

Employment Implications of Green Growth: Linking jobs, growth, and green policies

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This paper was prepared in the Environment Directorate by Tobias Kruse, Rob Dellink and Jean Chateau under the supervision of Shardul Agrawala (Head of the Environment and Economy Integration Division). For more information on the OECD work on Green Growth, please visit www.oecd.org/greengrowth. For more information about the main modelling tools used for quantifying environment-economy interactions, please visit: www.oecd.org/environment/modelling. For more information about the empirical analysis of environment-economy interactions, please visit: <http://oe.cd/eps>.

Employment Implications of Green Growth

Linking jobs, growth, and green policies

Highlights

- Ambitious green policies that improve environmental quality while maintaining economic growth do not have to harm overall employment—if they are well implemented.
- Green policies can achieve job creation in a number of ‘green’ economic sectors and through a transition of the economy towards more labour-intensive services sectors, while job destruction especially occurs in ‘brown’ sectors whose activities get replaced by green sectors. The knock-on effects on employment in other sectors can also be significant.
- The use of government revenues from environmental tax reform for lowering labour taxes, mitigating undesirable distributional consequences and funding education and training programs can be crucial in achieving positive overall employment outcomes from green policies.
- Well-functioning labour markets are important to achieve a smooth transition and reintegrate workers who lose their jobs.
- Existing labour market policy tools are largely sufficient, but can be applied more effectively. Education and training systems that prepare workers for future labour demand needs are especially important to smooth the transition. Special attention should also be paid to regions with a high share of workers in ‘brown’ sectors.
- Further research is required to quantify all employment dimensions of green policies, not least with respect to within-sector firm level effects, circular economy policies and the broad interactions with socioeconomic trends.

Green policies, economic growth and employment are intricately linked

The first and foremost objective of environmental policies is to improve environmental quality. Not acting on important environmental problems will not only have adverse consequences for the environment but can also negatively affect people's health and impact the economy. Climate change, air pollution and the degradation of the natural resource base affect all sectors of the economy, either directly or indirectly, and can impact the prospects of long term economic growth (OECD, 2015, 2016). Ambitious environmental policies are needed to avoid the risks of environmental degradation, prevent deteriorated health conditions and sustain economic growth in the long run.

Environmental policies themselves will also have a range of economic consequences. Typically, **environmental policies imply a transformation of the structure of the economy** towards less-polluting and more resource-efficient economic activities. They will also result in changes in aggregate income and the macroeconomic environment, affecting e.g. competitiveness and innovation (see Box 1). Achieving environmental objectives in a cost-effective manner through well designed policy instruments, and finding policy stringency levels that maximise the ratio of benefits to costs, – referred to hereafter as green policies – can avoid any unnecessary burdens on the economy, and potentially even boost economic growth.

The focus of this report is on the impact of green policies on labour markets. It will quantify and address concerns about employment losses from the transition to green growth and highlight ways in which green policies can stimulate employment levels.

Green policies will reshape labour markets in ways that create new opportunities for workers, but also new risks. Different environmental policies and instruments may have very different implications for changes in the level and composition of labour demand, and for specific jobs. The effects are also likely to be heterogeneous across sectors, regions, and categories of workers. Aggregate effects may therefore mask regional and other dislocations, particularly during the transition period. Impacts will also vary by the stringency of the policies, and will take place within the context of broader technological, economic and demographic trends that will also be concurrently impacting on the labour market.

A successful transition towards green growth can create new opportunities for workers, if the associated challenges are managed well. Jobs will be created in green sectors, and jobs will be destroyed in their 'brown' counterparts with high environmental footprints; the knock-on effects on employment in other sectors can also be significant. The overall employment effects of green policies are still unclear; yet, the net effect will be much smaller than the gross number of jobs created. While comprehensive empirical evidence of the overall employment effects of ambitious green policies is still lacking, preliminary findings and detailed modelling analysis suggest that well implemented green policies do not have to hurt overall employment. The challenge for labour market and skill policies is to prepare the labour market for this transition. In this way, the benefits from green growth for employment can be maximised, while also supporting broader green growth objectives (OECD, 2012a).

Box 1: The impact of environmental policies on growth, competitiveness, productivity, and innovation

A large part of the empirical literature on the economic impacts of environmental policies has so far focussed on competitiveness, productivity, and innovation (Dechezlepretre and Sato, 2017). In terms of competitiveness, there is emerging evidence suggesting that environmental policies can encourage *specialization* patterns across countries, leading to a relative increase in “cleaner” industries in countries with more stringent environmental regulation (Kozluk and Timiliotis, 2016). The effect of stringent environmental policies on firm- and industry-level *productivity* growth varies across firms and industries. The technologically advanced firms and industries tend to gain more, while the technological laggards lose out in terms of productivity growth (Albrizio et al., 2017). Regarding *innovation*, evidence indicates that environmental policies redirect innovation towards green sectors, but do not lead to more innovation per se (Kozluk and Zipperer, 2015).

Moreover, the potential link between stringency of environmental policy and the international *relocation of firms*, as well as *international trade* and *investment* patterns is a central element of the competitiveness debate. Environmental policies appear to be one driver, but not a major one, of relocation decisions of firms across countries (Garsous and Kozluk, 2017; Dlugosch and Kozluk, 2017). While overall evidence suggests that trade and investment flows will not be substantially impacted when countries implement environmental policies, improving the quantification of indicators of environmental policy stringency across countries will help to substantiate these results further.

There is a vast literature on the modelling of the macroeconomic consequences of environmental policies, but numerical results depend crucially on the type of model and the assumptions made with respect to key model parameters. For example, models that assume that new investments will crowd-out existing investments tend to find less positive macroeconomic effects than models that assume such crowd-out will not occur.

A specific case in this respect is the new modelling work on the low-carbon transition done by the OECD for the G20 (OECD, 2017d). This report stresses the important opportunities that current economic conditions create for allowing to boost economic growth through temporary increases in macroeconomic investments. By using these opportunities for investing in the low-carbon transition, a win-win situation emerges where both economic and environmental (climate change) objectives can be simultaneously stimulated. The report finds substantial improvements in GDP are achievable for many G20 countries, while implementing policies aimed at limiting global temperature change to 2 degrees.

Thus, the existing evidence on the links between environmental policies and economic growth is not yet conclusive, although the impact of existing environmental policies on macroeconomic indicators appears to be relatively small. Of course, the link between these macroeconomic indicators and employment effects is complex. Therefore, strong conclusions on the labour market consequences cannot be drawn without explicitly considering labour market indicators.

