TRANSFORMING ENERGY MAKES ECONOMIC SENSE

Renewable energy costs have fallen significantly in recent years.

Among the most transformative events of the current decade has been the dramatic and sustained improvement in the cost-competitiveness of renewable electricity generation technologies. Cost reductions along the learning curve and the opening up of new markets in countries with high resource potential continue to make renewables increasingly attractive.

Since the end of 2009, solar photovoltaic (PV) module prices have fallen by around 80% and the price of wind turbines by 30-40%. Biomass for power, hydropower, geothermal and onshore wind technologies can all now provide electricity competitively compared to fossil fuel-fired electricity generation. Most impressively, the levelised cost of electricity of solar PV has fallen by more than 60% between 2010 and 2016, based on preliminary data, meaning it is also increasingly competitive with conventional power generation technologies at utility scale. International Renewable Energy Agency (IRENA) analysis predicts further substantial cost reductions in the coming decade.

From a macroeconomic perspective, the energy transition can fuel economic growth and create new employment opportunities.

Through the energy transition, as mapped out by IRENA, global gross domestic product (GDP) is expected to be 0.8% higher in 2050, a cumulative gain of USD 19 trillion from 2015 to 2050. In a worst-case scenario (full crowding out of capital), GDP impacts are smaller but still positive (0.6%) since the effect of pro-growth policies (e.g. carbon pricing with revenues recycled to reduce income taxes) remains favourable.

Under the REmap case, the renewable energy sector alone could support around 26 million jobs in 2050, up from 9.8 million today. New job creation in renewables and energy efficiency would more than offset the job losses in the conventional energy sector. In fact, net energy sector employment (including in energy efficiency) would be higher by 6 million additional workers in 2050 compared to the Reference Case.[1] Furthermore, overall improvement in GDP would induce additional job creation in other economic sectors.

The energy transition will enhance welfare and therefore its benefits to society far exceed the costs.

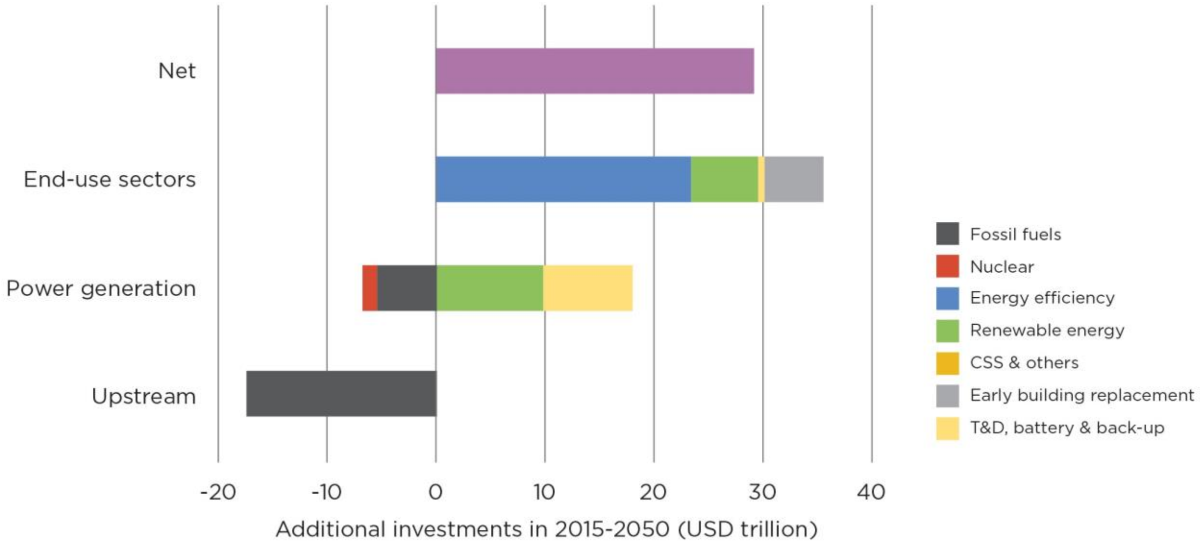
Renewables improve welfare in ways that are not captured by GDP, such as reduced health impacts from fossil fuel combustion. Welfare gains for society could also come from increased energy access, helping to generate sustainable livelihoods and better quality of life in rural areas. Therefore policy making requires a holistic approach that factors in all externalities, including the environmental and health benefits of decarbonisation through the integration of renewables.

