 1 * % of workers 50 and over between 2015 – 2030)* | *(35% of all workers)* | *(38% of all workers)* | *(33% of all workers)* | *(43% of all workers)* | *(20% of all workers)* | *(31% of all workers)* | *31% of all workers)* | *(35% of all workers)* |
| 5) Number of workers per year reaching 65 during 10-year transition period *(= row 4/10)* | 229 | 112 | 70 | 33* | 10 | 14 | 1 | 469 |
| 6) Number of workers requiring reemployment *(= row 3 – 5)* | 32 | 6 | 15 | 0 | 10 | 4 | 0 | 67 |

Note: *Number of workers per year reaching 65 is actually 35 (i.e., 350/10), but only 33 would be among the job losers due to the transition.

In summary, a clean energy transition will have minimal effects on fossil fuel workers, and these vulnerable workers can be generously compensated through a Just Transition programme. Since 35% of that the fossil fuel sector will reach retirement during the period 2021-2030, and 40% of fossil fuel employment will contract, this ultimately means that only 5% of the fossil fuel workforce will lose their jobs because of a shift from fossil fuels to clean energy. A Just Transition programme will help ensure that these workers do not in fact face losses due to policies that favour climate stabilization. The costs of retraining, reemployment, and other financial assistance are relatively low, and by pursuing a Just Transition programme, we not only serve the needs of people most vulnerable to the negative effects of clean energy transition, but we may even create some alliances that help advance the pursuit of environmental sustainability

## Country Case 4

# The transition in play: World employment trends in the electricity sector

*Guillermo Montt, Nicolas Maitre and Silas Amo-Agyei* [1]

## Summary

Human-induced greenhouse gas (GHG) emissions are the primary cause of current climate change (IPCC, 2013). A quarter of all emissions result from the burning of coal, natural gas and oil for electricity and heat. Electricity and heat production is the largest single source of global greenhouse gas emissions. Replacing fossil fuel-based energy sources by renewables such as solar or wind can contribute to mitigation of climate change while maintaining or increasing energy supply (IPCC, 2014). Transitioning to a low-carbon and resource-efficient economy by, among other things, increasing the reliance on renewables will have implications for the world of work and society akin to that of an industrial revolution (Bowen et al., 2016).

Greater reliance on renewable energy sources for electricity can be positive for employment, as suggested by individual studies on the labour requirements of renewables *vis-à-vis* fossil-fuel based energy production (Wei et al., 2010), literature reviews (Bowen and Kuralbayeva, 2015) or projections based on energy demand and associated labour requirements (Rutovitz and Atherton, 2009). Although projections and studies at the level of individual technologies exist, few, if any, analyses exist on the observed employment trends in the energy sectors in the past for developing countries and for the world as a whole.

Changes in the production structure of electricity towards renewable energy sources do not only create jobs in the electricity sector (direct effects), but also produce effects in other sectors (indirect effects). Indeed, the electricity sector is linked to other economic sectors (WEF and IHS CERA, 2012).

This paper contributes to the debate on employment creation associated with a transition to low-carbon electricity production. It takes advantage of the historic trends in employment in the electricity sector and in renewable and fossil fuel-based electricity production to estimate the observed employment impact of electricity generation across the world. In so doing, the estimates provided in this paper expand the coverage and do not suffer the limitation of using the estimates of studies prepared for a few specific countries to estimate employment impacts across the world. Rather, this paper draws on the observed energy and employment trends for each of more than 130 countries. To our knowledge it is the first study to establish these relationships on a global scale. This paper also explores the employment and GHG emission multipliers for both renewable and fossil-fuel-based energy sources for electricity generation.

## Data and Methods

To estimate worldwide trends in employment in the electricity sector, this study combines, using regression analysis, employment data for the electricity sector (ISIC rev. 4 section D and ISIC rev. 3 section E) from ILO's Trends Econometric Models (ILO, 2017) with data on total electricity generation from the Enerdata, Global Energy & $CO_2$ database (Enerdata, 2016) and on the shares of generation by source from World Bank's World Development Indicators (WDI, World Bank, 2017). In particular we use for each country data both on their total electricity production from coal, natural gas, nuclear, hydroelectric and other renewables for every year from 2000 to 2014, and on employment in the electricity sector for that period. We estimate an equivalent model estimating GHG emissions from the electricity sector in order to identify the energy sources that can simultaneously reduce GHG emissions and increase employment. We calculate worldwide employment multipliers for each energy source using Exiobase v3, a multi-regional

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[1] December 2017, ILO RESEARCH.

input-output table (MRIO) (Tukker et al., 2013; Wood et al., 2014)global, multiregional environmentally extended Supply and Use table (MR EE SUT.

## Results

In the 15-year period between 2000 and 2014 world electricity output increased by 54%, from 15,158 TWh to 23,635 TWh. This global growth is driven almost exclusively by developing and emerging countries. Electricity production more than doubled (a 132% increase) in developing and emerging economies; it increased by just 12% in developed economies. Globally, total output from coal, natural gas, hydro and renewables increased, with little change observed in nuclear energy and an 18% decline in oil-based electricity generation.

Over this same 15-year period employment in the electricity generation sector increased by more than 63%. Slightly more than 15 million jobs existed worldwide in the sector in 2000; by 2014 almost 25 million people were employed in the sector. Employment growth is driven almost exclusively by practically constant growth in developing and emerging economies, adding, on average, 534,800 jobs a year to the sector.[2]

Regression results show that, worldwide, additional generation from renewables, has in contrast been related to the highest job per TWh generated when compared to other energy sources. Net of the average growth of the sector – 2.2 jobs per year and 0.0002 per unit of GDP – for each TWh generated from non-hydro renewable sources an average of 1.6 jobs have been created in the electricity sector in each country.

Each additional TWh produced from coal, oil and natural gas creates comparatively fewer jobs on a worldwide scale, at 0.6, 0.1 and 0.3 jobs respectively as the global average. Electricity from hydroelectric power tends to be associated with fewer jobs in the sector, probably a result of the low labour requirements associated with large-scale hydroelectric power-based electricity (Wei et al., 2010).

In developed countries only generation from non-hydro renewables was related to employment growth in the electricity sector between 2000 and 2014 over and above the general trend. Each TWh generated by natural gas, hydroelectric power, nuclear power and coal in developed countries is associated with creation of fewer jobs than the average between 2000 and 2014. This is probably the result of the fact that any increase in generation in developed countries has been through more efficient modes of production. This is the case for natural gas, for example, which is associated with 0.1 fewer jobs per additional TWh. Indeed, natural gas generates electricity at a much lower labour-intensity when compared to coal (Houser et al., 2017).

In developing and emerging countries coal and natural gas have also created more jobs than the average trend (at an average of 0.4 jobs per TWh of additional generation), but far below the employment creation associated with the increased generation from renewables, at an average of 12 jobs per initial TWh, with diminishing effects to the extent that that job creation becomes null when generation reaches 324 TWh (-3.70E-08 x 324 324 = 0.012). Nuclear energy in developing and emerging countries seems particularly job-friendly, but this result is driven by the fact that only 13 developing and emerging countries had nuclear energy, with large investments made in a small subset of countries.[3]

Predictably, additional electricity generation from fossil-fuel based industries is related to higher GHG emissions than the average trend. The previous results are limited to the direct employment effects of different electricity generation sources. They relate to the number of jobs created in the electricity sector for each GWh increase in generation by source. But the electricity sector is linked to other economic sectors (WEF and IHS CERA, 2012), with comparatively large multipliers observed in the United Kingdom (Wild, 2014), the European Union (Stehrer and Ward, 2012) and

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[2] Figure 1 provides estimates for the 133 countries with employment, energy-source and GDP data. The appendix provides a comparable figure for the 181 countries with available employment data. It suggests that 25.6 million people were employed in the sector in 2014, up from 15.8 million people in 2000.

[3] This result is driven mainly by the Russian Federation. Excluding the Russian Federation from the analysis cuts the estimate for nuclear energy in half. The only other countries with electricity production from nuclear power in developing and emerging countries between 2000 and 2014, with the respective percentage of total nuclear electricity production in 2014 in parenthesis were Ukraine (48.6), Bulgaria (33.8), Armenia (31.8), Romania (17.9), the Russian Federation (17.0), South Africa (5.5), Pakistan (4.8), Argentina (4.1), Mexico (3.2), India (2.8), Brazil (2.6), China (2.3) and, since 2011, Iran (1.6).