The size of the overall job turnover created by green growth is likely to be relatively small compared to overall labour market movements. To the extent that it can be predicted, it does not appear that the transition towards green growth is likely to imply rates of labour reallocation or rates of change in job skill demands that are outside of historical experience. OECD (2017b) confirms this and projects that job turnover will be especially small for medium and high-skilled workers. However, this conclusion may say more about how difficult it is to predict the labour market

consequences of decoupling economic growth from harmful environmental impacts than how easily green growth-driven structural change can be managed (OECD, 2012b).

One of the key determinants of the ease of the transition for the labour force will be the transferability of skills across sectors. **Dynamic labour markets with sufficient flexibility are therefore crucial to manage the labour market during the green growth transition** and reduce the costs of transitioning to green growth. There is nothing inherently different about the job churn associated with a green transition than that associated with any other transition industrialised societies have experienced. Of course the composition of change will be different from that which drove the emergence of mass motorisation or the ICT revolution, but the reality of creative destruction has been around for a very long time. The challenge for labour market and skill policies is to maximise the benefits from this green transition for workers and help assure a fair sharing of unavoidable adjustment costs, while also supporting broader green growth policies. In this context flanking measures that may accompany environmental policies, such as the recycling of revenues from environmental taxes, as well as active labour market policies and skills development, will play a critical role. To avoid an unequal distribution of the transitional costs it might be desirable to complement the general active labour market policies with some specifically targeted programs for regions with a high share of the labour force currently working in heavily affected sectors.

This report is a synthesis of existing OECD work on green policies and labour market implications.

The quantitative insights largely focus on climate and pollution policies as that is where most of the existing evidence is, but it also provides examples from resource efficiency policies. Throughout the text, case study example boxes are presented that illustrate employment effects of the green growth transition. The general conclusion is that the overall employment effects of a green growth transition will likely be modest and manageable, but further quantitative analysis should be a priority for new research to provide more robust and detailed findings and to reduce the uncertainty around the existing knowledge.

Green policies affect labour markets in multiple ways

A transformation of the economy towards less polluting and more resource efficient activities will require structural changes in the nature of demand and production processes. For example, climate change and air pollution policies invoke a transformation of the energy system; circular economy policies aim to reduce the resource-intensity of production throughout the economy. These structural changes in the demand for commodities and in the production processes will in turn affect labour markets.

In general, the following mechanisms drive the change in employment from green policies: (i) job creation in 'green' sectors that produce goods and services that reduce environmental pressure; (ii) job destruction in the sectors with large environmental footprints, i.e. 'brown' sectors that get replaced by the green activities; (iii) changes in employment – likely a net job gain – that are induced by changes in relative prices causing a shift in the structure of the economy towards cleaner production sectors, mostly the relatively labour-intensive services sectors; and (iv) changes in employment from a change in the size of the economy – potentially a net job loss when ambitious policies slow down economic growth. Any of these effects can consist of a temporary part, i.e. driven by the transition to green growth, and a permanent part that is integral to a green growth economy. Box 2 presents the main channels involved in more detail.

Box 2: Channels through which market-based green growth policies can impact economic sectors and labour markets

There are four main channels through which market-based green policies can impact economic sectors and labour markets (OECD, 2017b forthcoming):

- *Changes in production modes:* When adapting to green growth regulation, firms will use fewer polluting inputs and pollution-intensive processes. Therefore, each sector will change its labour demand, creating or destroying jobs.
- *Changes in demand patterns:* Green policies lower the prices of clean goods relative to polluting products. This change in their relative prices impacts the demand for polluting and non-polluting goods. Therefore, individuals purchase increasingly cleaner goods, as they become cheaper than the polluting goods. This changes overall demand patterns and induces shifts in production across sectors. The extent to which workers are able to shift between sectors influences the overall effect on employment.
- *Changes in aggregate income and macroeconomic conditions:* The implementation of green policies can influence the overall economic activity, in particular aggregate supply, demand, and employment. Such policies may also trigger changes in the government budget e.g. through changes in tax revenues. Importantly, well-implemented green policies can achieve multiple dividends: Through the reduction of harmful labour market taxation, they can result in improved environmental quality, better health and wellbeing of citizens, and a more efficient economy.
- *Changes in trade and competitiveness:* Producing pollution-intensive goods in a jurisdiction facing green policies can make the good relatively more expensive compared to similar goods produced in jurisdictions without such regulation. Such concerns are relevant for internationally traded goods.

Different green policies may have very different implications for changes in the level and composition of labour demand, and for specific jobs. Policies that aim at reducing emissions of greenhouse gases and air pollutants will target different sectors than policies to improve recycling of metals or other material resources. Pricing the respective externalities with green policies implies a deliberate change in relative prices in the economy, thereby affecting the competitiveness of the different sectors. If the sectors that cause the largest externalities are also the most capital intensive (and thus create relatively few jobs), then green policies induce a shift towards more labour-intensive sectors. This is not unlikely given the relative capital-intensity of energy-intensive industries compared to more labour-intensive services sectors. Of course, if green sectors are very capital intensive they will also not create many jobs.

Market-based mechanisms provide an environment that encourages firms to reduce pollution at the lowest cost. **By linking market-based instruments with reductions in labour taxation, environmental tax reform might improve environmental quality, boost economic growth and increase employment.** The revenue raised through an environmental tax reform or by selling pollution permits allows governments to either reduce harmful taxation in the labour market, redistribute the revenue to mitigate negative distributional impacts, or to fund specific education and training programs. While the primary aim of environmental taxation is to improve environmental quality, it can at the same time achieve improvements in health and wellbeing of its citizens, and it gives the government budgetary flexibility to reduce harmful labour market taxation to improve the overall efficiency of the economy. Environmental taxation can thereby potentially

achieve multiple benefits for society (Château et al., 2011). Example boxes 1 and 2 present specific case studies.

Example 1: British Columbia's Carbon Tax

In July 2008, British Columbia implemented a carbon tax that was levied on almost all sources of carbon emissions covering all industries and residents (including gasoline, natural gas, coal, propane, and home heating fuel). While initially all sectors were covered without exemptions, agricultural industries have gradually been excluded from 2012 onwards. The tax covers 70-75% of British Columbia's GHG emissions. It was initially set at CAD 10/t CO₂e and was set to increase yearly by CAD 5/t CO₂e to reach CAD 30/t CO₂e by 2012. The tax was designed to be revenue-neutral, meaning that the entire revenue was returned to reduce personal and corporate income taxes and was used to reduce the burden on low-income households through direct transfers. Such specifically targeted revenue recycling to low-income households has reduced any regressive effects of the tax. Distributional effects of the tax are therefore likely to be small. Since, the tax rate was relatively high and was implemented across all sectors a comprehensive analysis of job gains and losses across the entire economy of British Columbia is possible.

