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Policy Brief

Technology development for demand-side mitigation

The demand for energy services is projected to increase significantly in all economic sectors

Decarbonising the world's energy end-use sectors (transport, buildings, and industry) is a major challenge for climate change mitigation. The demand for energy services is projected to increase significantly in all three sectors as a result of population and economic growth. For instance, assuming no new climate policies (hereafter referred to as the baseline scenario), energy demand in the transport and industry sectors is projected to more than double (Figure 1).

If stringent climate policy consistent with the 2° C target is implemented, all three sectors show strong potential for energy demand reductions (Figure 1). Demand-side technology options that increase energy efficiency or boost use of low-carbon fuels are important to fully exploit this potential.

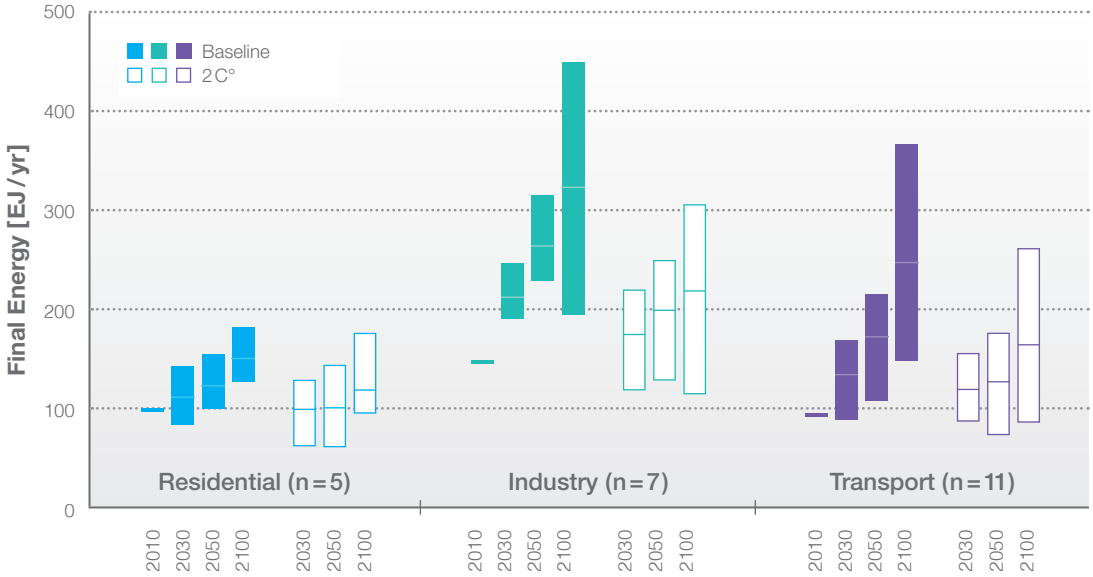

Fig. 1: Ranges of final energy demand in the residential, industrial and transport sectors for baseline and 2 °C scenarios. The line in the middle of the range indicates the average development across models. N indicates the number of models participating in the comparison.

A climate target of below 2 °C requires efficiency, electrification and fuel switching

Carbon dioxide emissions in energy end-use sectors can be reduced through a lower demand for energy services, energy efficiency improvements, electrification and a switch to less carbon intensive fuels, such as biomass (see Figure 2).

Even in the absence of new climate policies, energy efficiency is projected to increase in all three sectors in line with historic trends. For instance, efficiency is projected to increase annually by 0.5 % in the build-ings sector and by 0.7 % in the transport sector between 2010 and 2050. However energy efficiency improvements are substantially higher in the climate policy scenario. In 2 °C consistent model scenarios, yearly average efficiency improvements for 2010 - 2050 reach 1.0 % in the buildings sector and 1.3 % in the transport sector.

A large shift from the use of fossil fuels to electricity is projected in the residential baseline scenario. This is in line with current trends of increased use of electrical appliances and equipment, and less use of oil and coal boilers for heating. Electrification is also projected to take place in non-OECD countries, where biomass and waste are currently the largest sources of energy used. As a result the residential electricity share is projected to reach an average level of around 40 % in 2050. If climate policies are implemented

to stabilise warming below 2 °C, electricity use in the residential sector is projected to increase to 67- 85 % of total final energy demand by the end of the century.

In the transport and industry sectors, electrification has only a small impact on emission trends in the baseline scenario. Oil currently represents 94 % of the energy mix in the transport sector and, in absence of climate policies, this share is projected to decrease only slightly. The projections also suggest a limited increase in alternative fuel use in the industrial sector. However, in response to climate policy, alternative fuel use, both in the form of electricity and low carbon fuels, increases significantly, especially during the second half of the century. Conventional oil-fuelled vehicles can be substituted by electric vehicles in passenger transport, while biofuels are an important abatement option for freight transport.

