The Costs of the EU Energy Package for Finland- a Model-Based Assessment

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Abstract

The European Union has committed to cutting its greenhouse gas emissions by an average of 20 per cent by the year 2020. In addition, there is a commitment to increasing the share of renewable energy within EU to 20 per cent of energy consumption, also by the year 2020. Finally, energy saving is also given a 20 per cent target by 2020. The European Council accepted the Energy and Climate package in December 2008, making the targets binding for all member countries. This study evaluates the long-run effects of the package from the Finnish point of view.

The study utilises specific sectoral models and a CGE model to evaluate the effects of the full climate and energy package. The effects of specific policy measures on the choice of fuels and energy saving within industry and the energy sector are based simulations carried out with an engineering model, while the potential for increased domestic stumpage has been evaluated with forestry models and the potential for crop-based feed stocks for biofuel production, in turn, with agricultural models. Estimates on the potential for energy saving stem from several sectoral studies using also micro level data. The effects on the economy are studied with the VATTAGE model, a dynamic CGE model of the Finnish economy based on the MONASH-model.

Our sectoral effects indicate that the energy package accelerates structural change towards a more service-based economy. This may prove challenging, unless productivity growth in the service sector is increased, since the service sector is under increasing pressure coping with the demand of an ageing population. Our regional results also point to structural change in regions that are affected by the slower growth of energy-intensive industries. Finally, we find that the distributional effects of the energy package are surprisingly small, contrary to previous studies on the distributional effects of energy taxes. This is due to the energy package encompassing all energy, not just transport fuels whose consumption shares are larger in lower-income groups. The package thus also increases the costs of the non-fuel energy use of wealthy income groups, distributing the costs of the package more evenly

1 Introduction

The EU energy and climate package mandates increased use of bio-fuels in the transport sector as well as heat and power generation. Finland is one of the few countries that already exceeds the 20% target with a renewable share of 24% of all primary energy, with bio-energy accounting for some 20%. Finland does not meet the target for bio-fuels in the transport sector, however. The potential for increasing crop-based bio-fuels is limited by acreage and climatic conditions, but there is potential for increasing the production biofuel feedstock from agriculture and especially from the forest. According to agricultural models, as much as 20 per cent of total biofuel use could stem from agriculture. In contrast, forest models suggest some 65 per cent could be accounted for by forestry and forest industries. Finally, wind power is targeted to increase very significantly, with an additional capital cost to the energy sector. In the CGE analysis, we take these estimates as inputs for the analyses, finding that there is considerably job creation potential especially in forestry.

Energy saving potential in Finland stems mostly from heating and the transport sectors. The potential to cut energy use by the introduction of low-energy or passive houses is very large, but takes a long time to fully materialise because it only affects new houses. In the existing housing stock the potential is much more limited for many reasons, chief among them being the fact that most urban heating is already dominated by very energy efficient district heating. In industry, energy saving potential is also more limited and usually involves fairly high costs. In the transport sector, the available measures range from reduced speed limits to better urban planning and are not so readily associated with an economic cost. Similarly, more fuel-efficient vehicles are not necessarily more costly to produce than vehicles of recent past.

Emission targets are to be implemented separately for the emission trading sector and the rest of the economy. Emission trading covers about 60 per cent of Finnish emissions, and is easy to include in our CGE analysis. For the rest of the economy, economic measures include increased energy taxes but also some tax breaks designed to encourage a switch from fossil to renewable energy sources. We allow for both energy and raw material use of wood and agricultural products in our analysis to capture the price effects of these taxes and subsidies.

We study the energy package incrementally, introducing the goals one after the other. The starting point is formed by the existing climate target – the Kyoto target – followed by the 2020 climate target for the emission trading sectors, the renewables target, and, finally, the energy saving target. We find that the 2020 emission trading scheme increases the cots by roughly a quarter compared to the Kyoto target's costs, the renewables target by a half, and the full energy package roughly doubles the costs for Finland. However, in our sensitivity analysis we find that the effects depend very much on the flexibility of the labour markets, and also on the substitutability of primary factors and energy, which in Finland is somewhat lower than in many other countries.

2 Effects of the climate package on the energy sector

2.1 Energy baseline

The growth of energy consumption has been forecast in the National energy and climate strategy. There, industrial production is assumed to grow at an average annual rate of 3.5 per cent until 2010. Emissions of greenhouse gases are expected to grow accordingly, unless additional measures are taken, although at a slower pace than the economy. By 2010, CO2 emissions are expected to be close to 67 Mt. To reach the Finnish emission target (1990 levels), CO2 emissions from fossil fuels will have to be cut by 14 per cent (while the other green house gases can be cut slightly more). In the longer run, by 2025, the CO2 emissions are expected to rise well above 70 Mt. The structure of energy use is also changing, with electricity consumption growing from 85,2 TWh to 95 TWh by 2010, and to 108 TWh by 2025.