The most recent findings show that between 2008 and 2011 per capita GHG emissions declined by 10 percent in BC and that compared to the rest of Canada per capita fossil fuel consumption declined by 19 percent. With respect to environmental improvements the tax has thereby been fairly successful. Yet, the labour market implications are also an important determinant of the overall costs and benefits of the policy. Although benefits to the economy and the labour market were not the primary drivers for the introduction of the tax, the tax has nevertheless led to an increase in employment for British Columbia. It generated approximately 10,000 jobs per year between 2007 and 2013, leading to an overall 4.5 percent increase in employment over the 6 year period. However, the impact of the policy on employment differs across sectors. The most polluting and trade-exposed sectors have experienced a decline in employment (e.g. energy generation, metal- and chemical manufacturing), while "clean"- and service-oriented industries have experienced an increase in employment. The health care industry has for example experienced a 16% increase in employment over that four year period. It is interesting to note that when it was introduced a majority of the public opposed the tax. However, in subsequent years the public's perception improved so that three years later the public generally supported the tax (Harrison, 2013; Murray and Rivers, 2015; Yamazaki, 2017).

Specific sectors can benefit from green policies

Despite the uncertainty about the form that ambitious green policies will take, it can confidently be projected that green policies will entail a significant expansion of employment in a number of green economic activities. These activities either replace polluting activities with cleaner activities (e.g. renewable energy displacing fossil fuels) or provide environmental services (e.g. waste management and reforestation).

Green policies can boost economic activity and employment in green sectors. This is supported through anecdotal case studies in the example boxes in the Annex.

Examples of sectors with potential to create green jobs

Green agriculture (incl. organic farming)	Sustainable Construction
Sustainable Forestry	Public transport
Renewable energy	Recycling and waste management
Clean industry	Federal government activities

Source: Own elaboration based on ILO, 2013.

Example 2: Sweden's Green Tax shift and environmentally motivated subsidies

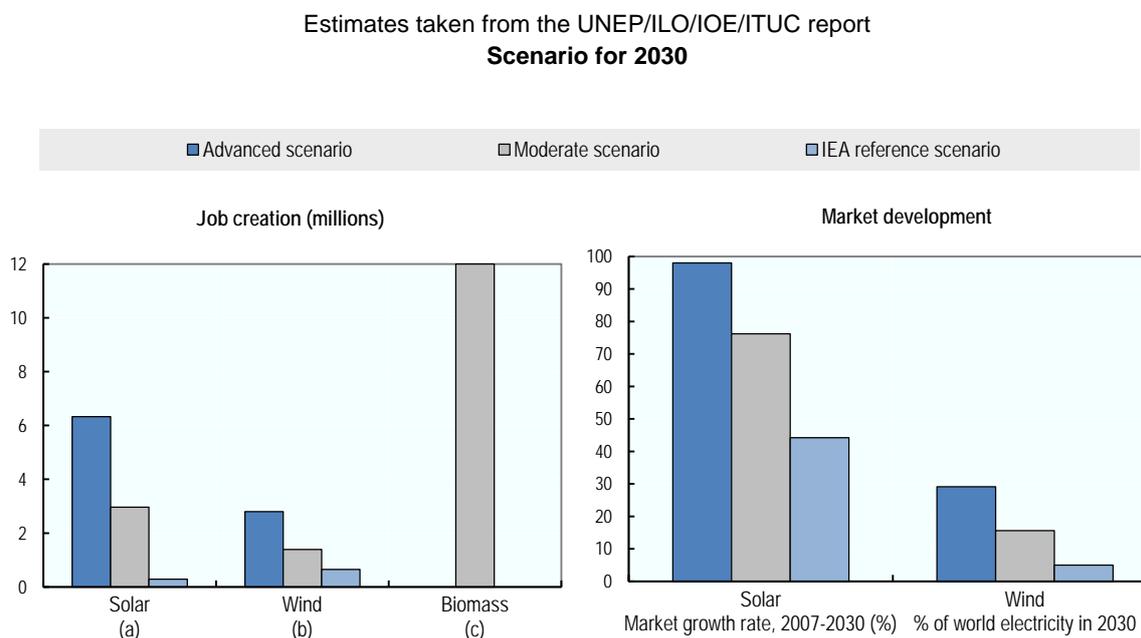
In 2001, the Swedish government implemented an environmental tax reform programme that aimed to reallocate taxes from labour to environmentally harmful activities. It was primarily focused on CO₂ taxation but included other environmental taxes on vehicles, waste landfilling, and pesticides. Between 2001 and 2006, the government raised 1.6 billion euros in additional environmental related taxes and reduced personal income taxes and social contributions, focussing on low-income households. Energy intensity and CO₂ intensity of the economy have declined during that period, which can in part be attributed to the environmental tax reform.

Sweden has shown that environmental taxes can make the overall tax system more growth-friendly while being revenue-neutral if the tax revenue is used to reduce distortionary taxes (e.g. taxes on labour). The tax reform has led to increased disposable incomes for most income groups, since potentially regressive effects were neutralised through redistribution or reduction in labour taxation. The tax reform has also provided the incentives and promoted the adoption of cleaner technologies. The extent, to which this has directly benefited employment or growth remains much less clear than in the case of British Columbia and is a potential avenue for future research.

Responding to the 2008/09 economic crisis, Sweden introduced a number of green fiscal stimuli to support the development of biofuels, batteries, electric cars, biogas, and solar cells, and energy efficiency measures. While it is difficult to attribute economic recovery or employment gains directly to these policies, they have nevertheless, substantially increased investment in these sectors and thereby stabilized the industries during an economic crisis (and possibly prevented the loss of jobs in these industries), and helped to expand the use of renewables for electricity, heating and transport. Such measures were not exclusively implemented in Sweden. Other countries have adopted similar policies to provide a fiscal stimulus during the economic crisis (OECD, 2014).

Renewable energy production is a key source of growth for new jobs. Such jobs can be temporary (e.g. in the construction of a new wind farm) or permanent (e.g. workers employed in operation and maintenance of the plant). Existing studies tend to combine temporary and permanent employment into one aggregate job creation number. In 2016, 8.1 million people were employed in the renewable energy sector worldwide (excluding hydropower). The sectors with the largest employment were solar PV, biofuels and wind. China, the EU, Brazil and the US lead global employment in renewable energies (IEA, 2016). In 2011 the overall share of employment in the renewable energy sector was still tiny and typically below 1% (0.7% in Germany and 0.8% in Denmark, 0.1% in China) (UNEP, 2011). Nevertheless, modelling work clearly suggests that employment growth in the renewable energy sector could be substantial. By 2030 up to 20 million jobs could be created worldwide: 2.1 million jobs in wind energy production, 6.3 million in solar photovoltaic and 12 million in biofuels-related agriculture and industry (Figure 1). In the US, employment in the clean energy sector could be expanded by 4 million jobs in 2030 if a 30% renewable portfolio standard were implemented together with aggressive energy efficiency measures (Wei et al., 2010).