Malta (Cassar, 2015), for example.

Results suggest that the indirect employment multipliers for the non-hydro renewable-based electricity sector are higher than fossil-fuel based electricity in 10 of the 15 largest economies and have higher cross-border multipliers in 11 of the 15 largest economies. Non-hydro renewables stimulate more employment locally (a finding consistent with Garrett-Peltier, 2017)renewable energy, and fossil fuels using an input-output model","container-title":"Economic Modelling","page":"439-447","volume":"61","source":"ScienceDirect","abstract":"Global carbon emissions have reached unsustainable levels, and transforming the energy sector by increasing efficiency and use of renewables is one of the primary strategies to reduce emissions. Policy makers need to understand both the environmental and economic impacts of fiscal and regulatory policies regarding the energy sector. Transitioning to lower-carbon energy will entail a contraction of the fossil fuel sector, along with a loss of jobs. An important question is whether clean energy will create more jobs than will be lost in fossil fuels. This article presents a method of using Input-Output (I-O and also internationally when compared to fossil fuel-based energy sources.[4]

## Conclusions

The decarbonisation of electricity production is a key step in mitigating climate change; around 25 per cent of GHG emissions originate in fuel inputs to electricity and heat production (IEA, 2016). The effects of such a transition on employment have been discussed, evidence suggesting favourable employment outcomes associated with generation from non-hydro renewables (e.g. solar, photovoltaic and wind). This evidence, however, tends to rely on a handful of empirical papers or scenarios (Cameron and van der Zwaan, 2015). This paper provides alternative – and complementary – evidence to previous findings by linking decades-long trends in employment in the electricity generation sector to the sources of electricity generation itself and by analysing the indirect linkages. Results show that increases in generation from non-hydro renewables favour employment in the electricity sector, with important differences observed as between developed and developing countries. Non-hydro renewables also offer higher indirect employment effects.

Some limitations need to be considered in interpreting these results. First, the linkage between employment and electricity generation used in this paper is indirect, as data on specific sub-sector employment trends are not available. Second, this paper relates to the overall jobs impact of additional electricity generation, ignoring the distributional impacts of replacing current fossil-fuel-based electricity generation with that from other fuels. These distributional impacts on employment, modelled by the ILO in its World Employment and Social Outlook (2018), will be important and will require support for displaced workers, for example through training (Louie and Pearce, 2016)a combination of factors is driving a decrease in profitability and employment in the coal-sector. Meanwhile, the solar photovoltaic (PV. Fourth, this paper relates only to absolute job numbers, but says nothing about job quality, primarily as a result of the dearth of quality world job indicators at industry level. Houser et al. (2017) notes how jobs associated with the coal industry – and coal mining in particular – are different from those opened up by solar PV electricity generation, offering for example lower average wages. Finally, this paper offers results at world level and country-specific trajectories may differ. Further research should explore how this shifting energy matrix has played out for employment and job quality at country level, with particular respect to developing countries.

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[4] Given the specificities of Exiobase and other data sources, multipliers calculated from it may not necessarily compare to multipliers calculated with other data sources, which may explain why specific results shown here compare to those estimated by Garrett-Peltier (2017)renewable energy, and fossil fuels using an input-output model","container-title":"Economic Modelling","page":"439-447","volume":"61","source":"ScienceDirect","abstract":"Global carbon emissions have reached unsustainable levels, and transforming the energy sector by increasing efficiency and use of renewables is one of the primary strategies to reduce emissions. Policy makers need to understand both the environmental and economic impacts of fiscal and regulatory policies regarding the energy sector. Transitioning to lower-carbon energy will entail a contraction of the fossil fuel sector, along with a loss of jobs. An important question is whether clean energy will create more jobs than will be lost in fossil fuels. This article presents a method of using Input-Output (I-O. Tukker et al. (2013), Wood et al. (2014)there is a need for databases to encompass the global dimension of societal metabolism. In this paper, we focus on the latest effort to construct a global multi-regional input−output database (EXIOBASE and Simas et al. (2014) provide details on the construction of Exiobase and the employment estimates.

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## Country Case 5

# Transition to a green economy: An opportunity for inclusive development in Argentina?

*Ernst, Christoph; Epifanio, Daniele* [1]

## Introduction

Climate change (CC) profoundly affects the economy, labour market, and society as a whole. This generates considerable challenges in which both international and national bodies, as well as public and private social actors, are required to cooperate with strong adaptation and mitigation measures. Within this framework, the effects on employment have caused growing concern and have recently received increasing attention.

Environmental uncertainty affects production chains and its workers in many ways, from the instability of supply of raw materials due to extreme weather conditions (i.e. hurricanes and late frost), to changes in human consumption habits in favour of more environmental-friendly goods and services (i.e. organic food and electric cars).

This generates important implications for the labour market, causing both positive and negative effects on employment and income, such as: i) the rising demand for jobs within new environmentally-friendly sectors (e.g. the renewable energy sector); ii) the replacement of some “old” job profiles with more modern ones - for instance traditional architects are giving way to architects with sustainable construction backgrounds; iii) the loss of jobs linked to non-environmentally-friendly sectors, such as fossil fuels; iv) the demand for renewed job profiles and working processes in all economic sectors[2].

Although the CC phenomenon is global, the role played by governments and public policies is key. As societies are used to living in the climates they were accustomed to in the past, they must now adapt to new climate contexts. Thus governments must implement public policies and adjustment measures such as prevention, adaptation and mitigation to meet new national needs which in turn respond to CC on a global scale.

Indeed, besides CC there is a generally increasing awareness of the need to shift towards a greener economy and towards a new pattern of development which respects society’s environment. However, given the delicate link between the environment, economy, and society (i.e. on employment, communities etc.), accomplishing this transition depends to a degree on promoting its inclusivity. This translates into a *just transition* toward a green economy which supports an environmentally-friendly model of economic growth that mitigates and minimizes negative social and economic effects, resulting in a positive net effect on workers, firms, national economies, and future generations. For these reasons, a greener economy is not only an objective of the 2030 Agenda and the SDGs, but is also a commitment of the current Argentine Government.

This paper analyses how the shift towards a green economy can be implemented in an inclusive way for the Argentine population and labour force, and towards policies that could strengthen and support a just transition to a green economy. It also discusses existing and planned policies for implementation of a sustainable and inclusive development strategy and analyses the potential winners and losers from a green economy and CC.

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[1] November 2017, ILO, Buenos Aires.

[2] Source: UNEP, ILO, IOE, ITUC (2008), “Green jobs: Towards decent work in a sustainable, low-carbon world”, Geneva.

## 2. Green economy in Argentina: environmental and socio-economic challenges

According to the Emissions Gap Report 2016 by UNEP, Argentina emitted 52.700[3] megatons of carbon dioxide equivalent to a share of only 0.7% world-wide. They were generated mainly by energy (53%), followed by agriculture (26%). Data also shows that there was a trend towards a rise in the value of GHG emissions during the period 1990-2014[4].

CC is a reality in Argentina, as phenomena such as flooding, storms, extreme temperature and fire have been recently observed with increasing frequency. Indeed, extreme temperature and river flooding caused almost 50% of natural disasters that occurred between 1950 and 2015[5].

Human interference with nature in Argentina is a key explanation for the rising frequency of natural disasters. Indeed owing to agricultural frontier expansion - particularly for soybean crops - between 2001 and 2014 Argentina lost over 12% of its native forest[6]. Nowadays, soybean cultivation covers more than 50% of cultivated land in Argentina to the detriment of cultivation rotation, which causes an imbalance between rainfall and evapotranspiration, leading to an increase in rainfall levels. Also the substantial use of pesticides and herbicides, and other unhealthy agricultural practices, are key environmental concerns[7].

CC is generating increasing threats to and consequences for the environment, and thereby on the economic and social stability of the country. For instance, in the Buenos Aires province, in 2015 alone 800.000 hectares were affected by heavy rain causing the loss of more than 650 million dollars-worth of production in the agro-industrial sector.