The Finnish economy is by many measures energy intensive (for example, in terms of primary energy use per unit GDP) but it is also energy efficient by others (for example, in terms of energy use per unit of output). Thus, energy intensive export industries – forestry and basic metal industries - account for around one third of the total value added, which is a much higher share than in most other OECD countries. On the other hand, most of their production is exported - Finland, with its population of 5 million people, produces paper for the needs of some 100 million people all over Europe and beyond.

At the same time, the share of renewable energy in Finland has been around 24 to 25 per cent of primary energy use, which is also far above the OECD or EU averages. The main reason for this is in the extensive use of wood residues in forest industries. Of all renewable energy sources – including hydro power – black liquor and wood residues stemming from the forest industries account for more than 40 per cent, and together they account for more than 80 per cent of bioenergy use.

The domestic sources of renewable energy are considerable, but not limitless. It is estimated that the domestic stumpage could account for between 60 and 70 million cubic metres by 2020. Here, it is assumed that 80 million cubic metres of wood is available, assuming continued imports of 10 to 15 million cubic metres. The potential for increasing the use of domestic forest residue could account for 22 TWh of energy (12 million cubic metres). It is also possible that imports of wood pellets or forest residue could be increased in the future. As for other renewable energy sources, mainly wind power generation can be increased from current levels (by an estimated 6 TWh), whereas potential for hydro power is very limited. Heat pumps offer a great potential but their effect is only felt gradually over time.

Finally, there is some limited potential for crop-based bioenergy and biofuel production from domestic sources. From imported sources, palm oil is already being used for biofuel production and its potential is significant also in the future, provided that it continues to be available.

2.2 Modelling the policies

We have studied the energy package with the POLA model of the Finnish energy system. The model takes into account several general measures for increasing the use of renewable energy sources, including:

- Fuel switching from fossil fuels to renewable fuels. For solid fuels this means increasing the share of wood in the over all fuel mix; for liquid fuels bio-based products substitute mineral oil products;
- Substituting wind generation for fossil fuel based electricity generation;
- Substituting biofuels for fossil fuels. The second generation bio-products are perfect substitutes for mineral oil products. Advanced biofuel processes can use both lignocellulosic and vegetable oil as feedstock in fuel production.

At the sector level, the mechanisms of adaptation vary considerably and include, for example, the use of pellets in coal fired condensing plants and in urban coal fired combined heat and power plants. The use of wood can be increased especially in district heating and industrial energy use. max pellet share in co-firing is set to 20 % of the total fuel input. The use of biofuels is mandated by an EU directive on bio based fuels in automobiles that sets the minimum share of bio-based fuels in transportation.

2.3 Results for the year 2020

In this section, we report the changes in electricity generation, in primary energy use by sector and by fuel in the year 2020. We compare the results of +7 per cent increase in the share of the renewable energy source to the MTI defined base case scenario.

In figure 1, we present the energy mix in electricity generation in the baseline case, and in the 7 per cent renewable target (RES 7) case.