Figure 1. Large job creation possible within the renewable energy sector



Source: OECD (2012a) from UNEP, ILO, IOE and ITUC (2008), Green Jobs: Towards Decent Work in a Sustainable, Low-carbon World, Geneva.

Across all these studies it is important to bear in mind that **the duration of jobs is crucial when assessing the economic and societal impacts of green policies**. Replacing permanent mining jobs by temporary wind farm construction jobs, results in an overall loss of long-term employment. Thus, future analysis should assess more carefully the duration of job creations and destructions, as well as the quality of the newly created jobs.

Per megawatt of generated power, the increase in renewable-energy employment tends to outweigh the decline in employment in fossil fuel production, but overall employment levels in the energy sector may still shrink (OECD, 2012a). The restructuring of the energy sector towards a cleaner energy-mix entails job destruction in the polluting sectors (fossil-fuel extractions and fossil-powered electricity sectors) as a result of clean energy expansion. The renewable energy sector tends to require more workers per megawatt of energy generated than fossil fuel-based energy sectors. However, green policies will likely also imply a reduction in overall energy production. Therefore, the result may be a smaller, more labour-intensive energy production sector, with unknown effect on total sectoral employment levels. Furthermore, there are potentially significant consequences for employment levels in sectors that provide inputs to energy production, not least the fuel extraction sectors (Chateau et al., 2011; see also Figure 3 below).

Energy efficiency can also create jobs. Examples are the construction workers that are needed to insulate houses, environmental consultancy firms that advise of improving energy efficiency, et cetera. Employment increases from expanding public transport is also often included in this category. OECD (2017b) highlights that including energy efficiency into a climate change mitigation policy package can significantly boost overall employment gains.

Industries in sectors like pollution management and control, waste collection and treatment, and recycling provide nearly 3.5 million jobs in the EU. More specifically, in the EU27 the recycling industry employs about 1.8 million people. By increasing the recycling rate from 50% to 70%, up to 322 thousand direct jobs could be created. Taking into account the indirect and induced jobs, up to 550 thousand total jobs could be created in the EU27. Increasing the productivity of resources can generate innovation and new economic activity in waste collection, treatment, and recycling, and help generating growth and green jobs (OECD, 2012c), although a large-scale transition to a circular economy may imply smaller employment in the waste sector as less waste is generated.

Example 3: Case Studies on job creation from a circular economy

There is a growing interest in policies impacting material- and resource-efficiency as part of a shift to a circular economy. The circular economy encapsulates the idea to reduce material-intensity in production and consumption and to reduce, reuse and recycle waste within the economy. The existing literature puts particular emphasis on the employment potential within the circular economy through a number of quantitative case studies:

United Kingdom*: The net job potential for the United Kingdom by 2030 from the circular economy is calculated from an inventory of existing jobs with activities related to the circular economy (reuse, repair, remanufacturing, recycling and servitisation) and growth projections of these sectors for the United Kingdom for 2030. It is estimated that net job creations vary between 10 thousand (business as usual), 54 thousand (advanced scenario) and 102 thousand (transformation scenario). These increases would result in a decline in the unemployment rate of 0.02%, 0.15% or 0.28% respectively (Green Alliance, 2015).

Netherlands: Using expert judgement about future trends in resource prices, and the increase in reuse, collection, and recycling of products and waste, it has been estimated that the circular economy can create an additional value of 1.2% of GDP and 54 thousand jobs (0.6% of overall employment) in the Netherlands (TNO, 2013).

Flanders, Belgium: The economic benefits from the circular economy for Flanders (a region in Belgium with approximately 6 million inhabitants) have been estimated by combining sector-specific data and predictions about the development of the circular economy by 2020. An added value of 2.3 billion Euro (1.3% growth of Flemish GDP) or approximately 27 thousand jobs can be generated in Flanders by 2020 through well-implemented circular economy policies (Dubois and Christis, 2014).

Overall, these studies provide some initial indication of the potential direction and order of magnitude of the effects. Yet, the precise numbers need to be treated with caution. Better data as well as more robust modelling tools are required in future research to substantiate these findings and identify the further induced effects on the rest of the economy.

* The data in this section do not cover Northern Ireland.

Organic farming tends to require more workers than conventional farming practices. In the US it has been estimated that the production and manufacturing of organic products creates 21% more jobs than conventional production. In the United Kingdom and Ireland organic farms require on average 32% more workers than conventional farms. Organic farming tends to use more labour-intensive production activities (e.g. complex rotation systems, mixed farming), as well as more labour-intensive crops (fruit and vegetables), less mechanisation, more on-farm processing and trading, and higher requirements for information. Yet, the employment requirements are specific by crop type and country: Organic horticulture requires substantially more labour, while cereal-livestock and dairy farms do usually not require more workers compared to conventional farms

(OECD, 2016). The flipside of the higher labour intensity is however that this can increase production costs, making products more expensive. Hence, increased employment can also have negative consequences for consumers. Furthermore, these analyses are specific to the farming sector and do not account for knock-on effects in other sectors. An increase in organic farming will likely lower the demand for fertilizer. As a result, jobs might get lost in the fertilizer industry, which the sector-specific analysis does not account for.

The net effect on employment is hard to measure but overall job creation and job destruction tend to be of similar size for well-implemented green policies

Robust empirical evidence of the overall employment effects of ambitious green policies is still lacking. Major transformations of the economy towards green growth are very scarce, and this complicates econometric analysis. Furthermore, existing work tends to concentrate on links between productivity and environment, not explicitly looking at employment effects. The empirical literature on economic effects of environmental policies tends to concentrate on verifying the so-called Porter Hypothesis – i.e. what effects do environmental policies have on innovation and productivity – or on competitiveness and leakage concerns, often broadly associated with the Pollution Haven Hypothesis (see Box 1 for more details). In all cases, the effects do not appear to be large, but at the same time the changes in environmental policies that have been analysed have been gradual and extensions of conclusions to large, bold policy actions need to be done with caution.