Extreme weather events also have negative effects on infrastructure (in particular transport and electricity) as well as on health[3]. The increase in extreme weather conditions increases the vulnerability of the population, for instance through urban inundations. Similarly, in urban areas air pollution is a critical health threat (see **Table 1**).

**Table 1:** Environmental problems, costs and current situation

| ENVIRONMENTAL THREATS | SOCIAL COST | PUBLIC EXPENDITURE | FURTHER INFORMATION |
|---|---|---|---|
| **Deforestation** | 0.74% of annual GDP | 4% of environmental protection budget | Extremely high deforestation rate |
| **Air Pollution** | 1.84% of annual GDP | - | Rising urban pollution |
| **Waste Management** | - | 5-25% of municipal expenditure | Weak and often absent municipal waste recollection system |
| **Water Pollution** | 0.4% of annual GDP | 46% of environmental protection budget | - |
| **Soil Degradation** | 3.56% of annual GDP | - | |
| **Pesticides/Herbicides Use** | - | - | High use levels |
| **Urban Inundations** | 3.32% of annual GDP | 17% of environmental protection budget | Increase in occurrence |
| **River Inundations** | 3.34% of annual GDP | 17% of environmental protection budget | Increase in occurrence |

*Source: adapted from (Banco Mundial en Argentina, 2016), p. 13.*

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[3] Among the gases, 67% was CO2, 21.2% CH4 and 11.6% N2O.

[4] Source: Ministerio de Ambiente y Desarrollo Sustentable, Presidencia de la Nación (2016), “Informe del estado del ambiente”, Buenos Aires.

[5] Source: World Bank in Argentina (2016), “Análisis ambiental del país, No. 9”, Buenos Aires.

[6] Source: FAO (2015), “Global Forest Resources Assessment”, Roma.

[7] Between 1997 and 2015, although average productivity per hectare of soybean, maize and cotton has increased by just 23.9 per cent, use of pesticides has shown 244 per cent rise. This translates into a critical increase of pesticide used per hectare, which is explained by the adaptive reaction of land that forces producers to increase use of agricultural chemicals. In 1996, use of herbicide glyphosate in Argentina was 3 kg-litres per hectare, while it currently reached between 10 and 12 kg-litres.

Argentina also faces critical socio-economic challenges which are expected to be acerbated by CC In 2017; for example youth **unemployment** (affecting 18 - 24 year-olds) affects one-quarter of the population, while informality affects 33% of the population (youth 57.3 %). Furthermore many people are trapped in **non-decent jobs** that offer low incomes, job instability, and a lack of social protection, labour rights and job alternatives. **Child labour** (5-15 years) and young persons' labour (16-17) are also critical challenges affecting respectively 10% and 30% of the population on a national scale.

## 3. The effects of the transition towards a green economy on the labour market

The transition to a low-carbon economy has social implications for the labour market, affecting jobs and incomes and generating both opportunities and challenges. Four main climate-change-related drivers affecting the economy were identified as follows:

i. the direct effects of CC on nature, the economy and the labour market;

ii. changing legislation towards promotion of more sustainable products and services;

iii. adoption of new business operations and technologies and the role played by the private sector;

iv. changing consumer habits.

The direct impact of natural disasters both on human activities such as extreme heatwaves, frosts or droughts and on agricultural production has the effect of limiting productivity and forcing workers to seek alternative jobs. This phenomenon was observed in Argentina. For instance, in the northern regions of the country late frosts had dramatic consequences for tobacco production and related employment, forcing workers to migrate to other agricultural activities.

Similarly, CC has triggered several mitigation and adaptation processes for both the public and private sectors, causing major changes at the level of the productive chain and generating demand for jobs and new job profiles within the labour market. This includes the birth of a new market segment alongside business-as-usual activities. An example is the exploitation of municipal solid and liquid waste for energy purposes, which is generating demand for new specialized job profiles and is also a key driver in the creation of new jobs.

Furthermore, consumer habits and the relative change in demand patterns within markets have had a direct effect on the economy, promoting a shift towards more sustainable activities. For instance, in Argentina the rising demand for organic and pesticide-free agricultural products as well as for energy-efficient buildings is steering the agricultural and construction sectors towards a green shift. When rising demand influences the supply chain, green alternatives appear as emerging sectors with considerable implications for jobs.

However the transition might also negatively affect the labour market. Although jobs are not expected to disappear or emerge from one day to the next, identifying the sectors facing transformation (realistic), decline (realistic) or disappearance (rare and quite drastic), is a key step in forecasting labour-market evolution and identifying the appropriate policy measures needed.

The major challenge is detecting those sectors which will experience a more substantial shift towards greener practices (e.g. traditional energy, traditional agriculture, traditional tourism, mining) and quantifying the jobs that are relatively under threat.

## 4. Green Jobs and Just Transition in Argentina

Up to 60 million jobs could be created globally as a consequence of the green transition[1]. Furthermore, studies have shown that in both developing and developed countries CC policies do not reduce the level of overall employment as long as they are well-designed and effectively implemented.

In Argentina national adaptation and employment policies have not evolved in an appropriate hand-in-hand manner so far. However green sub-sectors are mushrooming within the economy, gaining ground in terms of production and employment generation. In 2015 between 486,000 and 650,000 green jobs were estimated to exist in Argentina, that is between 4% and 7% of overall formal employment[8]. Higher green jobs presence was detected in manufacturing, followed by transport, agriculture, and waste management (see **Table 2**).

**Table 2:** Green Jobs and "Brown Jobs" by sector in Argentina, on the total of registered workers (2015)

| ECONOMIC ACTIVITY | REGISTERED WORKERS 2015 | | | |
|---|---|---|---|---|
| | TOTAL | GREEN JOBS | "BROWN" JOBS | GREEN JOBS ON THE TOTAL OF WORKERS BY SECTOR |
| | *THOUSANDS* | *THOUSANDS - (%)* | *THOUSANDS - (%)* | *(%)* |
| **Agriculture, livestock, silvicuture and fishing** | 366 | 40 (11%) | 326 (89%) | 7 |
| **Agriculture, livestock, linked services** | 341 | 33 (10%) | 308 (90%) | 6 |
| **Silviculture and wood extraction** | 11 | 4 (38%) | 7 (62%) | 1 |
| **Fishing and aquaculture** | 15 | 3 (20%) | 12 (80%) | 0 |
| **Mining and linked activities** | 97 | - (0%) | 97 (100%) | 0 |
| **Manufactory industry** | 1.274 | 170 (13%) | 1104 (87%) | 28 |
| **Electricity, gas, steam provision** | 71 | 11 (15%) | 60 (85%) | 2 |
| **Water provision; wastewater management, waste management** | 59 | 48 (83%) | 11 (17%) | 8 |
| **Construction** | 509 | 23 (4%) | 486 (96%) | 4 |
| **Transportation and storage** | 476 | 188 (39%) | 288 (61%) | 31 |
| **Tourism (without transportation)** | 315 | 21 (7%) | 294 (93%) | 3 |
| **Business services, social, personal and trading** | 6.844 | 63 (1%) | 6781 (99%) | 10 |
| **Total** | **10.377** | **602 (6%)** | **9775 (94%)** | **100%** |

*Source: Estimación del Empleo Verde en Argentina (OIT/MTEySS, forthcoming).*

The transition to a greener economy does not affect all economic sectors to the same extent. Some sectors are more sensitive to a changing climate and will experience a quicker and deeper transition, particularly those directly linked to the use of natural resources such as agriculture and fisheries, or those that are highly polluting such as energy generation and plastics production.

Looking at the economic structure of Argentina helps identify which sectors might experience the greatest transformation, and aid an understanding of where most job creation potential exists. Argentina is characterized by an economy reliant on several primary sector activities. The agro-industrial sector accounts for 10% of national GDP, 25% of activities within manufacturing industry (21% of GDP), and the national government is giving rising importance to

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[8] Source: ILO/MTEySS (forthcoming), "Estimación del Empleo Verde en la Argentina", Buenos Aires.

bio-economy-related activities and their value chains. Moreover a great percentage of alimentary outputs are produced for exterior markets which often require certification and specific organic labelling. Furthermore in Argentina there is a great development potential for numerous green sectors currently lacking good environmental practices, such as waste management activities, sustainable infrastructure and tourism.