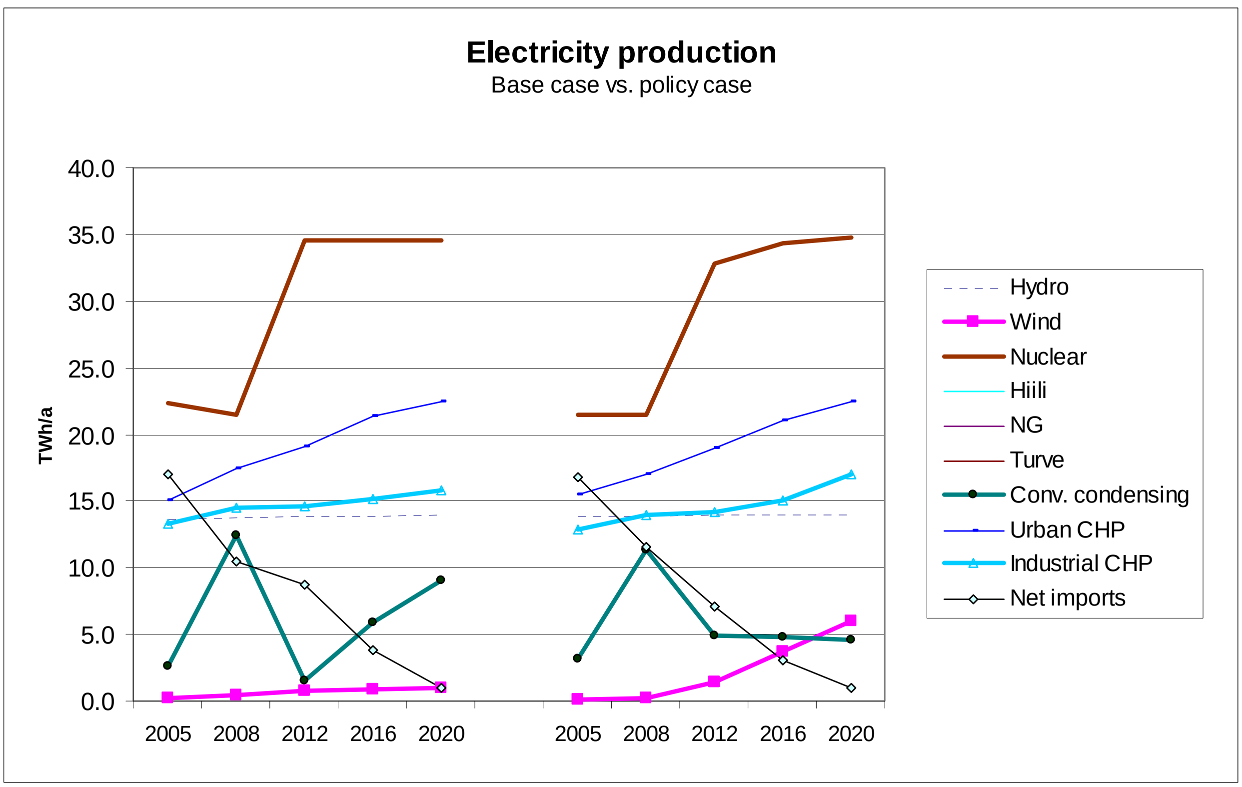


Figure 1. Electricity production in base case and in the RES 7 case.

The main difference in the cases is in the way generation is allocated between wind power plants and conventional condensing plants in 2020: in the base case only 1 TWh is generated by wind and in the policy case about 6 TWh is wind based. In combined heat and power (CHP) production and hydro power production no differences in the amounts of energy produced can be detected. This reflects the fact there are no additional heat demand available to meet by CHP plants. This does not mean that there weren't any differences in renewable use. These differences will be revealed in the fuel use figures below.