> Biomass, hydropower, geothermal and onshore wind can all compete with power generation from fossil fuels.

[1] The Reference Case is the most likely case based on current and planned policies and expected market developments. The REmap case is a low-carbon technology pathway that goes beyond the Reference Case for an energy transition to decarbonise the energy system in line with the goal in the Paris Agreement of limiting global temperature rise to less than 2°C above pre-industrial levels with a 66% probability.

The energy transition will reduce carbon dioxide (CO_2) emissions and therefore mitigate climate change, while also significantly reducing local air pollution. These benefits can be expressed in monetary terms. Reducing human health concerns and CO_2 emissions from the combustion of fossil fuels would save between two and six times more than the costs incurred from decarbonisation. Reduced outdoor air pollution accounts for two-thirds of the benefits. CO_2 savings are also important, but their relative importance depends on the assumed social costs of carbon. Even under the most conservative assumptions, the energy transition makes economic sense.

Figure 1: Additional investment needs, 2015-2050, based on today's policies and with more renewables



Notes: Electric vehicle charging infrastructure, hydrogen pipelines and refuelling stations are included; electrification also includes additional costs for electricity generation growth; CCS = carbon capture and storage; T&D = transmission and distribution.

To achieve these economic and welfare benefits, greater investment is needed. The quantities needed are feasible, but require adequate policy frameworks and new financial models.

In 2016 nearly USD 290 billion was invested in renewable power.[2,3] These investments in new capacity will need to be scaled up significantly to enable decarbonisation of the global energy system. Renewable energy alone, however, will not suffice. Energy efficiency investment will also be needed alongside significant investment in other low-carbon technologies. Under the Reference Case, IRENA analysis estimates a requirement for cumulative investment in energy supply and demand assets of USD 128 trillion between 2015 and 2050. To enable the transition to decarbonisation, cumulative investment would require an additional USD 29 trillion over the same period, as shown in Figure 1. This raises the investment in the Reference Case by about a quarter and, if annualised, amounts to approximately USD 800 billion per year, equivalent to 0.4% of 2050 GDP.

[2] Bloomberg New Energy Finance (2017), "Clean Energy Investment", Q4 2016 factpack.
[3] Investment figures do not include large hydropower.

Investment to meet client goals

Meeting the 2°C target requires investing an additional USD 29 trillion between 2015 and 2050 compared to what current plans and policies foresee.

Incremental investment needs in electricity generation or fuel supply are limited and therefore feasible (i.e. 0.4% of GDP in 2050). This is partially explained by the significant growth in renewable energy power generation investment in the Reference Case, as well as greater energy efficiency in the REmap case compared to the Reference Case, which reduces the need for additional energy supply. The bulk of the additional investment needs will be in end-use sectors, including buildings, industry and transport. Wider adoption of all types of low-carbon technologies will be needed in end-use sectors, notably energy efficiency in buildings. Supply-side investment (upstream and power supply) remains at the same level as in the Reference Case. The savings from avoided investment in fossil fuels, in the upstream and electricity generation sectors, add up to USD 25 trillion, as shown in Figure 1.

Importantly, an energy transition based on renewables and energy efficiency implies an energy system which is much more capital intensive, with upfront investment costs representing a higher share of total cost. This has important implications for policy makers, since the transition requires adequate financing mechanisms, new business models and solid policies to be in place, to allow consumers and companies to invest in the required assets (e.g. electric vehicles, better insulated homes, solar panels).

These investments, when annualised and considered in tandem with savings from reduced operations, maintenance and fuel costs relative to the technology they substitute, result in an average abatement cost of USD 60 per tonne of CO_2 in 2050. This assumes a crude oil price of USD 80 per barrel and a discount rate of 10%. Despite significant technological learning that has reduced and will continue to reduce renewable energy costs, some of the technologies will continue to be more expensive than their non-renewable counterparts in 2050. All technology options result in net cost savings as compared to their conventional alternatives, however, if reduced external costs (mainly in respect of human health) are factored in.

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