Climate Policy and Green Transition – a CGE Analysis of the Finnish 2035 Carbon Neutrality

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The European Union aims to reduce CO2 emissions by at least 55 % by 2035 and to achieve carbon-neutrality by 2050. Many EU Member States have declared more stringent – ambitious – targets. Finland has adopted one of the most ambitious among them, with the aim of reaching carbon neutrality by 2035. The technology for getting there exists already but the policies supporting the target are only partly in place. This paper studies the economic measures that may be needed to facitlitate a Green Transition of this magnitude. The Finnish case may serve to highlight the vastness of the task – but also its feasibility. Our main finding is that, given the technology, the economic costs are likely to remain small and, at times, even negative.

The paper is part of a larger study commissioned by the Prime Minister's Office, which studies the effects by sector. These studies cover agriculture, forestry, and land use; the transport sector; energy industry; housing; and export industry. Service sectors are not studied separately, but their emissions mainly them from energy use in heating and transports, and thus the costs of measures are covered in the economic analyses.

The paper lays out the economic scenarios produced of the study. We describe the baseline scenario (the so-called WEM, or With Existing Measures scenario) of the economy, based on a comprehensive futures study of the Finnish economy, which is here updated on the basis of industry-specific low-carbon strategies. The policy or WAM-scenario (with Additional Measures) then evaluates the effects of climate policies compared to the WEM-scenario. Most of the effects on the economy stem from the need to invest in new, carbon-free technologies in the energy sectors, industry and the transport sector. These very large, investments dominate economic activity for most of the next two decades and entail current account deficits, but once completed, they facilitate a structural shift of the economy towards an energy and material efficient, low carbon economy, where many of the current industries become newly competitive and create growth through exports.

The effects on the economy thus stem mainly from the efficiency costs of economic measures. From the point of view of welfare effects, the most important economic measures are emission trade and domestic carbon taxes, which affect the purchasing power of households. Households also face the costs of electrification of the transport sector with a third of the passenger car fleet is forecast to consist of electrical vehicles by 2030. The transition exerts pressure on public finances as well as emission-based tax bases erode, and as likely that many of the new technologies need to be subsidized. Still, we find that once the transition is well on its way, the effects on the economy are likely to be small.

The rest of the paper is organized as follows. The second section describes the main technological drivers in the WEM- and WAM-scenarios, and describes the WEM-scenario of the economy. The third section analyses the effects of the additional measures in the WAM-scenario, and the last section concludes

1 The WEM scenario

1.1 Economy in the WEM scenario

The economic baseline is constructed to conform to medium-term official forecasts at the macro level. However, at the sector level, it is based on an extensive study of the structural trends of the economy that stem from a historical analysis of the development of the Finnish economy. The baseline also uses macro and, to an extent, industry level forecasts from other studies. We use macroeconomic forecasts for the early years of the scenario, and population and age-related expenditure forecasts for the whole scenario. The main medium-term macroeconomic assumptions in our scenario conform to the medium term forecast of the Ministry of Finance. In the longer run, macroeconomic development is determined by population trends, which affect public demand for services and other public expenditures, as well as private consumption, whereas industry-level development depends on productivity trends and commodity-level export trends. The baseline also evaluates the development of public sector debt and deficit, given policy measures already taken. Throughout the scenario, developments in energy sectors affect the economy, as power generation adopts renewable energy sources, and as energy use especially in housing and transport sectors becomes more energy efficient and less dependent on fossil energy. These changes stem from simulations with an energy-economy model (the well known TIMES-model). Examples of these changes are given in the next section.

Figure 1 shows a decomposition of baseline growth from the supply side. The scenario here starts from 2020 and so also includes effects of the pandemic. Finland weathered the pandemic relatively well, as the strict but periodic shut-downs of risky sectors of the economy (mainly the trade and travel related services and also public transport) and of course the increasing availability of vaccines kept mortality at bay. There was also wide-spread consensus about compensation for the worst-affected (economically) sectors, which helped to ease the effects of shut-downs. The forecast in this study expected the economy to reach pre-COVID levels by 2023 but in reality these levels were achieved by the end of 2021. The main source of growth stems from productivity growth – or technological change – as Finnish working-age population is already shrinking and is forecast to do so for the foreseeable future.

Figure 2 gives the demand-side decomposition of growth in the WEM-scenario. Private consumption accounts for about half of total growth, and net exports and investment for some quarter each. Public consumption contributes but little, because the scenario assumes that new technologies can keep growth in demand for especially health care at bay.
Average growth hovers at a 1.5 per cent during the 20’s but begins to slow down during the 30’s. By the 40’s, growth is less than one per cent a year.