On the one hand green jobs can be created from the "greening" of some currently "brown" sectors. Sectors with the highest potential for further green job creation are expected to be agriculture (326,000 jobs), manufacturing (1,104,000) and construction (486,000). Similarly, significant potential was also found in to exist in tourism (294,000) if appropriate policies to promote environmentally-sustainable activities are implemented.

On the other hand, formidable green jobs potential can be found within the current "environmental sector" which does not fulfil the decent jobs criterion, such as informal workers in solar heater installation. The transition to a green economy also has the potential to generate higher-skilled job profiles which are expected to positively affect job conditions and the quality of employment. Also certification schemes such as organic food labelling are expected to progressively incorporate more of the decent job criteria. The transition is an opportunity to improve the quality of jobs, reduce informality and fight aberrant practices such as child labour. From this perspective sectors with a high informality rate such as agriculture, construction, waste management and transportation are key drivers in the creation of green jobs.

However, the effects of the green transition on the current structure of the economy, and the consequences for the labour market, will be considerable and must be identified in order to be mitigated. Polluting sectors, such as mining, traditional fossil fuel-related energy, and other key industrial activities (e.g. plastics production) will experience a downturn and in some cases are expected to disappear. As mentioned this also opens opportunities for creation of green jobs, both in transforming sectors and within those new economic activities taking the place of traditional activities. However it also generates challenges for the labour market, owing to this change of paradigm. Particular attention has to be paid to those workers which will lose their jobs because of the changing economy. This translates into the need for key social actors to develop coherent labour market policies as well as skills development and educational policies aimed at mitigating the negative effects of the transition and adapting professional profiles to the new economy. The following section explores key labour measures.

## 5. Policy measures to make the transition just

A just transition to a green economy is not an automatic process as it has to be shaped by public policies and accompanied by associated and coherent policy measures. Similarly, potential jobs will not automatically crystallise into real jobs. There may also be hardship: workers may lose jobs in polluting sectors or have to learn new tasks. These workers will also need measures to guarantee their income during this transition period and hasten their reincorporation in the labour market.

However the cost of the transition can be mitigated. There is a need to integrate national employment policies with green-economy-related policies, promoting not only generation of new jobs but also market interventions and further measures aimed at temporarily protecting and assisting those recently made unemployed by the green transition. Policies and measures aimed at mitigating the social cost of the transition might include:

v. industrial policy and industrial restructuring for enterprises;

vi. local development policies;

vii. professional re-orientation policies, such as training of workers;

viii. social protection measures such as guaranteed income during the transition period.

There is a need for an integrated policy framework since isolated policies would not be sufficient to tackle such a complex issue. This will in turn affect production, the labour market, the environment, consumption, and indeed society itself. The following policy areas are key to a successful shift to a green economy.

**Industrial policies** will play a fundamental role in accompanying the technological shift to a green economy, as this shift will need new and appropriate regulatory frameworks. Indeed, in order to implement their technological and productive transition, enterprises have to be supported and directed through carefully drafted environmental regulation (i.e. carbon taxes). Critical measures include training programmes, subsidies, credit schemes, and investment in R&D.

**Active labour market policies** are vital for mitigating the possible negative effects of the transition towards a green economy, but also for grasping the opportunity for potential green jobs. These measures include labour market intermediation services, training schemes, local employment policies for areas affected by job losses (e.g. mining), employment subsidies, green works, and others.

Within active labour market policies, **skills development through training policies and programmes** will be key within the just transition process. These include revision of professional competence certification systems and professional profiles; adaptation of courses and curricula in technical schools and in professional training centres; re-orientation programmes for workers who have lost their (brown) jobs, along with awareness campaigns targeting affected workers.

**Social protection** policies will support those workers losing their jobs or seeing their incomes seriously diminished. Social protection measures have to be in place to ensure a basic income for workers and their families during this transition period. Workers and households may also be increasingly affected by CC from flooding, tornadoes, and similar disasters. Furthermore social protection measures have to be in place to compensate them for the effects of natural disasters and to generate and reinforce resilience.

From a wider perspective **education policies** also play an important role in the transition. The new generation has, on the one hand, to be sensitized to the new environmental paradigm and what it implies for their daily lives, and on the other hand to benefit from a school system that prepares students efficiently for a green economy and labour market.

In conclusion a transition to a green Argentine economy will generate not only positive externalities for the environment but also net positive impact on the economy, employment and society, as long as inclusiveness is promoted and the social costs are limited. But without a national strategy and a comprehensive and integrated policy package coherently implemented by the various ministries, the potential for such a shift may not be realised and social adjustment costs could be high, threatening a just transition towards a more inclusive, productive and sustainable society.

## Country Case 6

# Modelling the economic impact of decarbonising car travel

*Richard Lewney* [1]

The paper reports the method and results of the *Fuelling Europe's Future* study carried out by Cambridge Econometrics and partners for the European Climate Foundation. The original study was completed in 2013 and is currently being updated.

This summary reproduces the Executive Summary from the full report, available at https://www.camecon.com/how/our-work/fuelling-europes-future/.

Europe could improve its growth prospects and increase overall employment by supporting auto sector innovation to curb its dependence on imported oil. There are currently concerns that the transition to a low-carbon economy will be too costly to embark upon during the economic crisis. But improving auto efficiency and switching to domestic energy sources for vehicles could contribute to Europe's key objectives of stimulating economic growth and mitigating climate change. These are the main findings of this in-depth technical and macro-economic study, which has drawn on the advice of a broad range of stakeholders in the transport sector.

The innovations investigated would also cut direct $CO_2$ emissions from cars and vans by between 64% and 93% by 2050 in the three technology scenarios examined in this project, helping the EU achieve its goal of cutting overall transport emissions by 60%. Tailpipe emissions of health-damaging pollutants, such as $NO_x$ would be cut by more than 85%, with soot particles down by more than 70%. And European motorists would benefit from lower costs of vehicle ownership. Job creation is a priority for policy makers across Europe.

One way to boost growth in Europe would be to improve its trade balance, while another would be to shift the focus of spending from areas of low labour-intensity to areas of higher labour-intensity. The switch to low-carbon vehicles achieves both.

The fossil fuel supply-chain – including refining, distribution and retail – is one of the least labour-intensive value chains, and has most of its value-creation outside Europe. Therefore, reducing EU citizens' bills at the fuel pump and shifting spending towards other, more labour-intensive, areas of the economy induces net job creation. Furthermore, Europe excels in auto technology, and therefore increased spending on low-carbon vehicle components will create supply-chain jobs.

Between 660,000 and 1.1 million net additional jobs could be generated by 2030 in the three low-carbon technology scenarios examined in this research project, compared to a reference scenario in which cars continue to run on today's technology. In 2050 this rises to between 1.9 million and 2.3 million additional jobs, even when the jobs lost during this transition are taken into account. These benefits take time to achieve, because Europe's vehicle fleet takes 12 years to renew, but new jobs are created from day one.

Somewhat less than half of the additional jobs identified are direct jobs within the value chains for manufacturing vehicles and the supporting infrastructure. The prospect of these new jobs is set against a background in which Europe's auto industry is struggling with sluggish sales at home. Thus any new jobs arising from the manufacture of low-carbon vehicles would be offset by likely job losses as the industry in any case restructures to reduce over-capacity. The transition to low-carbon vehicles will also demand new skills from the workforce and that existing technologies are optimized. So, Europe must develop a pioneering environment to ensure it captures these opportunities.

Most of the new jobs are created outside the automotive value chain, in sectors such as services and construction, which benefit from the shift in spending away from the fossil fuel value chain and towards domestically-produced goods and services.

There are obvious uncertainties in assessing scenarios out to 2050, and the project has therefore taken care to use

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[1] 6 December 2017.

conservative assumptions throughout. Data on the cost of low-carbon vehicle technology have been largely sourced from the auto industry itself, including industry submissions for the European Commission’s impact assessment on the proposed $CO_2$ standards for cars and vans in 2020. These have been supplemented with data from similar assessments for the UK and US governments, especially for the cost of zero-emissions vehicles.