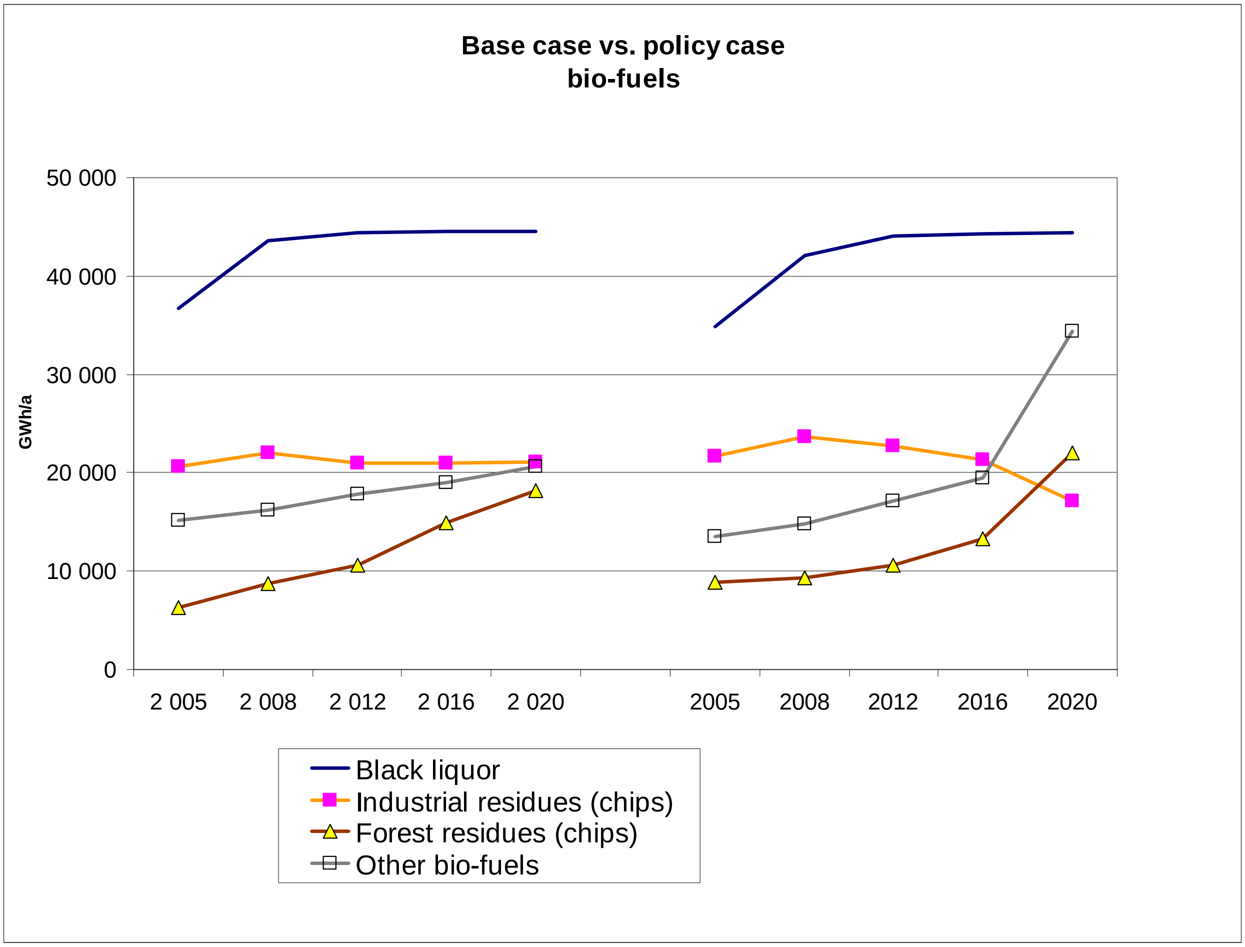


Figure 2. Use of renewable fuels.

The use of renewable fuel increases dramatically during the last time step in the policy case reflecting the fact that it is a more expensive option than using fossil fuels. In practise it is not possible to carry out all the needed changes in the production equipment during a few years. We have not added these features yet to stress the fact that these changes "do not materialize without an economic burden".

In oil use (figure 3) the drop during the last time step is due to the increased use of bio-based oil instead of mineral based product. The use of coal decreases in the policy case as it is partly replaced by pellets. The use of peat is on a higher level through out the study period in the policy case as its use is determined by its low price compared to the alternatives. Wood is co-fired in the peat plants and its share can be varied and thus the peat fired plants form an existing equipment base to increase the use of renewable fuels.