Figure 1

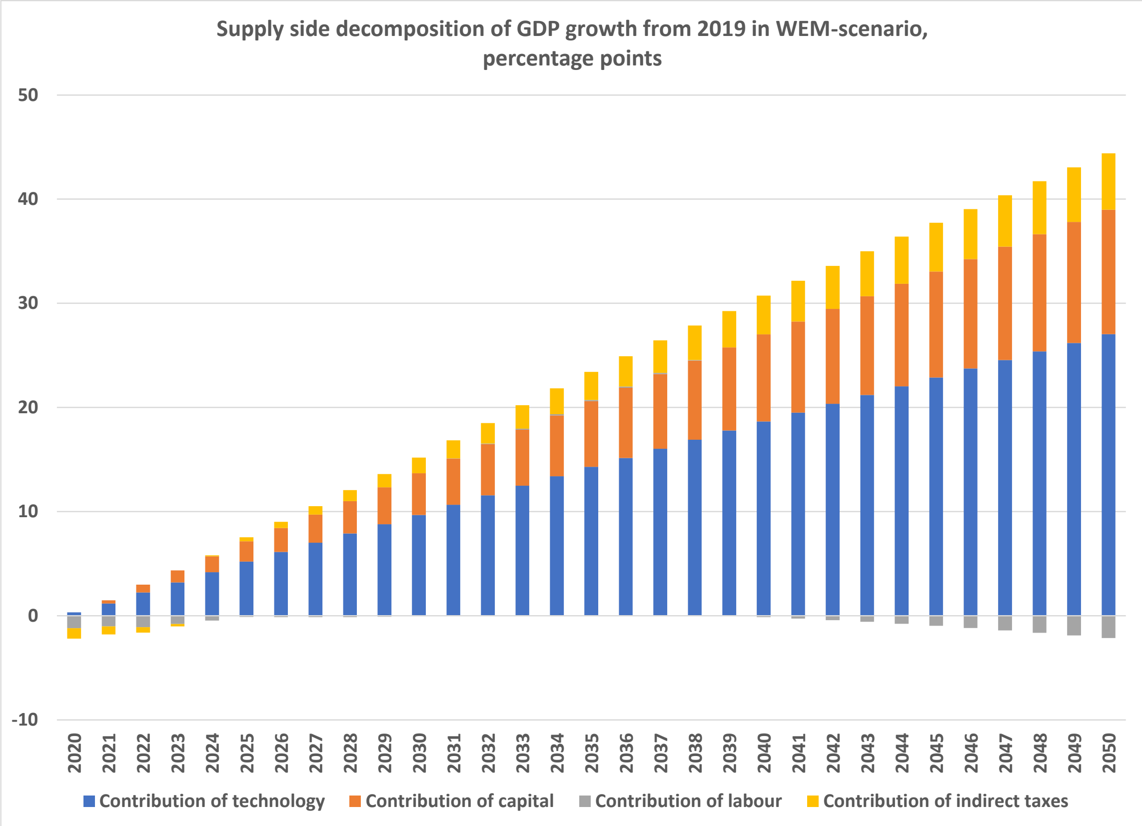
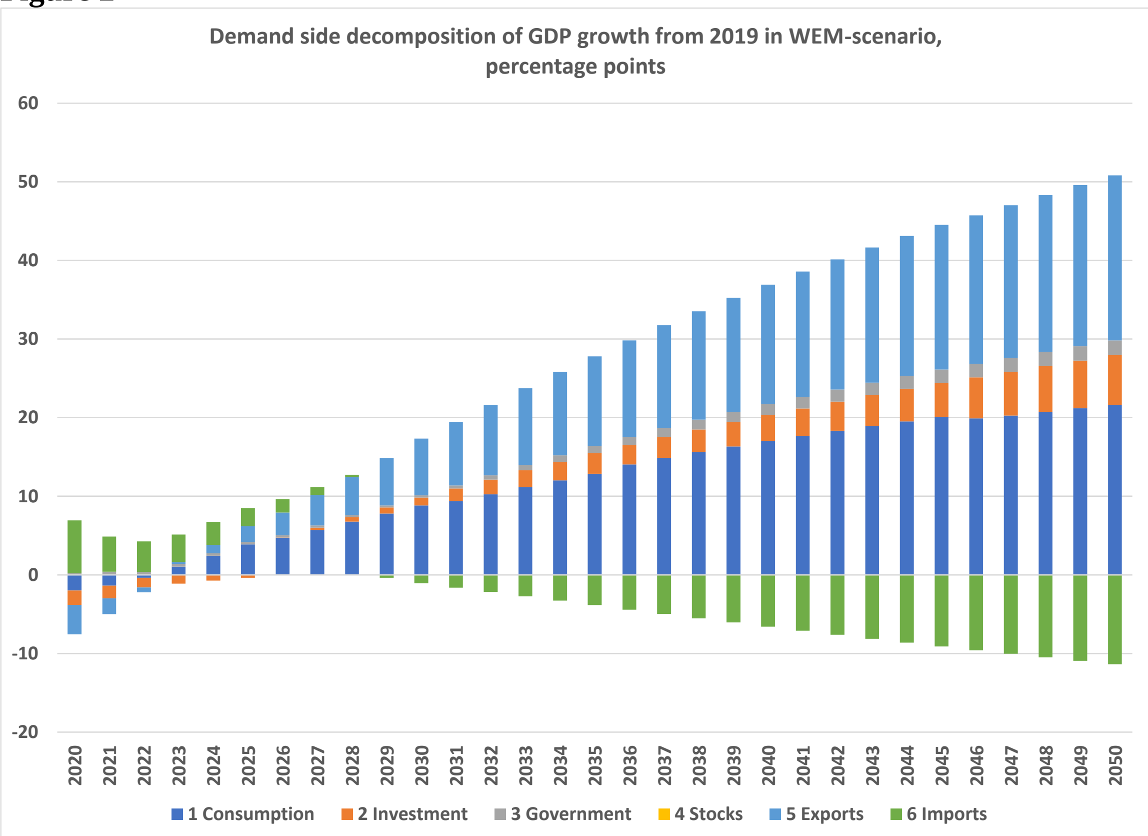