Fuel price projections are based on the International Energy Agency’s World Energy Outlook. Despite the long-term uncertainty, much is already known about the vehicles that are being designed today for 2020, and these are the vehicles that will deliver most of the benefits in the timeframe to 2030.

At an individual level, the cost of additional vehicle technology adds about €1,100 - €1,200 to the production cost of the average car in 2020 in the two scenarios that rely on conventional technologies, compared to the average 2010-manufactured vehicle. However, this is more than offset by the fuel savings realised by consumers.

The owner of the average new car in 2020 will spend around €300 to €400 less on fuel each year than the owner of the average 2010-manufactured car. Given that the increased capital cost is less than the amount saved on fuel, this improves the budgets of households.

At the EU level, the two scenarios that rely on conventional technology add €22-46 billion to the yearly capital cost of the EU car and van fleet in 2030, but this is more than offset by avoided yearly spending on fuel worth €57-79 billion in 2030. This makes the total cost of running and renewing the EU car and van fleet in 2030 about €33-35 billion lower than if the fleet were to continue running on today’s technology.

## Country Case 7

# The socio-economic impacts of renewable energy and energy efficiency in Egypt

*Ulrike Lehr, Maximilian Banning* [1]

## 1. Background

Renewable energy (RE) expansion and energy-efficiency (EE) increases exhibit several benefits, be they environmental quality, climate change mitigation or economic impacts in terms of savings, value creation and domestic employment. The MENA region has large RE potential owing to its geographical and climatic situation. Excellent locations for solar energy are found for instance in Egypt, owing to high radiation (up to 6,800 wh/$m_2$; IRENA 2017a) and wind speeds of up to 10 m/s on average at 200m altitude (IRENA 2016b) in the New Valley and Minya Governorates. The MENA region is also characterized by high potential in the labour market, youth unemployment and few opportunities for an above-average-qualified body of young workers. Regarding energy-efficiency, MENA countries - oil-exporting and non-oil-exporting alike - realize that subsidies are too costly and high energy demands are harmful both for government budgets and for the environment.

Policies in support of renewable energy and energy-efficiency have therefore been developed in several MENA countries. National Energy Efficiency Action Plans (NEEAPs) have been developed by Lebanon, Jordan, Palestine, Egypt and Tunisia. The League of Arab States (LAS) offers an award for the best practice in the region and the best implementation of NEEAPs. To support renewable energy and energy-efficiency, mechanisms such as PROSOL, PROSOL elec (Tunisia), strategies such as the Tunisian Solar Plan or Egypt's Vision 2030, and institutions such as MASEN in Morocco or LCEC, the Lebanese NEEREA, or the Tunisian ANME, as well as RCREEE as a regional centre, have been developed.

To control what has been achieved and what will be achievable along the expansion path, however, a monitoring process is necessary. Monitoring also serves the detection of successes, which will support development paths by encouraging continued successful strategies and incentives. Part of this monitoring process consists of activities of the German developing organization GIZ which commissioned studies in several MENA countries through a variety of initiatives, such as RE-Activate (GIZ 2017a) or Med-ENEC (GIZ 2017b), to name just two.

The discussion, methods and results presented in the following are part of this process. The results have been obtained from a study commissioned by RE-Activate and RCREEE. The task was to develop a method and a tool for estimating employment from renewable energy and energy-efficiency in Egypt. The time horizon spans an *ex post* analysis until 2010 and an *ex ante* simulation until 2030.

Egypt faces challenges in the energy sector with increasing energy demand, decreasing domestic shares and energy subsidies. Population growth puts strain on the job market, in particular from young adults seeking to enter the labour market at the beginning of their working life. As our results show, RE and EE expansion can help mitigate both strains. The underlying theory of the modelling exercise and the tool developed is input-output theory with synthetic demand functions (Garett-Peltier 2017). The approach does not follow the route of detailing the green and brown parts in the input-output table as suggested in Harsdorff et al., 2014. The methodology is described in greater detail in the next section, while section 3 gives results and a conclusion.

## 2. Methodology

How does one measure employment from renewable energy and energy-efficiency? The scientific community has discussed this question at length. Meanwhile, a consensus has been found which developed from literature over-

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[1] 6 December 2017, *Gesellschaft für Wirtschaftliche Strukturforschung mbH (GWS), Osnabrück, Germany.*

views in peer-reviewed journals - lately by Cameron and van der Zwaan 2015 - or earlier the seminal work by Daniel Kammen in 2004 or Wei et al. in 2008, as well as guidebooks from international institutions such as Breitschopf, Nathani and Resch (2011), published and commissioned by IEA RETD, or Renewable Energy and Jobs published by IRENA in 2013. From this starting point the analyses have set out to quantify the effects and apply the suggested methods leading to a large body of case studies. However, as Cameron and van der Zwaan state in their 2015 review: "[…], few studies of the employment potential of renewables have been conducted in developing or emerging countries. For those cases where such studies have been performed, often surrogate figures are quoted from OECD country studies, with only rarely an attempt to adapt them to the local context. Simas and Pacca's study for Brazil and Lehr's study for Tunisia are two of the very few exceptions with a detailed analysis of employment impacts of renewables deployment outside the OECD." Although this is flattering, the main body of literature focusing on green employment includes renewables in a wider scenario of greening or sustainable development (cf. the literature of the ILO on Green Jobs (e.g. Marek Harsdorff and Riad Sultan on Mauritius 2014, or Sherman Robinson's work on sustainable development in Africa, e.g. Ethiopia 2015, or lately the GAIN Training Guidebook.).

Input-output-analysis-based calculations established themselves as the method of choice for calculating employment from RE (cf. IRENA 2013). The discussion in IRENA 2013 (p. 5152) states "I-O modelling is a useful tool for calculating the effects of changes in demand, such as those triggered by investments in renewable energy." Bacon and Kojima (2011) cite several advantages of I-O analysis. It permits a full analysis of all indirect employment effects. Further, I-O tables indicate the proportion of total demand for goods and services emanating from the renewable energy sector which is met by imports. This in turn can be used to quantify the effects on domestic and foreign employment. Bacon and Kojima (2011) caution that even where I-O tables are available, they may not be sufficiently disaggregated: "some sectors, notably solar and wind power, are typically not identified separately so that coefficients are not fully representative." Writing from a South African perspective, Maia et al. (2011) similarly note that the highly disaggregated sectoral data used in industrialized countries are not available in South Africa. The same is true generally for other developing countries, although additional information can be obtained from local experts familiar with and monitoring the infant renewable energy industries. The economic input-output analysis (for a very comprehensive overview see Eurostat 2008) applied in this fashion, combines an understanding of economic theory and the development of employment by sector with technology-specific information on renewable energy systems.

Input-output (IO) modelling revolves around the flows of goods and services between different branches of an economy, in this case specifically the relationship between the renewable energy sector and the energy-efficiency sectors and their supplier industries. At the centre of the model lies an IO table that maps the supply of goods from each economic branch to all other industries. It contains input structures for every industry as well as information on gross value-added and employment.

For Egypt we used the input-output table provided by the EORA network (Lenzen et al 2012). In addition the model takes into account the cost structure of different RE and EE technologies (for which synthetic demand is derived), varying production, construction and maintenance costs over time and the share of locally-added value.

The analysis conducted is twofold: historic investment in renewable energy (RE) and energy-efficiency (EE) are examined with respect to jobs created in Egypt. Proceeding from there, the employment effects of future investments and future RE capacities up until 2030 are estimated. For the *ex post* and *ex ante* analyses IO modelling is applied.

The approach follows the value chain and employment from installation, manufacturing of systems and operation and maintenance (O&M) being calculated individually. A distinction is made between employment directly related to new installations, production and operation and maintenance of renewable energy and energy-efficiency technologies and indirect employment. The latter is a result of the increase in the production of input factors due to higher demand in certain industries that is induced by the initial investment.