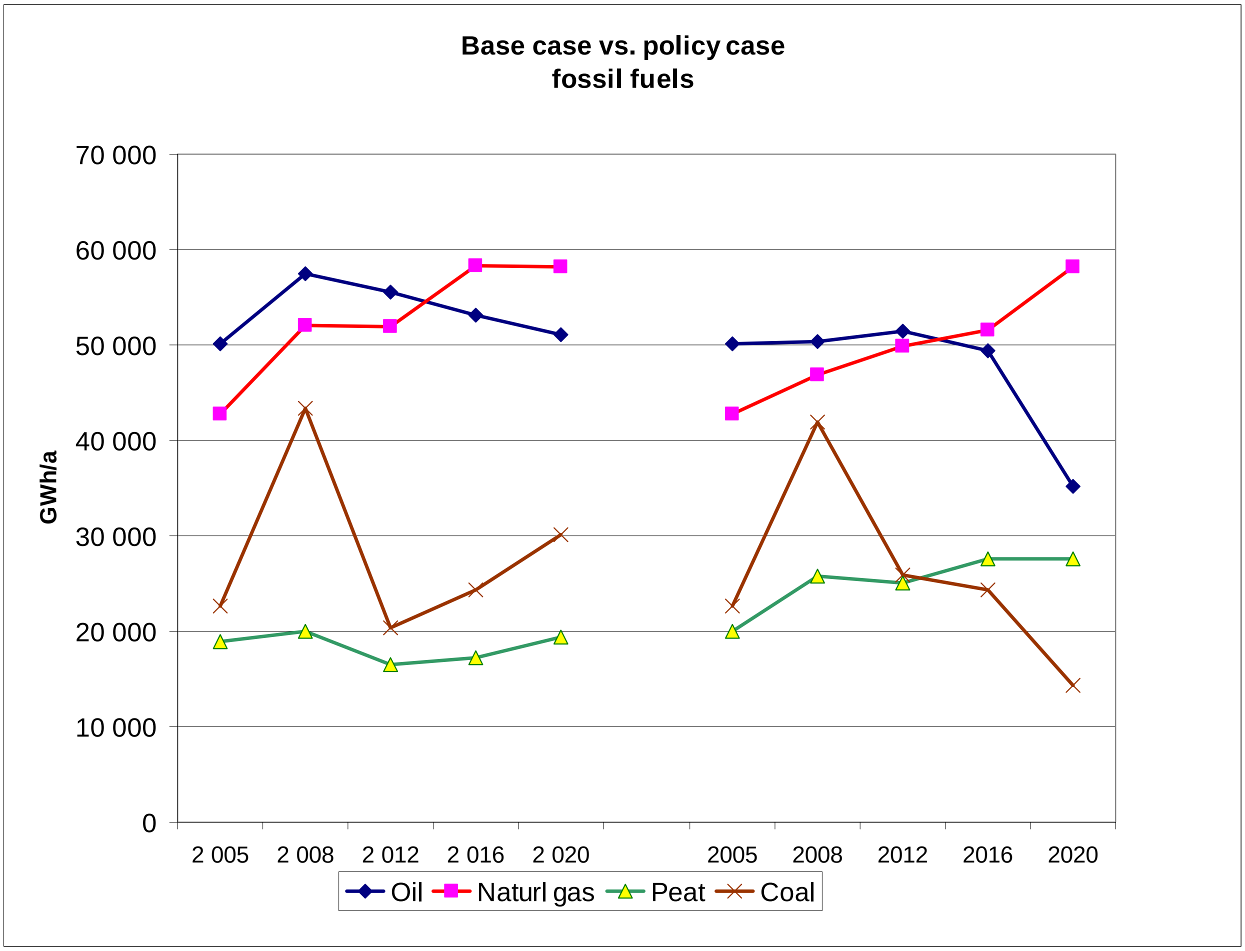


Figure 3. Fossil fuel use.

In district heating, pellets are used in co-firing in coal fired CHP-plants if pellet imports are available. Pellet firing also displaces ageing heavy fuel oil fired boilers in industries. In forest industries, the use of wood chips for drying increases as pellet production increases substantially. Fuel switching away from heavy fuel reinforces the trend. 20 % increase in fuel chip use Reduction in oil use is about 40%. In space heating in detached houses, 50 % of light fuel fired boilers will be replaced by electricity driven heat pumps and additional 35 % by pellet based heating. Oil keeps 15 % market share of the base case

Sectoral changes in fuel use can be put in a nutshell as follows:

1. In elelectricity generation
    a. 20 % share for pellets in coal-fired plants.
    b. Wind energy generation is sixfold (6 TWh) compared to that of the base case.
    c. Fossil fuel use deceases by about 40 % because of the above mentioned measures
2. In district heat production
3. n pellets are used in coal-fired CHP-plants
4. In other industries than wood processing industry pellet firing displaces heavy fuel oil fired boilers. Reduction in oil use is 40%.
5. In space heating in detached houses 50 % of light fuel fired boilers will be replaced by electricity driven heat pumps and additional 35 % by pellet based heating. Oil keeps 15 % market share compared to the situation in 2005.
6. Light fuel oil use is partially replaced by bio-based product in agriculture or in other sectors.
7. In wood processing industries the large scale production of pellets increases fuel demand as the drying energy demand increases compared to the base case.

Figure 2 shows the changes by fuel. It can be seen that the use of wood increases significantly, but that increases in the use of other biofuels is also necessary. This is only possible with increased imports of biofuels.

There are no changes in bio based fuels used in transportation. Small amounts of ethanol will be produced out of barley but the bulk of the fuels is based on palm oil. Although wood could be used for producing transportation fuels it is not done but it is used directly as a solid fuel substitute for fossil fuels, at least as long as palm oil is available at steady prices. (Palm oil based production cost is estimated to be about 30 % more expensive than the corresponding mineral oil based product.)

Energy saving displays a huge potential for cutting emissions and energy use. Most of the potential stems from spatial heating, where it can come from the adoption of district heating, saving of fuels (by e.g. fuel switching), or from saving electicity. The potential has a time-dimension: for the household sector, most measures are economically viable before 2020. The flip-side of the large potential is that it takes a long time for it to be fully realized, as the turnover of housing stock is slow. In industries, on the other hand, the costs are higher, and it is optimal to take additional measures somewhat later than in the household sector.