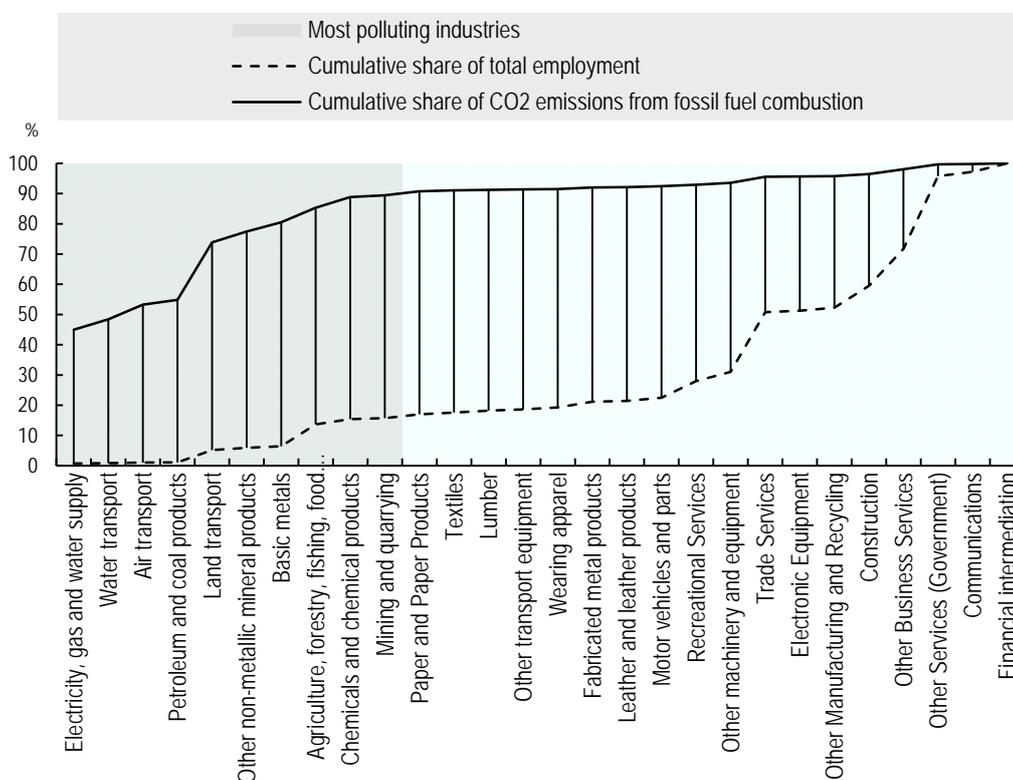
Leading macroeconomic modelling analysis tend to find that green policies – or at least energy and climate change policies – do not have large implications on overall employment. A small number of economic modelling teams have developed and applied macroeconomic models to analyse the economic impacts of energy and climate change policies, including the impacts on labour markets. The estimated impact of such policies on economic growth and employment varies somewhat across studies and countries, the type and stringency of the policy, and underlying assumptions, not least on the functioning of labour markets and the supply elasticity of labour (Hafstead and Williams, 2016). In a study for the USA across three macroeconomic models, climate change policies are projected to have only a very small effect on overall employment (and the sign of the effect differs across models) (CBO, 2010). However, levels of job creation and destruction across sectors are substantially larger (Chateau et al., 2011). These studies strengthen the notion that a substantial degree of labour market flexibility is important to achieve a smooth transition to green growth (OECD, 2012a). As with all modelling analysis, the interpretation of results should be balanced, and underlying assumptions should be clear, to avoid a biased interpretation of the quantitative findings (IPI, 2017). Furthermore, a wider set of policy analysis with state-of-the-art modelling tools, more detailed representation of the different segments of the labour market, and careful analysis dynamics of the interactions between economic activity and employment are all required to provide more robust insights on the overall employment effects of green policies.

Green policies induce changes in relative prices that strengthen relatively clean sectors, while hurting dirty sectors. Thus, changes in employment levels occur in all sectors of the economy, and some of the biggest job creation may be realised in the relative clean services sectors. While these are not directly “green jobs”, they are the result of the green policies. Depending on the initial structure of the economy, and the degree of trade openness, economies that can specialise in relative clean sectors will be better off – and can boost employment more – than economies that rely extensively on exploiting polluting resources.

The net job gains from green policies also depend on how the macro economy is affected by the policy. If overall economic activity is reduced, this puts a negative pressure on employment in all sectors.¹ Net job gains can then only be secured if the cleaner sectors that will be boosted by the policy are on balance more labour-intensive than the directly or indirectly negatively affected sectors – which is generally the case for the services sectors – or if the direct job creation in green sectors strongly outweighs job destruction in other sectors.

The most carbon-intensive industries employ relatively few workers compared to their economic output. The ten most carbon-intensive industries in the EU-25 account for almost 90% of all CO₂ emissions, but for only 14% of total employment (OECD, 2012a) (see Figure 2). The job losses from reducing dirty economic activity will therefore be very modest in these industries. However, there remains uncertainty about the potential size of knock-on job destruction effects in sectors that provide inputs to the carbon-intensive industries, especially fossil fuel extraction.

Figure 2. In 2005, the ten most carbon-intensive industries in the EU-25 accounted for almost 90% of all CO₂ emissions, but for only 14% of total employment



Source: OECD (2012a).

Dynamic labour markets with sufficient flexibility of labour across sectors are important to smooth employment effects across sectors. This means that labour markets need to allow workers to change jobs and shift across sectors without long periods of unemployment; geographical mobility of workers are also essential. Macroeconomic models with flexible labour markets tend to find that ambitious and well-designed green policies, i.e. policies that reduce environmental pressure and maintain economic growth, do not hurt overall employment, net job gains and losses differ across