Data on capacities installed – new and stock – as well as on labour-intensities of these activities in the past have been collected from local institutions for O&M of RE and the implementation of EE measures. A list of the institutions contacted is available from the authors on request. Data gaps are closed using international publications and data such as employment factors from Rutovitz and Harris (2012) or Rutovitz and Dominish (2015). Local manufacturing was as yet of minor importance for most technologies in Egypt. For the calculation of jobs indirectly created by construction and operation of RE as well as application of EE, the input-output approach is applied.

For the analysis of future developments data from the *ex post* analysis are used as well as insights from local experts with respect to possible expansion paths. A benchmark scenario is compared with alternative settings featuring either a higher level of investments, a shift of investments into certain technologies – namely small PV and SWH – or an increase in the local share of domestic added value and manufacturing.

An Excel-based tool was developed to calculate employment following the steps outlined above. It has been distributed to local institutions, namely the New and Renewable Energy Authority (NREA) and the Regional Center for Renewable Energy and Energy Efficiency (RCREEE). It allows modifications to investment paths, changes in productivity, employment factors, domestic filters and various other variables. The tool contributes to capacity-building and supports the monitoring process of the Egyptian RE and EE deployment strategies.

## 3. Results

In the past renewable energy in Egypt focused on hydropower, with a capacity of 2,800 MW in recent years. Wind power and solar pumping has steadily increased in the recent past, amounting to 860 and 700 MW respectively. Usage of Biogas and SWH also increased; the former's installed capacity increased to close to 5M $m^3$ in 2016, the latter to around 800 $m^3$.

The analysis shows that around 6,800 jobs in Egypt could be attributed to renewable energy technologies and energy-efficiency measures in 2010. With around 3,800 jobs, the operation and maintenance of hydropower was directly responsible for the majority of employment. Indirect employment is of overall lesser significance with around 700 jobs in total, of which the highest share stems from installation of solar water heaters (ca. 300). Energy-efficiency measures accounted for over 500 jobs, nearly all of them linked to the production of LEDs. Around 640m USD were spent on RE and EE in 2010. Over 400m USD went into manufacture of solar pumping technology and around 160m USD into manufacture of wind power technology.

Over the next six years investment rose to around 800m. Up until 2016 the total number of jobs increased to nearly 9,000. Although absolute numbers and therefore the share of direct employment due to hydropower O&M decreased, it remained the main source of employment with well over 3,000 jobs. With more investments in solar water heaters (around 370M), this technology comes second with over two thousand direct jobs and nearly an additional 300 through indirect channels.

To conduct the scenario analysis and evaluate future investment plans, a benchmark scenario is needed. Coinciding with Egypt's strategy it is assumed that 5,000 MW of wind energy are installed by 2022, increasing to around 13,000 MW in 2030. By the end of the prognosis horizon SWH reaches roughly 14 million $m^3$, biogas around 75 million $m^3$. Energy from solar pumping increases modestly to a little above 2,000 MW, hydropower remains at 2,800 MW over the whole projection horizon. Annual investment in RE increases from around 900m in 2017 up to nearly 3bn in 2030.

Total employment in the benchmark scenario increases from 9,700 in 2017 to ca. 28,500 by 2030. At the end of the observed time period SWH would be responsible for the major share of jobs with well over 9,000. Wind power contributes roughly 5,000 jobs, PV 3,000 jobs. Owing to productivity gains workers linked to hydropower will have decreased in number to under 3,000.

Three different scenarios were compared with the benchmark: an ambitious scenario in which investment from 2022 onwards lies above the benchmark investment for both wind power and on-grid PV; one scenario in which small technologies are favoured from 2019 onwards; and one scenario in which the share of locally-manufactured technologies increases in comparison with the benchmark.

In the ambitious scenario, investment in RE is about $2bn higher in 2023, with the difference increasing to around $2.8bn in 2030. The majority of additional expenses go into installation while O&M accounts for less than 10%. As a result total employment goes up to roughly 36,000 in 2013 –the benchmark scenario's result being 8,000 less than that. The drivers are of course wind and PV. The former now accounts for over 8,000 jobs, the latter for about 7,700.

In the small technology scenario, investments in on-grid PV change to off-grid PV. Moreover expenses in SWH are higher from 2020 onwards – with a steady increase they average approximately $390m a year. Compared to the benchmark scenario total employment is around 11,000 higher at the end of the time period examined. While jobs directly and indirectly linked to PV increase to 4,500 (now off-grid, compared to 3,000 from on-grid PV in the benchmark), jobs from SWH increase to over 19,000.

Finally, in the scenario that features more local content, the share of production and services generated domestically – of RE systems as well as intermediate input factors –is assumed to be higher. Equipment and components of wind power, off-grid PV and solar pumping are now manufactured in Egypt and the previous manufacture of SWH is being increased in scale. Total investment in USD, however, stays unchanged in relation to the benchmark during the whole observed time period. In this scenario employment in 2030 reaches 47,000 – amounting to an additional 18,000 jobs compared to the benchmark. Direct and indirect manufacturing employment each account for around 2,800 jobs.

Employment and Expenditure - Scenario More Local Content (strong) compared to Benchmark (shaded)

The figure shows the scenario featuring more local content in comparison with the benchmark scenario. While expenditure on RE and EE is the same in both scenarios, the difference in employment is significant and increasing over time.

In terms of the increase in green jobs and development, this scenario is rather more favourable, as it offers opportunities at various levels of qualification and develops local industry. The policy measures to attain this scenario span a wide range: industry development can be enhanced by strengthening capacities, supporting the private sector, in particular SMEs and in decreasing red tape and corruption. Energy planning is involved, as is education and capacity-building. Egypt has the potential for becoming a regional hub for renewable energy and energy-efficiency. Together with other environmental fields, the country has room for extensive green jobs development.

## Country Case 8

# Do green investments boost climate change mitigation and adaptation benefits while delivering positive social and employment related outcomes? A meta-analysis of 17 green economy country studies

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## Introduction

### International agendas on green economy and climate change

At the 2012 Rio+20 Summit, the Outcome Document "The future we want" of the United Nations Conference on Sustainable Development (UNCSD), recognised " . . . green economy in the context of sustainable development and poverty eradication as one of the important tools available for achieving sustainable development".[3] Many countries around the world have since embraced the concept of green economy as a pathway to achieving sustainable development. Although "green economy" is interpreted and adapted by countries according to their policy context and national priorities, the approach of the UN Environment Programme prevails as the primary concept: "a green economy improves human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy is low-carbon, resource efficient and socially inclusive".[4]

In 2015 the 21st Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Paris Agreement, which will be the main international climate change regime post-2020 once the second commitment period of the Kyoto Protocol has expired on 31 December 2020. The main purpose of the agreement is to keep global average temperature change under 2°C in the context of sustainable development and of efforts to eradicate poverty. The framework for reaching this goal is through Nationally Determined Contributions (NDCs). The agreement includes *inter alia* provisions for i) mitigation as it calls for "peaking greenhouse gas emissions (GHG) as soon as possible"[5] (mainly Article 4); and for ii) adaptation by "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change" [6] (Article 7).

It is a fact that international agendas for green economy and climate change have different frameworks, namely the UNCSD and the UNFCCC, which concur on achieving sustainable development and poverty eradication. However two fundamental questions remain: (i) do green investments **deliver benefits from climate change mitigation and adaptation**? And (ii) how do climate-oriented green investments provide benefits from climate change mitigation and adaptation, and at the same time **contribute to sustainable development**?

This paper is an attempt to answer both questions by highlighting results from case studies which show how green investments can contribute to key elements of the Paris Agreement, notably to climate change mitigation and ad-

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[2] This short working paper is part of a series of articles on green economy and relevant topics, such as sustainable development and climate change, by the author. For instance, see the related working paper in French "Investing in the green economy: Is it a way to achieve Sustainable Development Goals? An analysis of the experience of eight African countries".

[3] United Nations General Assembly, 2012, Resolution 66/288: "The future we want". Available at http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/66/288&Lang=E

[4] UNEP, 2011, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, page 16, available at http://web.unep.org/greeneconomy/sites/unep.org.greeneconomy/files/field/image/green_economyreport_final_dec2011.pdf

[5] United Nations, 2015, Paris Agreement. Available at http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

[6] Ibid.

aptation. An analysis of green economy targets and required investments in 17 countries for which Green Economy Policy Assessments (GEPA) was carried out with the support of the UN Environment Programme between 2012 and 2017. Most of these GEPAs examined the economic, environmental and social impacts of green policies until 2030 or beyond.