3 Economic effects of the energy package

3.1 Methodology

In this section, we study the dynamics of long-run emission targets. The study uses VATTAGE (Honkatukia 2009), a dynamic AGE-model based on the MONASH model (Dixon and Rimmer, 2002). The distinguishing features of the model concern its dynamics. Three inter-temporal links connect consecutive periods in the model: (1) accumulation of fixed capital, (2) accumulation of financial claims and (3) lagged adjustment mechanisms notably in the labour markets and in the balancing of the public sector budgets. Together, these mechanisms result in gradual adjustment to policy shocks to the economy.

In the model, capital is sector-specific and it therefore takes time for an industry to adjust to the increased energy costs caused by emission trading and increased energy taxes. In energy-intensive industries, the rise of energy costs lowers the rental on capital, which slows down investments until a new equilibrium is reached. In other industries, similar effects are caused by a rise in domestic energy taxes. Some of the industries, however, gain from the subsidies granted to renewable energy, and even in energy-intensive industries, the subsidies can dampen the rise of costs if they can substitute renewable energy for fossil fuels.

VATTAGE assumes sluggish real wage responses to policy shocks, much in the vein of the NAIRU theory of Nickell and Layard. Real wages adjust sluggishly to deviations from expected equilibrium wage growth, with the result that in the short run, adjustment occurs partly through increased unemployment. In the long run, wages adjust fully to one-off shocks, whence full employment is restored. In the case of gradually tightening emission targets, however, the shocks are not one-off, implying sustained above-equilibrium-unemployment rates.

3.2 Modelling the policies

The macroeconomic assumptions on the baseline for the Kyoto period follow the EU Stability Pact assumptions for Finland. Thereafter, the economy is assumed to converge to a long-run scenario that is consistent with the Ecofin Ageing Working Group assumptions. These assumptions give more detail than the national energy and climate strategy assumptions for the demand for services, whereas the sector-level growth of the economy is covered in much more detail in the climate strategy. Overall, the economy grows by slightly more than two per cent a year on average until 2025. Growth is fastest during the last years of the current decade and begins to slow down, driven by first and foremost by the ageing of the population after 2010. Ageing is also reflected in faster-than-average growth of pension and age-related service expenditures, both public and private. General government, on the other hand, grows slower than average.

In the policy scenarios, we impose the changes in the energy sector obtained from the POLA model on the economy. In the economic context, some of the results are assumed to be due to economic measures. For example, the increase in the use of wood in energy production is achieved partly by the changes in the relative prices of fossil fuels and wood, but also by assuming tax cuts or subsidies where this is necessary. Feed-in tariffs are modelled as increases in electricity taxes. Emission trade is modelled by imposing an exogenous emission permit price on the use of coal, oil, and peat. Energy saving is modelled as improved energy efficiency that comes with additional capital costs.

Biofuels are taken into account in the model with the help of the blending proportions. The POLA simulations report the mix of fossil fuels and biofuels in different uses in the economy. Based on these results, we assume a similar mix in VATTAGE and evaluate the economic impact of increased use of biofuels by taking into account the effect of biofuels on fuel prices – which rise by between 10 and 20 per cent depending on the fuel and the mix of cheaper fossil fuels and more expensive biofuels – and emissions of CO2, which fall in direct proportion to the use of biofuels.

The simulations take as given the policies required for meeting the Kyoto and long term emission targets. These consist of several parts. First, the European Emission Trading Scheme (EU ETS) has been operational for more than two years now, and forms a natural starting point for the simulations. We also take into account planned increases in energy taxes during the Kyoto period. Third, We assume that ETS emission permit prices will gradually rise to hit 25 euros per tCO2 by 2012. Second, by 2020, when the target is tightened to 20 per cent below 1990 GHG levels, we follow the European Commission and assume a CO2 price of 30 or 45 euros per tonne CO2. Thirdly, increases in the use of renewables are assumed to be achieved with economic measures – tax cuts and subsidies for the use of wood mainly – as well as mandatory requirements – mostly for blending biofuels and fossil fuels. And finally, when energy saving measures are taken we have the full measure of the energy package.

3.3 Effects on the macroeconomy

The main macroeconomic results are shown in figures 4 to 6 below, showing the effects of the GHG and RES targets on GDP, consumption and employment. GDP effects are shown in figure 4. From the figure, it is clear that the CO2 cost affects the economy considerably. With Kyoto targets, GDP is 0.4 per cent lower in 2020 than in baseline. The post-Kyoto target for emission trading increases the GDP loss to 0.6 per cent, and the cost of the full energy package is about 0.8 per cent if emission permits cost 30 euros per tonne, or 1 per cent, if permits cost 45 euros.