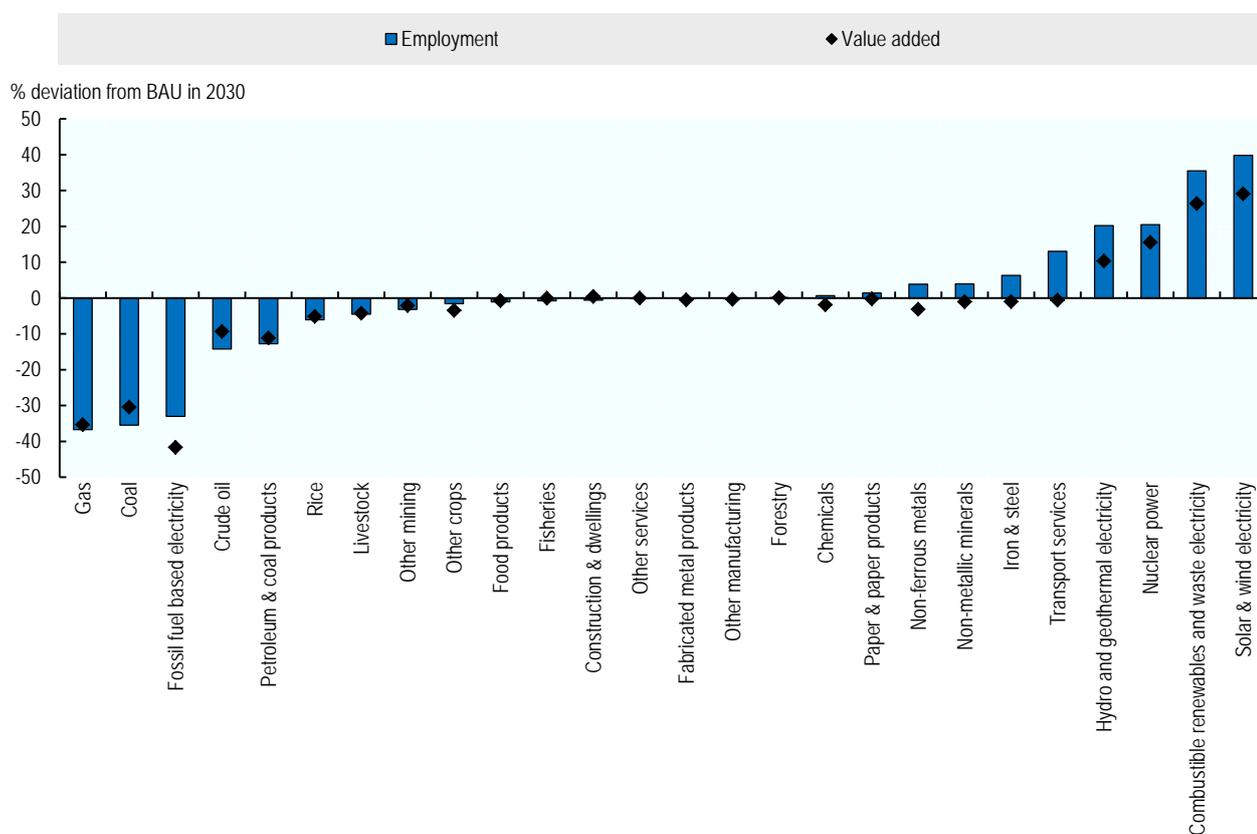
¹ This is one reason why this report focuses on green growth policies that balance environmental and economic objectives, rather than all possible environmental policies.

sectors (Figure 3). The impacts will depend on the ability of workers to adapt their skills and switch across sectors. The costs tend to increase with the extent of imperfections in the labour market (Chateau et al., 2011).

These model-based simulations of green policies may miss some new sources of job creation and destruction from green policies. For example, it is not well understood how policies stimulate innovation and thus the emergence of new green technologies, which can be a source of new jobs but can also destroy jobs when the new technologies are labour-saving.

Green policies also help prevent potential job destruction from environmental damages. Heat stress, extreme weather events, and air pollution cause a reduction of labour productivity, an increased incidence of illness, and premature deaths (OECD, 2015a; 2016). Empirical evidence for the US shows for example that ozone air pollution can significantly reduce the productivity of agricultural workers: a decrease of ozone concentrations of 10 parts per billion (ppb) leads to an increase in worker productivity of 4.2 percent (Graff Zivin and Neidell, 2012). Such labour market consequences are projected to reach quite significant levels in the coming decades, with e.g. the lost working days from outdoor air pollution to rise to 3.8 billion by 2060 (OECD, 2016). By preventing these consequences, green policies can stimulate labour markets. Adapting to remaining environmental damages can also stimulate employment, for instance through reconstruction activities.

Figure 3. The net job effects of GHG mitigation policies differ across sectors



Source: OECD (2012a).

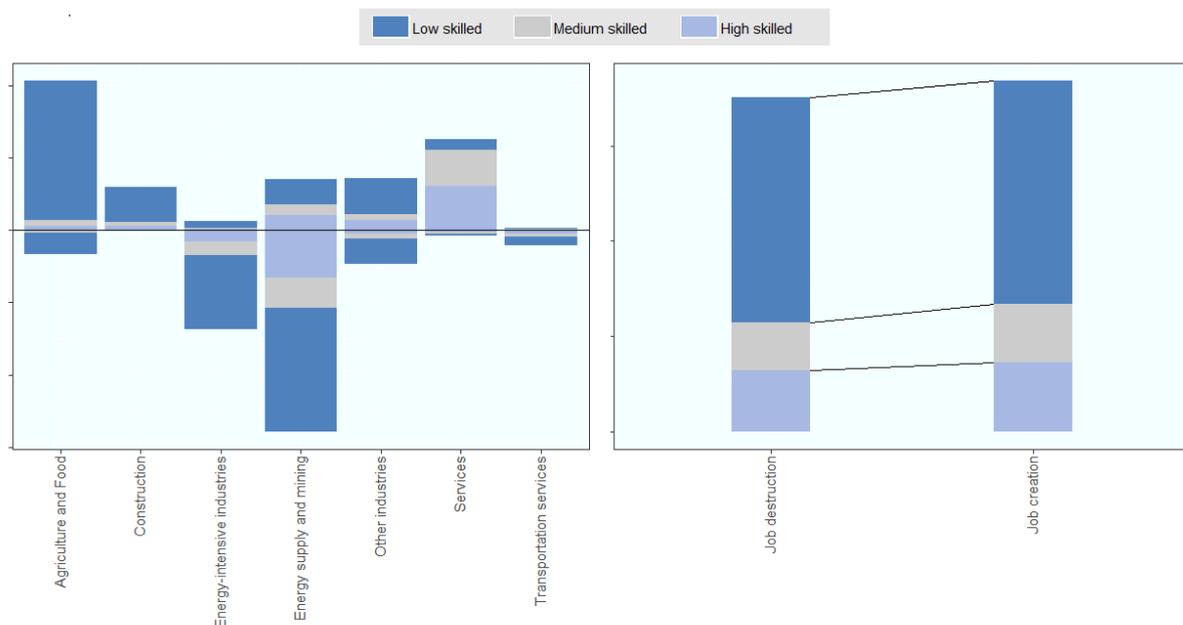
Job duration is important to determine the gains to society from green policies. When analysing the output of employment studies it is important to distinguish between short-term and long-term impacts, and between temporary and long-term employment. Any job creation that is triggered by a transformation of the economic system risks being temporary in nature. Therefore, long-term employment effects that result after the transformation is completed are equally important to consider.

The wider benefits to society from green policies extend beyond gains for growth and jobs. While a positive employment effect is helpful for the political acceptability of green growth policies, it is crucial to include the wider social benefit of such regulation into the evaluation. The social benefit from avoided premature deaths from air pollution tends to substantially outweigh any costs arising from job losses as a result of economically sound air pollution regulation (OECD, 2016). Thus, employment effects of green growth policies should be considered within a wider framework of costs and benefits. A full-fledged cost-benefit analysis (CBA) can be a valuable complement to such models to appropriately account for the societal benefits and costs of green growth regulation (OECD, 2017a, forthcoming).