By 2050, the average electricity share is 7 % in transport, 38 % in industry and 46 % in buildings for the 2 °C-consistent scenarios. Moreover, across models, carbon intensity of non-electric fuel will have decreased from an average of 69 g/MJ to 49 g/MJ in transport and 92 g/MJ to 74 g/MJ in industry, indicating a substantial shift to low carbon fuels. In the residential sector, by contrast, carbon intensity increases from to 37 to 50 g/MJ due to decreased use of traditional biomass in developing countries.

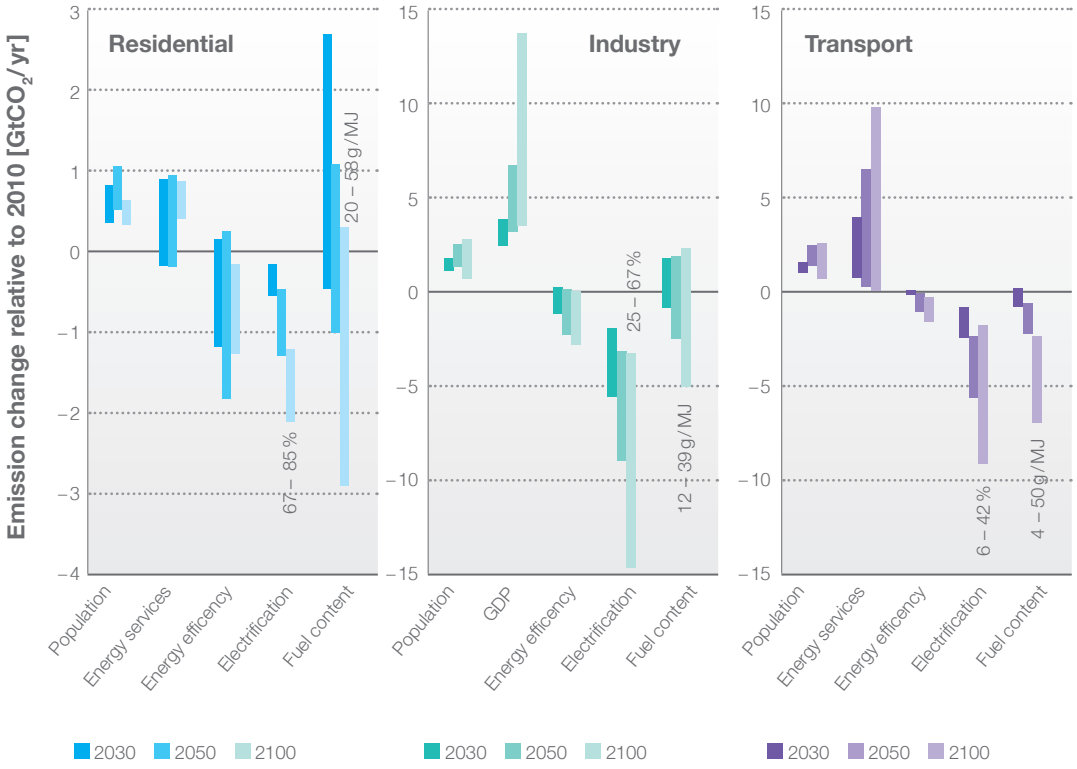

Fig. 2: Decomposition[10] of carbon emissions per end-use sector in the 2 °C-consistent climate policy scenario. This figure shows, for each sector, how population and activity growth[11] (e.g. passenger kilometre growth for the transport sector) contributes to increasing emissions (positive values), while energy efficiency (i.e. the energy used per activity), electrification, or shift to less carbon intensive fuels for the remaining non-electric final energy shares contribute to decreasing emissions (negative values).

10 Additive logarithmic mean divisia method index I (LMDI) is used to decompose sectoral emissions.

11 For those models that do not model physical sectoral energy service data (for example kilometres travelled or floor space of residential buildings) we explicitly used GDP per capita values. For industry, we used GDP as the activity indicator.

The mitigation potential of the transport sector is highly dependent on technological innovations

Alternative fuels and technologies have significant potential to mitigate emissions, particularly in the transport sector in the 2nd half of the century. As an example, several ADVANCE models project a complete phase-out of conventional fuels in transportation in 2100. They also project that activity reduction (i.e., less travel) and a shift towards less carbon intensive modes of travelling (e.g., public transport instead of cars) will only play a minor role in reducing emissions.

Do these technological changes imply a radical break in the trend? The global efficiency improvements required are similar to the maximum value of efficiency improvements measured in the OECD regions between 1973 and 2007. In contrast however, switching fuels (towards electricity, hydrogen and biofuels) marks a strong break in the trend, as the transport sector has been historically dominated by oil use. Clearly, this transition would not only depend on the development of alternative technologies, but also on the propensity of consumers to adopt them, as discussed in the following Chapter 5.

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