## Green Economy Policy Assessment (GEPA)

For its part, the UN Environment Programme supported the development of GEPA in around 17 countries between 2012 and 2017. These studies are a critical part of policymakers' decision-making process for developing and adopting green economy policies for achievement of sustainable development targets. Although it has been empirically applied since 2012, the methodology for the GEPA was only distributed as a guidance manual in 2014.[7] A typical GEPA includes five steps: i) identifying national priorities for sustainable development targets; ii) estimating the amount of investment required to achieve such targets; iii) identifying the policies or policy reforms that are essential for enabling the required investments; iv) assessing the impacts of the required investments as well as the enabling policies, using a range of economic, social and environmental indicators and comparing the results with the business-as-usual scenario (BAU)[8]; and v) presenting the assessment results to inform decision-making.

Modelling is used the foregoing step "iv" of the GEPA process and is an important tool for: a) establishment of the relationship between policy targets and relevant factors from different dimensions; b) projection of the impacts of policy measures; c) analysis of the effects of existing policies; and d) identification of synergies and cross-sector impacts from among policy choices. Although there are other modelling tools, System Dynamics is the modelling technique used most frequently in a GEPA.[9]

## Major elements of climate change-oriented investments from 17 Green Economy Policy Assessments

**Climate-oriented investments are at the heart of all 17 Green Economy Policy Assessments (GEPA)**. As revealed in Figure 1, countries perceive green economy as a means of adapting to and mitigating climate change while advancing towards sustainable development. On mitigation, most green and climate-oriented investments are focused on increasing the share of renewables in the energy matrix of the countries along with ambitious targets for higher energy-efficiency across the transport, tourism, manufacturing and construction sectors, in that order. Investments in the third priority sector, the forestry sector,, (see Figure 1) are viewed as a means of increasing GHG sequestration and storage. On adaptation, climate-oriented investments tackle the need to improve water availability for both population and the economy, and to prepare country readiness for more severe climate change scenarios probably characterised by water scarcity. Investments in more efficient crop irrigation systems and in improving infrastructure for rainfall collection are some of the interventions considered by most of these countries.

**A green economy is a vehicle for building climate resilience while taking account of country priority issues**. Food security is a priority issue identified by most of the 17 countries for achieving sustainable development, an issue compromised by water scarcity and soil erosion. It is expected that future climate change scenarios will worsen the situation. Quantitative results from the GEPA (see Annex I) show that green investments in the agriculture and water sectors contribute to increasing the climate resilience of these countries during the simulation periods up until 2030 and beyond. Irrigated cropping areas would substantially increase and entail an increase of productivity per hectare, while making more efficient use of water resources as measured by a reduction of the water stress index. This, added to green policies for sustainable management of agriculture lands, has positive impacts on land degradation. It is worth mentioning that water availability is key for most of these countries.

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[7] UNEP, 2014, A Guidance Manual for Green Economy Policy Assessment. Available at http://www.un-page.org/files/public/content-page/unep_assessment_ge_policymaking_for_web.pdf

[8] A scenario for future patterns of activity which assumes that there will be no significant change in people's attitudes and priorities, or no major changes in technology, economics or policies, so that normal circumstances can be expected to continue unchanged.

[9] UNEP, 2014, Using Models for Green Economy Policymaking. Available at http://www.un-page.org/files/public/content-page/unep_models_ge_for_web.pdf

*Figure 1.* **Climate-oriented investments in Green Economy Policy Assessments**

**A green economy approach which is climate-oriented also delivers sustainable development benefits.** In addition to the fact that green investments were analysed for a few sectors, Annex I compiles evidence from the 17 GEPAs on the positive balance it has on an economy, measured mainly by GDP and social indicators. On the one hand, mainstreaming climate change variables into planning processes results in building more resilient economies, making them more competitive as environmental costs are taken into consideration. On the other hand the different studies demonstrate that the transition to a green economy creates jobs and helps escape from poverty, while improving access to basic services such as water and sanitation.

## Conclusions

Through the presentation of 17 specific country case studies on green economy investments, this paper has addressed two fundamental questions regarding the role of green investments in the delivery of benefits from climate change mitigation and adaptation in the context of sustainable development. The key findings are highlighted below.

Climate-oriented investments are a central part of the 17 Green Economy Policy Assessments. Countries perceive a green economy as a means of adaptation to and mitigation of climate change while advancing towards sustainable development.

The top priority for green investments is to reduce GHG emissions and increase their sequestration and storage. Even though all the 17 countries are “Non-Annex I countries” of the United Nation Framework Convention on Climate Change, allowing them to prioritize economic development and poverty eradication, most of the green investments considered in the studies focus on increasing the share of renewables in the energy matrices of the countries. These are accompanied by ambitious targets on energy efficiency across the sectors, followed by massive investments in the forestry sector which are viewed as a way of increasing GHG sequestration and storage. This result shows the significant predisposition and political commitment of all 17 countries to climate change mitigation.

Climate-oriented investments related to adaptation focus on improving water availability for both population and the economy, and prepare country readiness for more severe climate change scenarios characterised by probable water scarcity. Investments in more efficient crop irrigation systems and improved infrastructure for rainwater collection are some of the interventions considered by most of these countries.

A green economy is a vehicle for building climate resilience while giving due attention to country priority issues. Food security is a priority issue identified for achieving sustainable development in most of the 17 countries, an issue which is compromised by water scarcity and soil erosion. Quantitative results from the Green Economy Policy Assessments show that green investments in the agriculture and water sectors contribute to an increase in the climate resilience of these countries during the simulation periods up until 2030 and beyond. Crop irrigated areas would substantively increase, along with green policies for sustainable management of soil and its positive impacts on land degradation and agricultural productivity.

A green economy approach which is climate-oriented also delivers sustainable development benefits. The 17 Green Economy Policy Assessments show the positive balance these investments have on the economy and on social indicators. Mainstreaming climate change variables into planning processes results in the building of more resilient economies and making them more competitive. The different studies demonstrate that the transition to a green economy creates jobs and helps escape from poverty, while improving access to basic services such as water and sanitation.

# *Annex I.* Climate change and sustainable development benefits from green investments based on results from Green Economy Assessments

| Country | Climate change benefits |  | Sustainable development benefits |  |
|---|---|---|---|---|
|  | ADAPTATION | MITIGATION | ECONOMY | SOCIAL |
| **Burkina Faso**[1] | Reduced land degradation and increased of crop irrigated areas. | Emissions intensity of $CO_2$ per unit of GDP produced would be 10% lower in the green scenario compared to BAU by 2050.<br>Expected increase in forest cover. | GDP of US$37-41 billion – increasing at an annual rate of 5.1-5.3% – by 2050, 22–23% higher than the BAU scenario.<br>Cereal production per capita would increase by an average of 25% by 2050 in green scenarios. | The proportion of the population living below the poverty line is expected to be less than 20% by 2030 in the green scenario, lifting an additional one million people out of poverty.<br>The green scenario creates 0.16 million additional workstations compared to BAU.<br>The country's Human Development Index (HDI) would increase from 3.5% to 3.7%. |
| **China**[2] | In the green scenario the total volume of water resources increases slightly, while demand shows a tendency to decline.<br>Chronic water scarcity would be mitigated by 2030, and the water stress index would be less than 1. | In the "Green Scenario", China's emissions will peak in 2025 at 9.702 billion tonnes.<br>Forest cover rate would be 28.2% higher than in under BAU. | The "Green Scenario" projects a decrease in the rate of GDP growth from 7.46% to 7.28% over the period of 2015~2020, and from 4.75% to 4.52% over the period of 2020~2030. However, GDP under the green scenario is more competitive because it takes into account environmental costs. |  |
| **Ghana**[3] | Crop-irrigated areas double. | Energy intensity is improved in the green scenario by 2030 but is primarily driven by stronger economic development.<br>Total $CO_2$ emissions from fossil fuel consumption will be higher in the GE scenarios.<br>Forest area would increase by 3.2 million ha by 2030. | Annual economic growth rate would be 6.9% between 2013 and 2030 in the green scenario *versus* 5.9% under BAU. | A green scenario would lead to a 5% reduction in poverty by 2030, which is 2% lower than under BAU.<br>The green scenario would create 400,000 more jobs than under BAU.<br>HDI of Ghana will improve by 1.5% to 2.3%. |
| **Indonesia**[4] | n/a[5] | As a result of a reduction in deforestation the annual amount of $CO_2$ emitted by forests is projected to decline.<br>The green scenario shows a reduction in the depletion of natural capital.<br>Secondary forest in the GE scenario is projected to remain higher and almost eliminate the trend of decline visible under BAU. | Growth rate of Green GDP[6] to be higher than that of GDP in the green scenario. | Household income is improved in the green scenario. |