Potential skill mismatches should not be overestimated

Job creation and destruction tend to involve largely similar categories of skills. The occupations offered in the various sectors can vary more, but the broad level of skills required for different job types tends to be more homogeneous. Thus, while there is job creation and destruction in all individual sectors of the economy, the overall employment effect of broad green policies that affect many sectors of the economy is unlikely to require a major increase in the levels of initial schooling, although they undoubtedly will require considerable retooling as regards fields of study and vocational skills (Figure 4).

Figure 4. Ambitious green policies create and destroy similar job types



Source: Own compilation based on OECD (2017b, forthcoming).

Note: Preliminary results for a global carbon tax scenario.

At the global level, low-skilled jobs tend to account for the largest share in both job creation and job destruction, while high- and medium-skilled labour accounts for most of the net job gains. This is at least suggested by the existing evidence on energy and climate change policies. Overall, agricultural and energy sectors are among the most affected by green policies. While low-skilled workers will not face large employment losses, they will face relatively large employment shift across sectors (Figure 4). Well-functioning labour markets are therefore important to ensure a smooth transition across sectors. For high-skilled workers, green policies imply relatively strong opportunities for job growth. Adalet-McGowan and Andrews (2015) find an empirical link between skill mismatches and labour productivity, with clear implications for public policies: well-designed product and labour market policies can reduce skill mismatches and thus boost labour productivity.

General statements on the skill requirements of green policies only hold for fairly broad policies that affect many sectors, either directly or indirectly, such as economy-wide carbon taxes. For very specific policies that focus on one particular element in the economy, more pronounced skills mismatches may occur, although in those cases the economy-wide effect on the employment by skill category will likely still be limited.

Training policies are important to ensure a smooth transition of workers across sectors in the short term. One of the key determinants of the costs of green policies is the transferability of skills from declining to emerging sectors. Since skill requirements are likely to differ to some extent, training programmes can play an important role in filling gaps between workers existing competencies and the skill requirements of newly created jobs. These programs will be particularly important to facilitate the transition of low-skilled workers from jobs in the declining sectors to jobs with not-to-dissimilar skills in emerging sectors. The relatively clean services sectors may be the biggest source of net employment gains, and are relatively labour-intensive, especially for high-skilled labour. Training programs must therefore facilitate this expansion and ensure that a lack of skilled workers does not become a drag on expansion of the services sector. Although green policies are generally not implemented suddenly, it should be noted that the speed of implementation of the green policy should also take into account how the adjustment processes involved temporarily disrupt labour markets. If workers and businesses adapt less quickly to the changing circumstances, such temporary disruptions will be larger.

Example 4: Systematic forecasting of emerging demands for “green skills” (OECD, 2015b)

The Austrian and French governments regularly forecast the future skill requirements resulting from the transition to low-carbon growth and feed this information into education and training policy: The Austrian New Skills framework monitors trends in skill demands via its Standing Committee on New Skills. This group recently concluded that “energy efficiency, the use of alternative sources of energy, resource-saving production, the identification of cause-effect relationships, recycling and ecologically sound disposal of materials, etc. are increasingly becoming a business necessity for all companies. In this connection the development of environmentally efficient production processes, service processes and products constitute an increasing challenge for employees from many different areas and at all qualification levels, both technically and in terms of awareness-raising and understanding” (Bliem et al., 2011: 2).

In line with the national strategy and national pact to transition towards a green economy, France has established L’Observatoire national des emplois et métiers de l’économie verte (National Observatory for Green Economy Jobs and Skills), which forecasts the sectoral and macroeconomic impact of the green transition, with special attention to its implications on the numbers of jobs and skills requirements (Commissariat Général au Développement Durable, 2014). In developing these forecasts and assessing their implications for training policies, partnerships have been developed with trade unions, employer organisations and Pôle Emploi (the public employment service). Pôle Emploi, for example, has studied the supply and demand for green skills to guide the design of its programmes to up- or re-skill job-seekers to better meet the requirements of this transition (Pôle Emploi, 2011a; 2011b).

To prepare well for the long term, education and training policies need to be aligned to meet the future new skill demands. The transition to green growth will need to be managed alongside other megatrends, such as population ageing, globalisation and income convergence across countries, an overall shift towards a service- and knowledge-based economy, and increased digitalization and automation of production processes. All of these megatrends will affect future job skill requirements and how well they match the skills possessed by workers. Education and training policies need to be aware of these megatrends and accurately assess their implications for future skill needs and then act proactively to develop the needed skills (OECD, 2016c). Since private actors play an active role in choosing and financing vocational training, it is also important to create financial incentives to steer these investments towards meeting emerging skill demands. More generally, the success of the green growth transition will depend on how well it will be integrated in the policies that manage the underlying megatrends.

Active labour-market policies are important for the transition

The existing labour market policy toolkit is largely sufficient to ensure a smooth transition of sound green policies, but these tools could be used more effectively. Labour and skills policies play an important role in determining the total costs of a transition to green growth. Active labour market policies include spending on job-search assistance, training, public sector job creation and subsidised employment in the private sector. These are in contrast to passive labour market policies which include spending on unemployment insurance and related welfare benefits (Andrews and Saia, 2016). Active labour market policies need to ensure that workers and firms can adapt quickly to changes brought about by greening the economy (OECD, 2011b). Historical analogies can be made to other drivers of structural change in the labour market such as the ICT revolution or the shift to a globalised economic system (OECD, 2011b). Within the context of structural changes from globalisation, OECD (2006) conducted an in-depth analysis on structural adjustment policies. It concluded that general labour market programmes should be relied upon as much as possible, since

issue-specific programmes increase administrative complexity. This is likely to hold as well for a green growth transition (see example box 5 for an example of general labour market policies that helped establishing a green economy in Copenhagen, Denmark).

Example 5: Copenhagen Clean Tech Cluster

Denmark and in particular Copenhagen's Clean Tech Cluster (CCC) have established themselves as leaders in green technologies. Within the CCC there are approximately 600 clean-tech companies employing 78 thousand people, of which around 34 thousand work directly in clean-tech activities. The dynamic growth in the green tech companies also benefits companies that operate in the same broader market but are not directly part of the green-tech sector, illustrating positive spill-over effects across sectors. The clean tech industry will likely generate further demand for a new generation of medium- to high-skill workers, requiring university education. Denmark has had a long term focus on integrating environmental and climate issues into its educational and vocational training systems. It thereby set the foundation for further green skills developed across levels of education. Interestingly, Denmark does not have an explicit green jobs program. Instead, its Ministry of Employment has focussed on ensuring that the labour market is efficient and well-functioning. These conditions have in turn allowed companies to move into new markets, like green technologies. Thus, a combination of incorporating environmental topics into the existing educational and vocational schemes together with good labour market policies have enabled Denmark to become a leader in green technologies (Martinez-Fernandez et al., 2013).