Figure 2

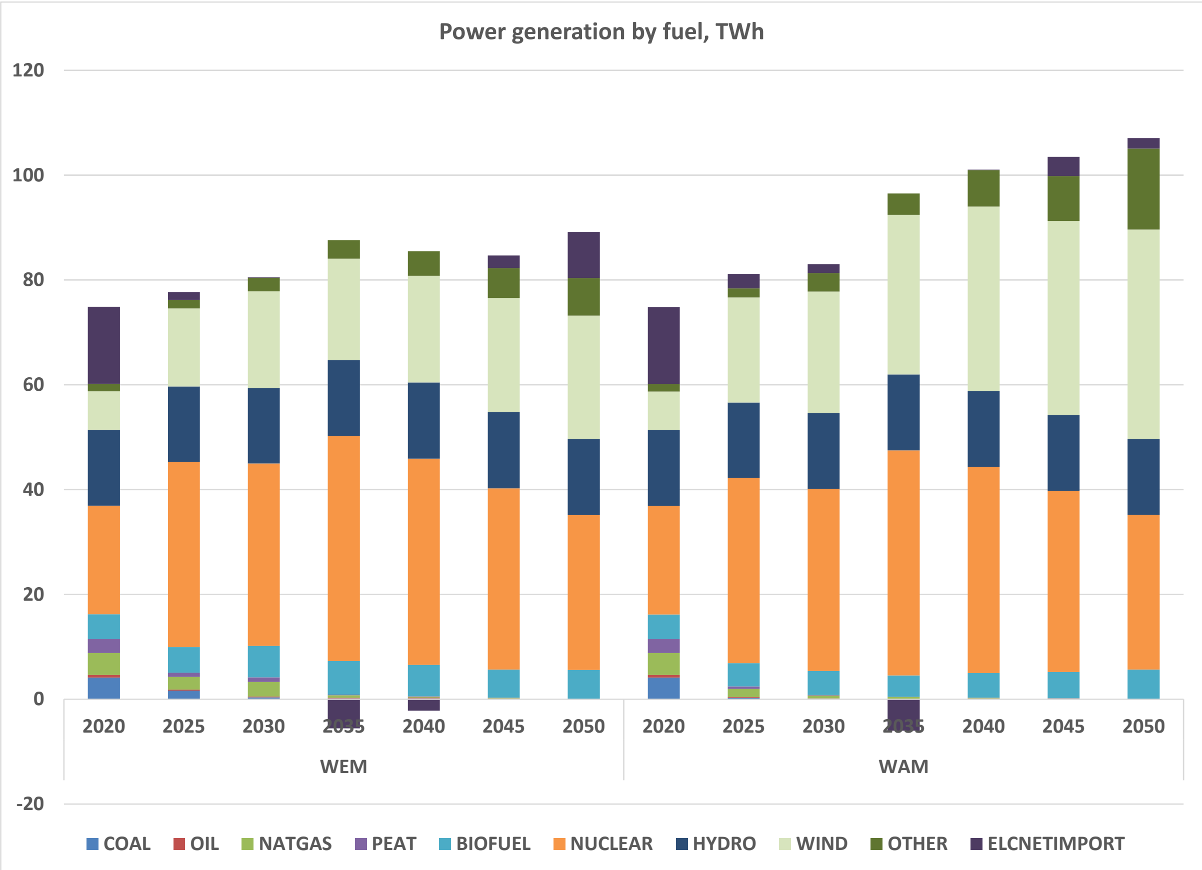


1.2 Technology in the WEM and WAM scenarios

The Finnish aims to achieve carbon-neutrality by 2035. Reaching this target is not possible without major changes in the energy system and in energy use. Examples of new technologies include switching from coal to hydrogen in the production of steel (generating emission reductions of some 4 million tonnes of CO2 in Finland), and the rapid switch to electricity of especially the housing and transport sectors.

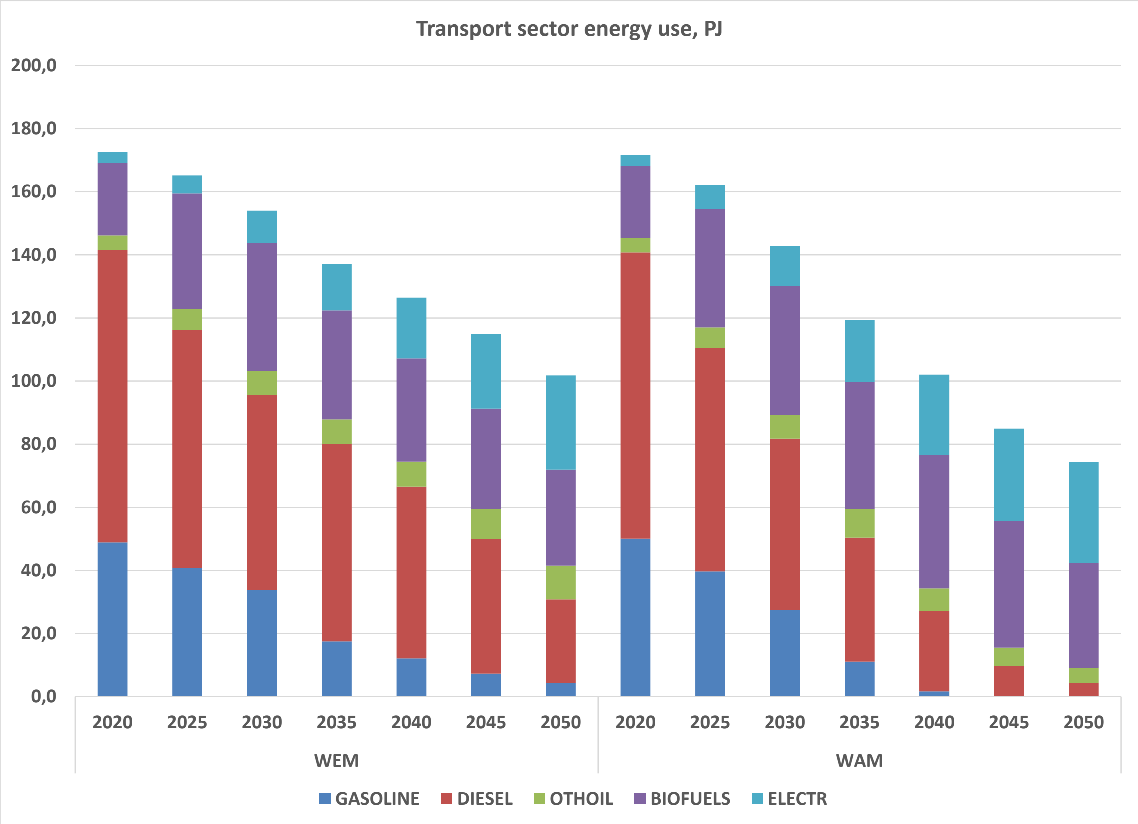
Figure 3 shows how power generation is forecast to change. Demand for electricity is increasing in the WAM scenario, because almost all sectors in the economy switch to electricity. But also the sources of electricity are changing. Fossil fuels are abandoned during the 2020's, and renewable energy, especially wind, is increasing. Finland is also increasing nuclear power already in the WEM-scenario. The TIMES-analyses produces estimates of the required investments in the energy sector and also in process industries and the housing sector, and these estimated costs are used as inputs in the economic modelling along with the effects on energy use and production.