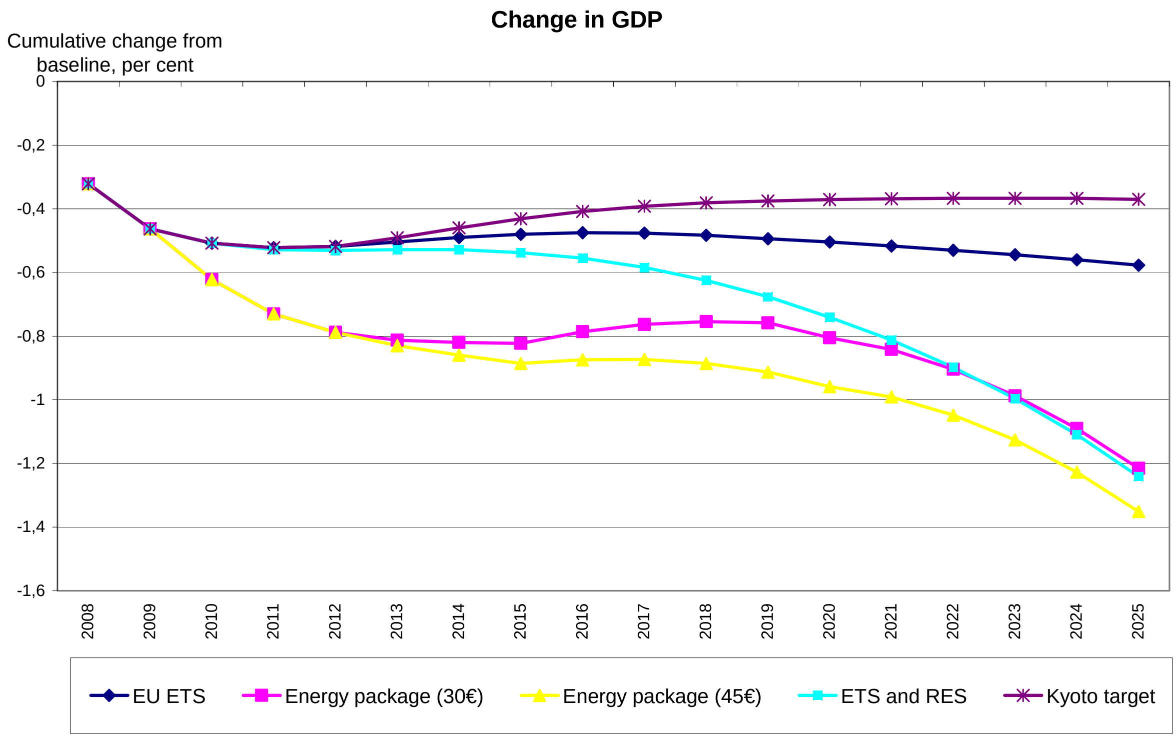


Figure 4. Effects on GDP

From figure 5, it is clear that a fall in private consumption explains a large part of the fall in GDP. The overall rise in energy costs cuts purchasing power directly, while falling demand for labour also has an effect on disposable income. Third, real wages start falling after a while to restore the labour market equilibrium. The consumers are thus definitely facing a large part of the bill.