A combination of labour market-, social protection-, and skills development policies can help to achieve a dynamic and inclusive labour market. In the short run, training and skill development programs are important to allow workers to shift from declining to emerging sectors. In the long run, structural changes in the education system need to be addressed. It is important to bear in mind that labour market inefficiencies such as wage rigidities can prevent employment gains. This needs to be addressed through conventional labour market policies that enhance the adaptive capacity of the labour market. To maintain a high level of employment and a fair distribution of transitional costs, four policy areas should be given special attention (OECD, 2011b):

- *Supply side policies:* Active labour market programmes and skill development systems to facilitate a smooth re-integration of jobseekers into employment.
- *Demand side policies:* Strong product market competition and moderate employment protection are important to facilitate the creation of new competitive green sectors.
- *Income support:* Unemployment insurance and in-work benefits can help to ensure that the transition is not achieved at the cost of excessive insecurity or inequality for workers.
- *Regional support policies:* Regions with a heavy reliance on fossil fuel and energy intensive industries might require specifically targeted policy measures to facilitate the transition.

Dedicated labour market programmes focussing explicitly on new skill requirement can be an important complement, particularly for SMEs and some specific sectors. SMEs face challenges in upgrading the skills of their workforce to the new skill requirements due to limited ability to provide training. Energy-efficient construction and retrofitting, renewable energy, recycling, and environmental services appear to be the sectors, which can benefit most from targeted initiatives, since they tend to require workers equipped with new skills. Since the impact of the green transition will vary across geographic regions, local administrations can also play a key role in reducing the transition costs. They can be crucial in identifying skills in the local work force in declining sectors, which are transferable to emerging sectors (OECD, 2011).

Particularly in advanced economies, science, technology, engineering and maths (STEM) skills, as well as technical, managerial, and leadership skills are likely to be important for the transition.

Preliminary empirical evidence for the USA suggests that green growth will require general analytic and technical competencies and some specific skill needs within science and engineering disciplines (Vona et al., 2015). Therefore, educational policies that aim to increase overall educational attainment are important, in combination with some more targeted approaches that focus on STEM skills, as well as some more specific training in e.g. renewable energies engineering. Furthermore, more knowledge-based outputs and high levels of human capital will be required in the future, while skills related to natural resource extraction or use are likely to experience declining demand. The increased need for R&D in green technologies is likely to increase the demand for high-skill labour (OECD, 2011). To accommodate the need for these skills in the long run, governments need to promote education policies to obtain a sufficiently qualified labour force. These policies should be largely focussed on STEM skills, which are easily transferable to green sectors (OECD, 2012a). Such a focus should, however, not imply that the facilitation of training to smooth job transitions for lower skilled workers is ignored.

Specifically targeted labour market policies might be necessary in geographic regions with a high share of the labour force working in fossil fuel and energy-intensive sectors. In order to ensure a just transition to a low-carbon economy it is essential to consider the geographic distribution of costs. Fossil-fuel industries tend to be geographically clustered in proximity to fossil fuel reserves (with the exception of refineries). Thus, a transition towards renewable energy sources can result in large regional employment losses. In these regions specifically targeted active labour market policies might be required to enable large shares of the local labour force to shift to green jobs. In addition to the regional clustering, older workers are also overrepresented in polluting industries. Since they might experience particular difficulties in finding new employment possibilities, specifically targeted active labour market policies might also be necessary to reintegrate these workers into the labour market (OECD, 2012a).

More quantitative evidence is needed

As laid out above, evidence is gradually emerging that well-implemented, ambitious green policies can improve environmental quality, maintain economic growth and reduce unemployment. Nonetheless, **more work is needed to provide more robust and comprehensive insights into the employment effects of green policies** for a number of important aspects:

The political economy challenges to implementing green policies can be large and they often focus on the perceived labour market impacts. **More empirical evidence is therefore needed on the numbers and characteristics of the jobs that are created and destroyed:** How many workers will need to switch to working in different occupations and sectors? Will they have the skills required by the newly created jobs? Will the new jobs be in the same locations as the lost jobs and at least as good in terms of job quality and durability? How can policies be designed to take these elements better into account, for instance through flanking policies that anticipate potential bottlenecks and take proactive action?

An important source of job turnover can come from the rebalancing of firms within specific sectors: empirical evidence suggests that ambitious green policies can stimulate the more advanced firms, while less productive 'laggards' decline (Albrizio et al., 2017). If the more productive firms are also the ones that generate relatively few jobs, then this tentatively suggests that **green policies might reduce within-sector employment levels**. But more analysis is needed to robustly investigate the firm-level implications of green growth for employment.

As indicated above, green policies interact with a number of megatrends that will affect labour markets in the coming decades, not least deepening globalisation and the transition to a knowledge

economy. If the net impact of these megatrends goes in the direction of an increased demand for high-skilled workers, then a general policy to raise educational levels should go some way towards meeting the skills needs for both the green growth transition and these other megatrends. However, population ageing will make it relatively more difficult to raise the skill level of the workforce via ever higher educational attainment for new cohorts of labour market entrants. This implies that adult education and training will need to play a larger role. A more detailed understanding of future skills demand and supply is also needed to identify where bottlenecks may arise. **It is therefore essential to create finely grained projections of how the green growth transition and other megatrends will interact in shaping future skill supply and demand.** To accomplish this, dynamic economic system models, such as dynamic general equilibrium models, with detailed projections of future economic activity, fragmented labour markets and green policies are needed.

Much of the evidence on the employment gains from green policies is limited to a transformation of the energy sector, where renewable energy technologies replace fossil fuels. It is much less clear, however, what the employment effects are of transformations in other sectors of the economy. Green policies for specific sectors will always require an analysis that is tailored to that sector. But wider transformations in the economy, not least the transition to a circular economy, transcend the sectoral level and have implications for the entirety of the labour market. Therefore, **future analysis of the labour market consequences of green policies should focus on policy mixes that stimulate resource efficiency and the transition to a circular economy.**

Finally, **evidence is severely lacking on the policy instruments that work best in making the green growth transition as beneficial as possible in terms of labour.** New analysis can focus e.g. on how fiscal initiatives can best be designed to combine environmental, economic and labour objectives. Such analysis can build on a comparison of best practices across countries, as well as rigorous econometric analysis.

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Further Reading

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