Figure 3



The change in the transport sector is even more dramatic than in the electricity generation. The stated goal is to cut transport emission by a half from 2005 levels by 2030. This necessitates a rapid increase in the share of Electric Vehicles, mostly in the passenger car fleet. Currently, it is expected that the number of EVs will rise from less than a hundred thousand (out of the passenger car fleet of some 2.3 million) to 600 000 in the WEM-scenario, and by a further 150 000 in the WAM scenario. The past year has seen a very rapid growth in the EV fleet, and as EVs become more competitive with combustion engines (price-wise) their number is bound to increase. Overall passenger-miles are not expected to be affected by much, but as is evident from the picture, EVs produce similar passenger-miles with significantly lower energy consumption. Nevertheless, the increase will require massive investments in the charging infrastructure. Finland had expected to invest some half a billion euros to support a fleet of 200 000 EVs (National Communication to EU 2019) but now the bar is considerable higher. The economic analysis of the WAM scenario takes into account these additional investments, as well as the initial extra cost of EVs and the resulting gains in energy efficiency.

Figure 4



2 Economic effects

The economic effects of the WAM-measures stem mostly from the positive and negative spill-over effects of the huge additional investments; positive, in that they ultimately increase energy-efficiency and may also affect the output composition of e.g. forest industries, raising value-added content; negative, as sudden investment boom makes replacement investments more expensive for all industries, not just the reforming ones.
Figure 5 shows that once the transition to fossil-free economy is well under way, technology does boost the economy compared to the WEM-scenario. The effect is not huge – it ranges form some 0.4 percentage pints in 2030 to 0.2 in 2040, but it is still remarkable that such a huge shift in technology can be achieved so seemingly effortlessly. The effect on capital and labour inputs in turn, is smaller than that of technological change, but the effect of indirect taxes is larger, and it is negative. This contribution, though, stems fror diminishing energy and emission tax revenues, and it serves to highlight the fact that most of the – negative – economic effects actually stem from the efficiency costs of taxation.

Figure 6 shows the effects from the demand side- Most effects stem from a fall in private consumption, reflecting the effects of carbon pricing but also those of changes in the vehicle fleet and increased costs of housing. It is still remarkable that these costs stem are roughly the equivalent of year's growth in the WEM-scenario – climate policies definitely do not ruin the welfare of the consumers. From figure 2 it can also be seen that the additional investment to new technologies is a boost to the economy, and, once it is in place, a source of growth from exports, as especially metal and forest industries, as well as many technology industries benefit from the innovations in energy and production technologies.