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|---|---|---|---|---|
| **Kenya**[7] | Increase in irrigated crop areas | Emissions would be about 9% lower in the green scenario compared to BAU by 2030. | Real GDP in the green scenario is expected to exceed the BAU scenario by 12% by 2030. | The proportion of the population living below the poverty line is expected to decline by 2% between 2015 and 2030 in the green scenario compared to the BAU scenario. |
| **Mauritius**[8] | Water stress index would be 0.11 in the green scenario as against 0.13 in the BAU, meaning that 2% of total available water resources would be saved under the GE scenario in 2030. | Emissions from fossil fuels in the green scenario are expected to be 20% lower than in the BAU by 2035.<br>It is estimated that 2.25 million tons of $CO_2$ emissions would be avoided every year between 2014 and 2025. | Increase of 6% of GDP in the green scenario *versus* the BAU scenario by 2035. | In the green scenario jobs in the energy sector are expected to increase by 240% by 2025. |
| **Mexico**[9] | n/a | A carbon tax at US$3.5 rate enables renewables to surpass gas-fired sources by around 2033, with renewables accounting for approximately 60% in 2050. At a US$25 rate, renewables surpass gas-fired generation around 2026. | Investing revenues from carbon tax in greening the energy sector has an improved effect on GDP. | The gains are more or less evenly distributed over all consumers, with a slight bias towards the richest agents in the economy. |
| **Moldova**[10] | n/a | 1.8 million tonnes of $CO_2$ emissions would be avoided in 2030.<br>Cumulative avoided $CO_2$ emissions over the simulated time period are estimated at 14.9 million tonnes. | Positive balance for the economy of MDL million 2,740 due to total savings and avoided costs. | An average of up to 643 additional jobs would be created between 2015 and 2030 in the green scenario.<br>Renewable energy employment would be 57% of total employment in 2025. |
| **Mongolia (forthcoming)** | In the 4.0% green scenario, 98% and almost 85% of the national population will have access to clean water and sanitation, respectively, by 2026. | The 4.0% green scenario would avoid 2.7 million tonnes of $CO_2$ emissions by 2030.<br>$CO_2$ emission intensity would be 1 811 tonne/GWh in the 4.0% green scenario against 3 650 tonne/GWh under BAU in 2030. | Real GDP *per capita* would be “Tugruk 2005” 3 153 554 in the 4.0% green scenario against “Tugruk 2005” 2 963 441 in the BAU in 2030. | Unemployment would be lower by 9.5% in the 4.0% green scenario against 11.9% in the BAU in 2030. |
| **Montenegro**[11] | n/a | Transport emissions decline to 570,000 tonnes of $CO_2$ in 2020 (14% below BAU) and power emissions for the residential and services sectors decline by up to 300,000 tonnes of $CO_2$ in total by 2020 (26% below BAU) in the GE20 scenario. | The green investments would generate a net saving of EUR 3.7 million per year on average during 2012–2020 in the GE20 simulation. | The GE20 green scenario would generate 730 full time direct jobs by 2020.<br>From an economic perspective, the jobs created could potentially generate up to EUR 2.66–5.25 million of income in 2020 in the two GE scenarios. |

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| **Mozambique**[12] | Better quality of water in the areas around the mining zones. | 1.2 million tonnes of $CO_2$ can be avoided each year between 2015 and 2030 in the green scenario. The green scenario would lead to a forest cover that is 8.5% larger than under BAU by 2035. The economic value of the carbon sequestered is 3.8% higher in 2030; and the added value of the sector would be 10% higher. | No specific data is provided on the overall impact on GDP, but some sectoral results are evident. For example, green investment in the energy sector would bring in US$1.2 billion of savings to the country. | There are no data at macroeconomic level but some very specific sectoral estimates. For example, employment in the forestry sector will increase by more than 2,000 under a green scenario by 2035. |
| **Peru**[13] | Increased irrigated crop areas for agriculture use | Reforestation would go from 1 119 ha/year (under BAU) to 18 806 in the green scenario by 2030.<br>Net emissions from deforestation would decrease by 3.77% in 2030 compared to the BAU scenario.<br>Emissions from private vehicles in Lima and emissions from public transport in Lima would respectively be 5.76% and 0.36% lower in the green scenario *versus* the BAU by 2035. | Real GDP is 1.85% higher in the green scenario than under BAU. | The population below the poverty line is reduced by 4.77% in the green scenario *versus* under BAU in 2035.<br>GDP of agriculture in the Peruvian highland regions would increase by around 28% in the green scenario *versus* BAU in 2035, directly increasing the income of farmers (low-income households). |
| **Rwanda**[14] | n/a | Replacing diesel generators by cleaner sources of energy has a positive impact on reducing GHG emissions in the green scenario. | No specific data is provided on overall impacts on GDP. The study focuses on the energy sector, where there is considerable investment to increase access to energy for the population. | 50% of the population would have access to electricity in 2020 in the green scenario (compared to 16% in 2013).<br>Thousands of jobs would be created as a result of the construction, operation and maintenance of the power generation facilities (2012–2020). |
| **Senegal**[15] | Reduced degraded land by 37% compared to under BAU by 2035. | In 2035 energy supply renewable should represent 30%-60% of the energy mix, reducing GHG emissions.<br>An increase in forest cover of nearly 28% in 2035 compared to the BAU scenario. | Real GDP is expected to be US$14 billion in the green scenario *versus* US$12.6 billion in the BAU scenario in 2035. | The population with less than US$1.25 per day would be less than 20% in 2035, compared with almost 25% in the BAU scenario.<br>Renewable energy production is expected to create between 7 600 and 30 000 jobs by 2035. |

| | | | | |
|---|---|---|---|---|
| **Serbia**[16] | n/a | Energy consumption and emissions in the transport sector would be 17% below that under BAU by 2030.<br>Energy efficiency is improved by 12% across sectors relative to BAU, lowering GHG emissions by 11% in 2030. | n/a | Investments simulated would have the potential to create 5 000–8 000 jobs by 2030 in the energy demand side; and an average of between 1 500 and 1 600 jobs in the energy supply side. |
| **South Africa**[17] | The water stress index would be 2.82% in the green scenario *versus* 3.07% in the BAU by 2030.<br>Additional 46.4% restored land. | GHG emissions in the green scenario would reach 461 million tonnes compared to 477 million in the BAU by 2030. | Real GDP in the green scenario is expected to reach ZAR 2 907 billion against ZAR 2 879 billion in the BAU scenario by 2030. | The green scenario potentially creates, on average, 10.5% more jobs between 2012 and 2030 than under BAU. |
| **Uruguay**[18] | Water stress index in the green scenario remains below a desired value of 5.<br>Soil erosion is expected to decrease (agriculture and livestock lands). | $CO_2$ emissions from fossil fuel use will be 1.1% lower than in the BAU.<br>In the green scenario, electric energy consumption in the hotel and industry would be 4.2% lower compared to the BAU.<br>Reduction in fuel consumption of 3.4% in 2035, compared to the results under BAU. | GDP would be 1.9% higher in the green scenario than under BAU.<br>Public investments catalyze private investment into green activities. The latter would be 2.5% higher under the green scenario. | In the green scenario, population under the poverty line would decrease during the simulation period (2015-2035) at an average rate of 3.25% compared to under BAU. |

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