Figure 5

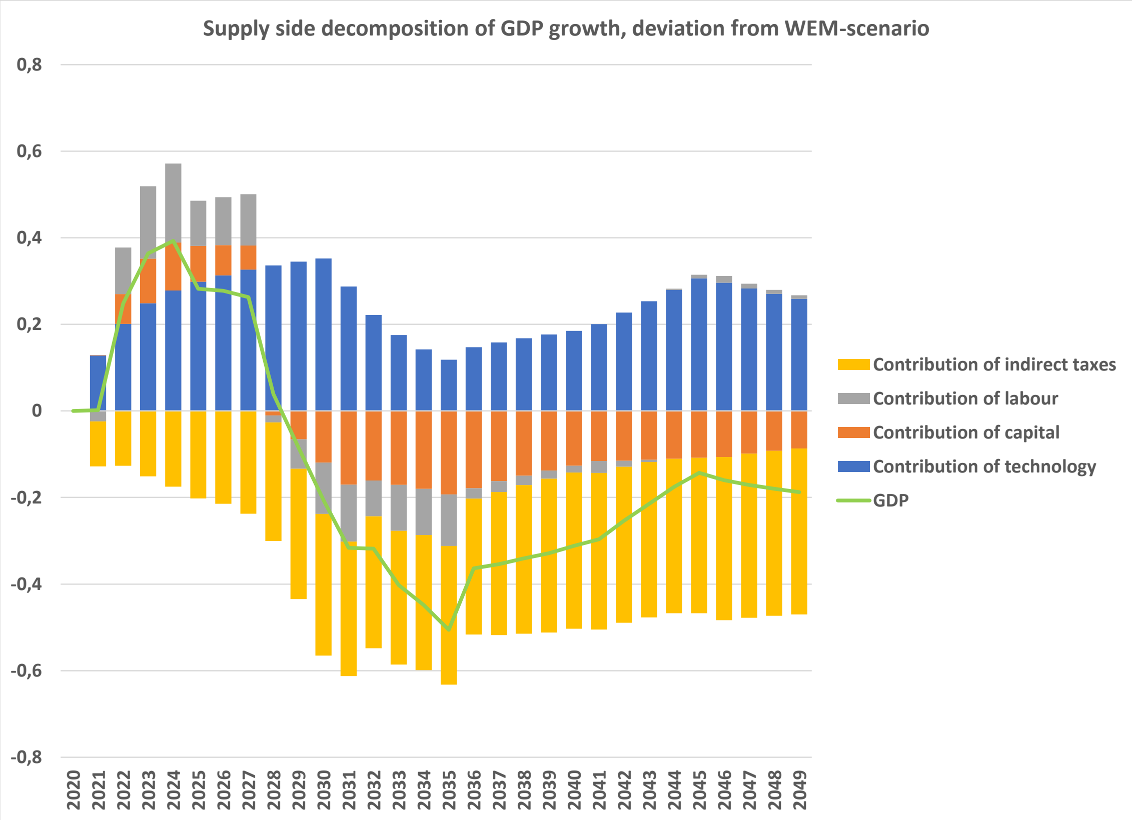


Figure 6

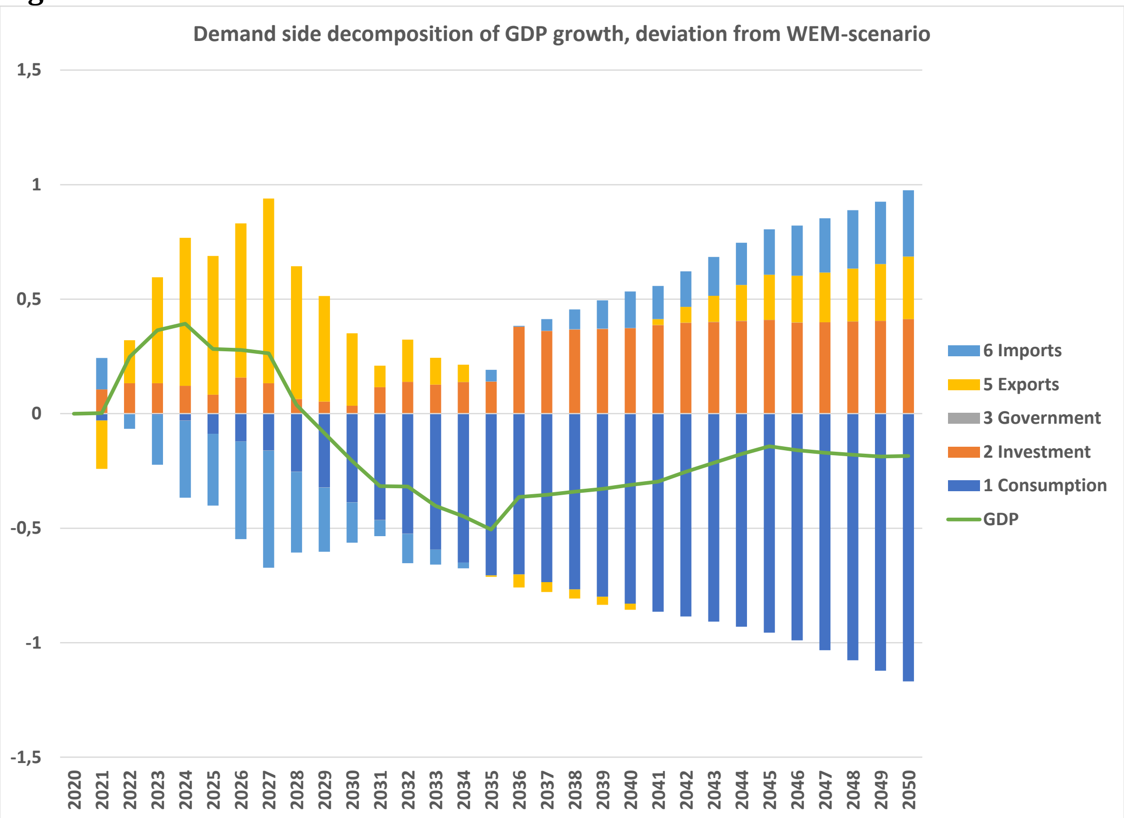
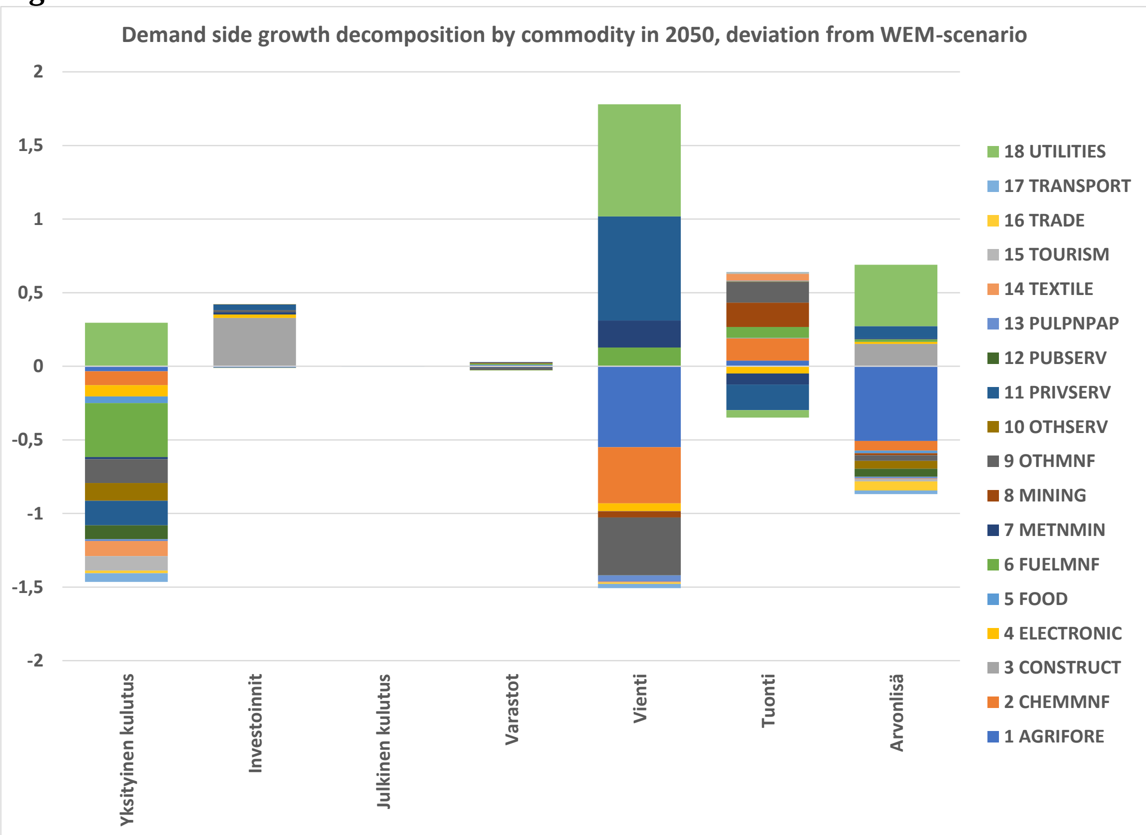


Figure 7 shows growth contributions by commodity and type of end use, as well as contributions form value added by sector. By 2050, one of the larges contribution stems from exports of private services (about 0.7 percentage pints from WEM-scenario). Also, export of electricity create extra growth. Increased household consumption of electricity also boosts the economy, although most other consumption draws growth down somewhat. The economy's external balance is improving, as its reliance on imported energy decreases and the share of domestic value added in exports is increasing. This implies that the economy is capable to finance the investments to new technology that initially must be met with external debt.

Figure 7



The structural change in the economy is also apparent in the demand for labour. Figures 8 and 9 show how the boom in investment increases demand for labour in the construction sector for each year of our simulation. Energy sector employment is also increasing, as there is significant growth in installed, maintenance-intensive capacity. Exports of private services grow faster than in the WEM-scenario in the 2020's but in the 30's and 40's growth in industry attracts employees and displaces service industry growth relative to the WEM-scenario. This is a reflection of the nature of technology-driven climate policies: they enable previously emission-intensive industries to remain in business, now renewable-energy intensive. Figure 10 shows the same pattern from the point of view of occupations.

Figure 8

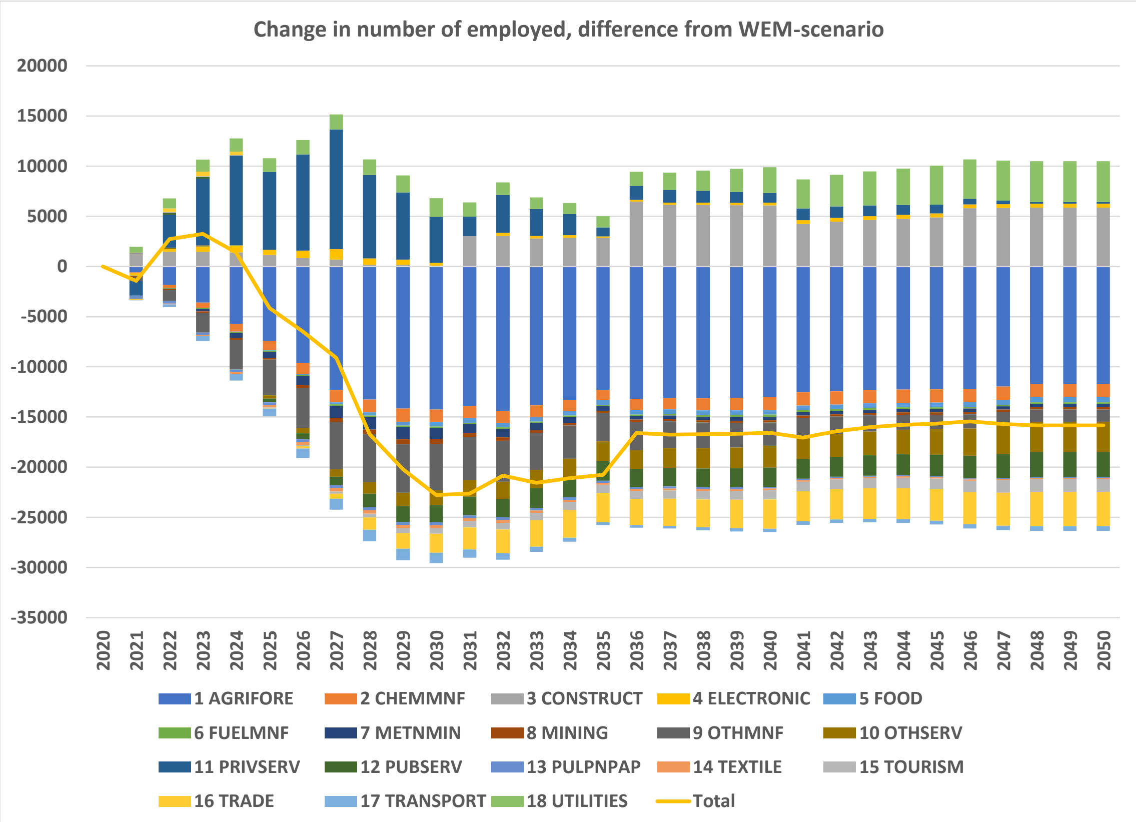


Figure 10

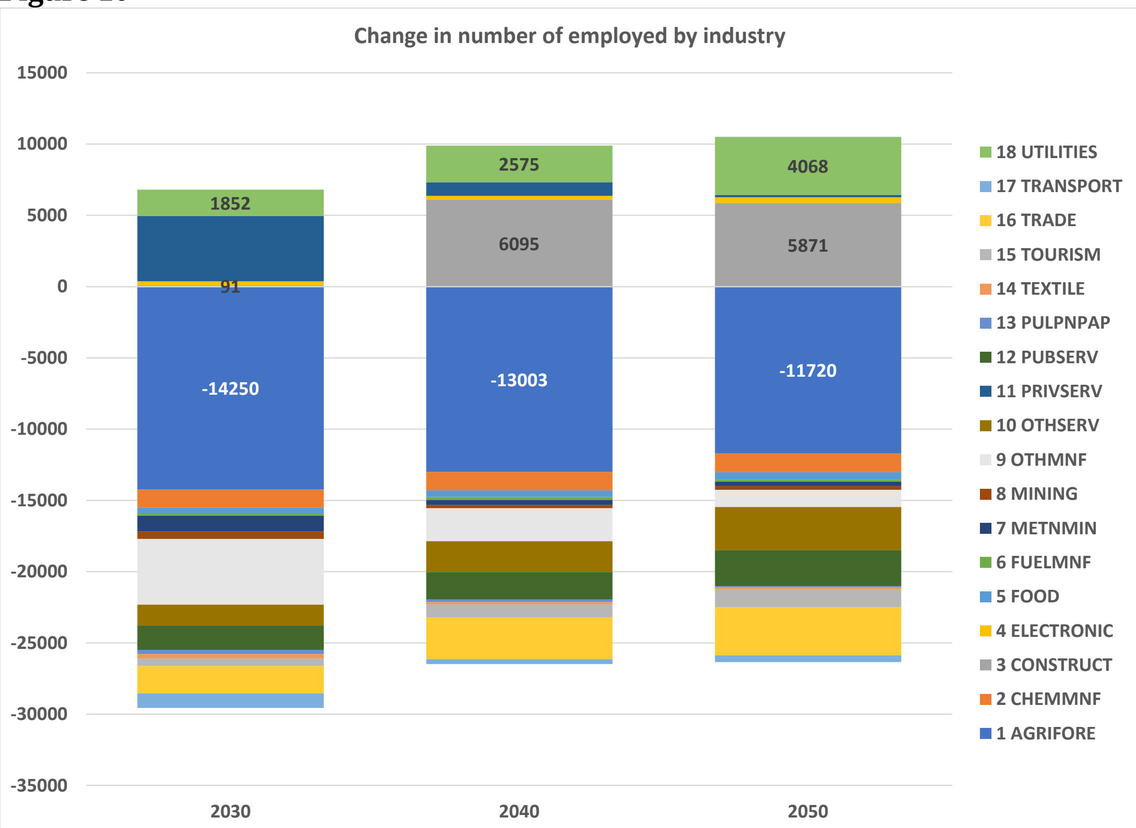
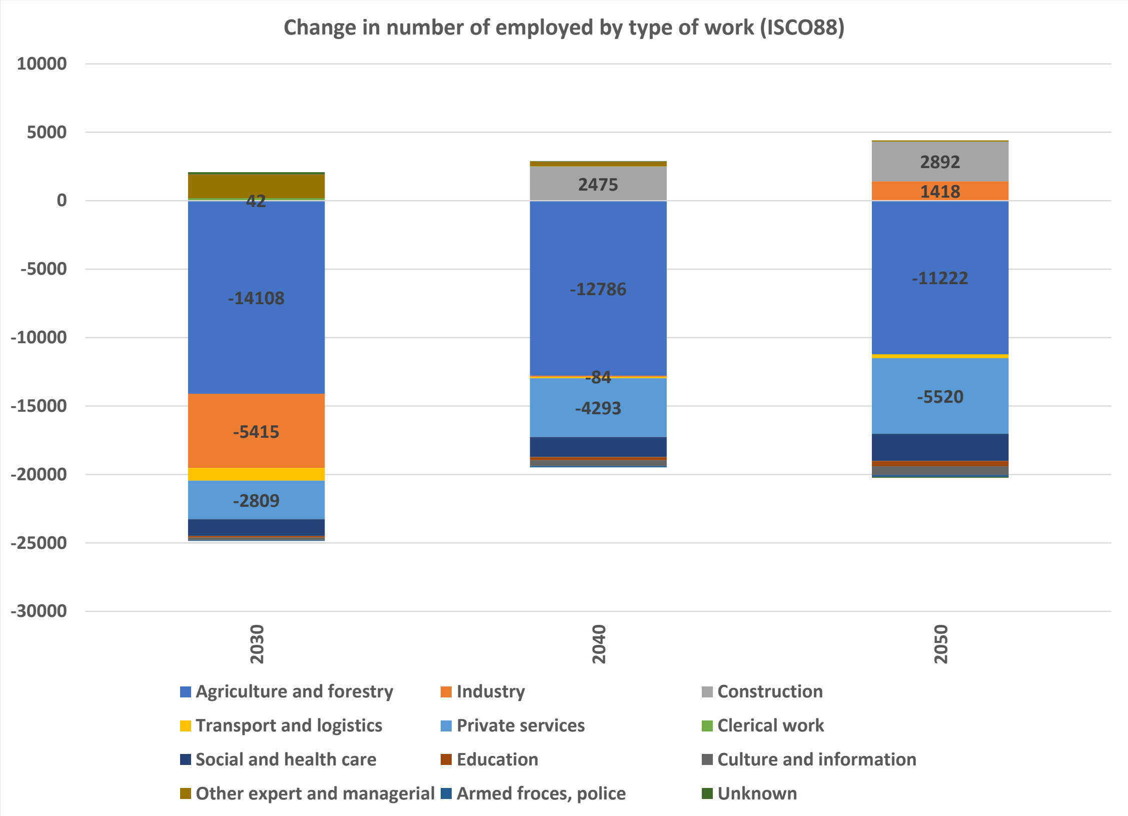


Figure 11



We have also evaluated the regional effects of climate policies. This is carried out in a top-down fashion, basing on the sectoral composition of the regional economies. Figure 12 shows the effects on regional value added These tend not necessarily to be the most population-rich counties, because the location of heavy industries has historically been driven by access to raw material (especially forests and to some extent minerals), waterways and hydro power, and/or ports. The population-rich areas include the capital and its surroundings (Uusimaa) and two coastal industrial centers (Varsinais-Suomi and Pohjois-Pohjanmaa) and Pirkanmaa in more central Finland (where industry thrived because of access to hydro and inland water-routes.

Figure 13, finally, shows effects on households in different income deciles. Since climate policies affect all uses of energy, it is ultimately not just the direct use of energy but the energy-intensity of the services and goods households use that determines how much they are affected by these policies. Higher income household tend to use energy and energy-intensive services (travel, housing) relatively more than low-income households, and thus they end up paying more both in absolute and relative terms.

Figure 12

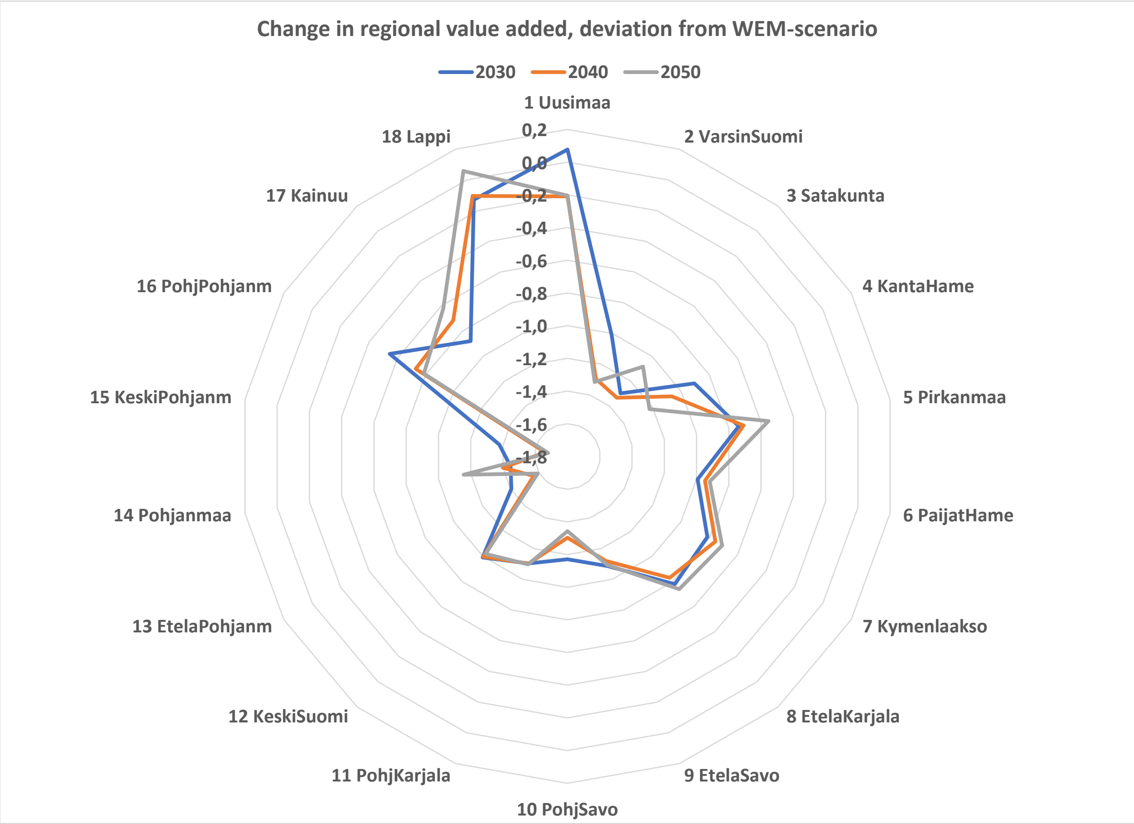
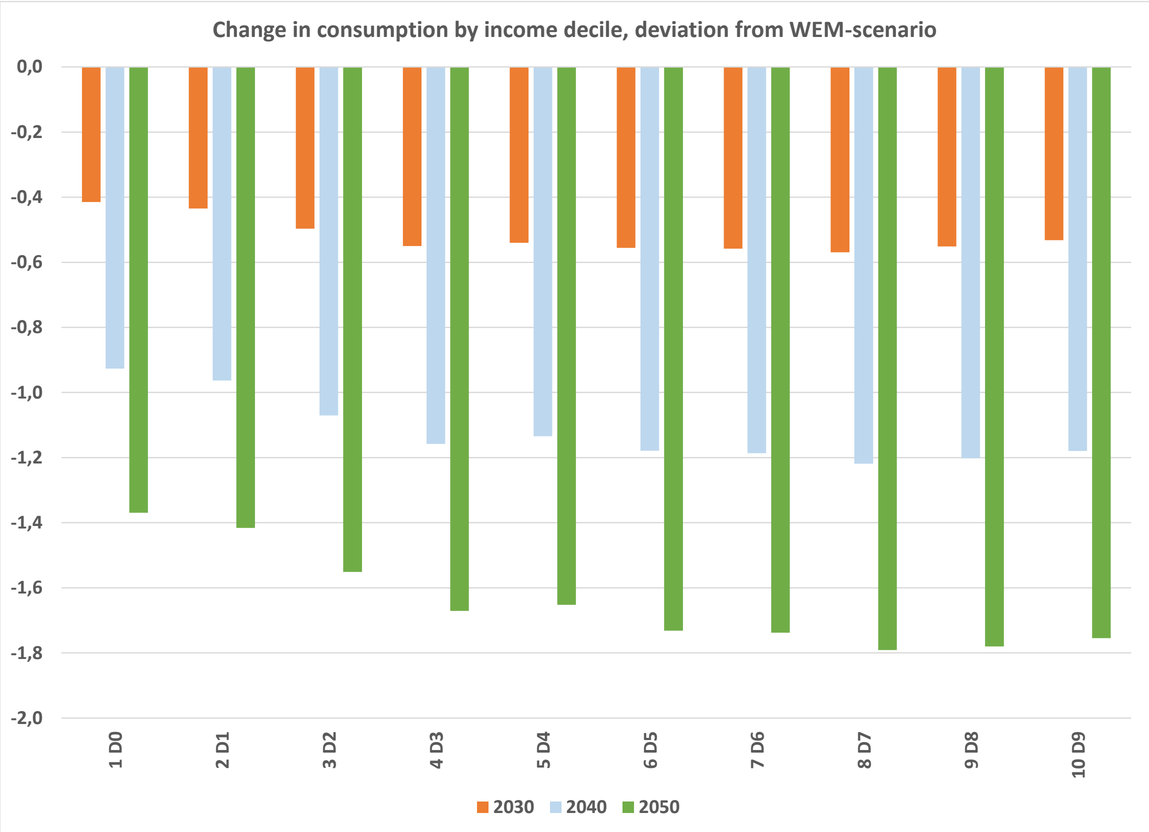


Figure 13



3 Conclusions

References

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