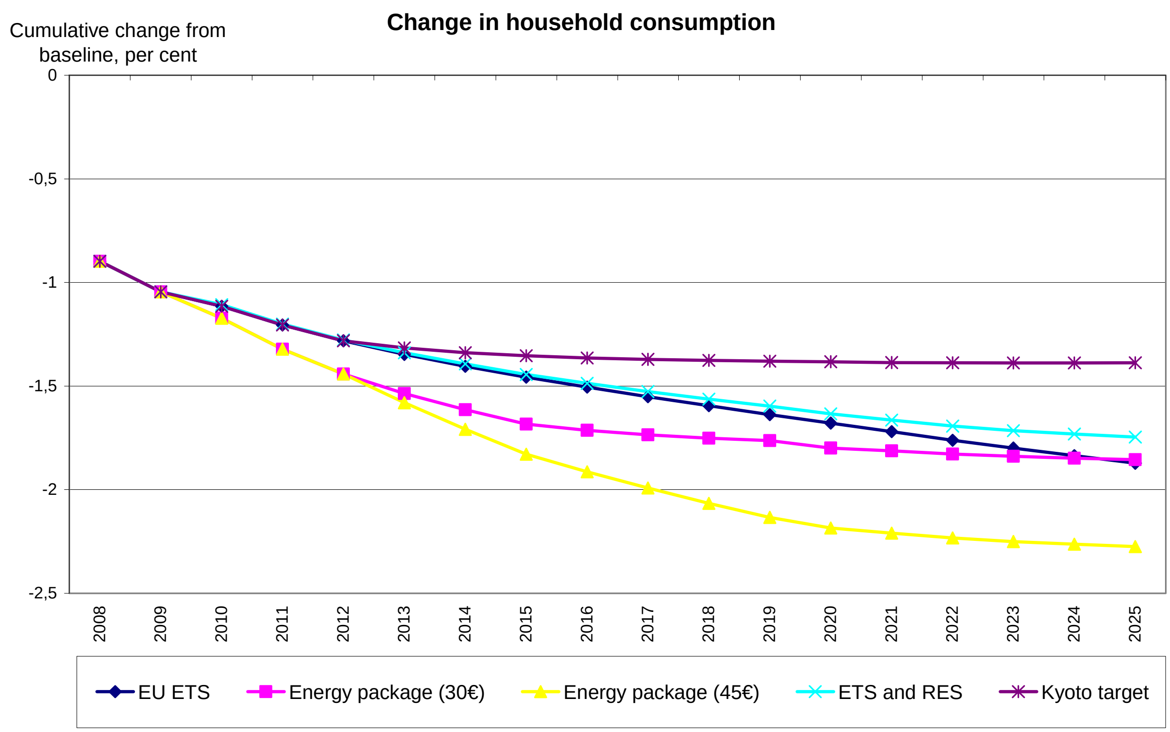


Figure 5 Effects on private consumption

Figure 6 shows the effects on employment. We assume here that employment eventually recovers back to baseline. The speed of this adjustment depends on the flexibility of real wages, which have to fall to restore employment. The results are sensitive to this assumption, and if structural unemployment changes, the economy may well be hit harder.

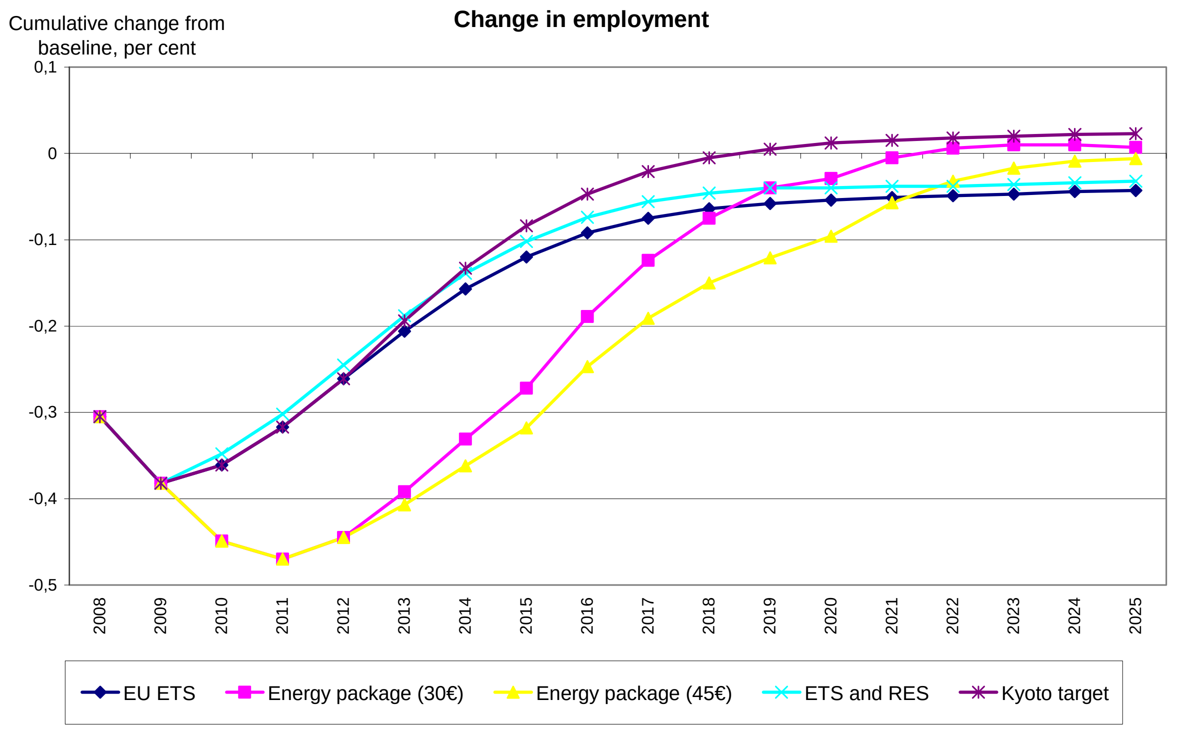


Figure 6. Effects on Employment

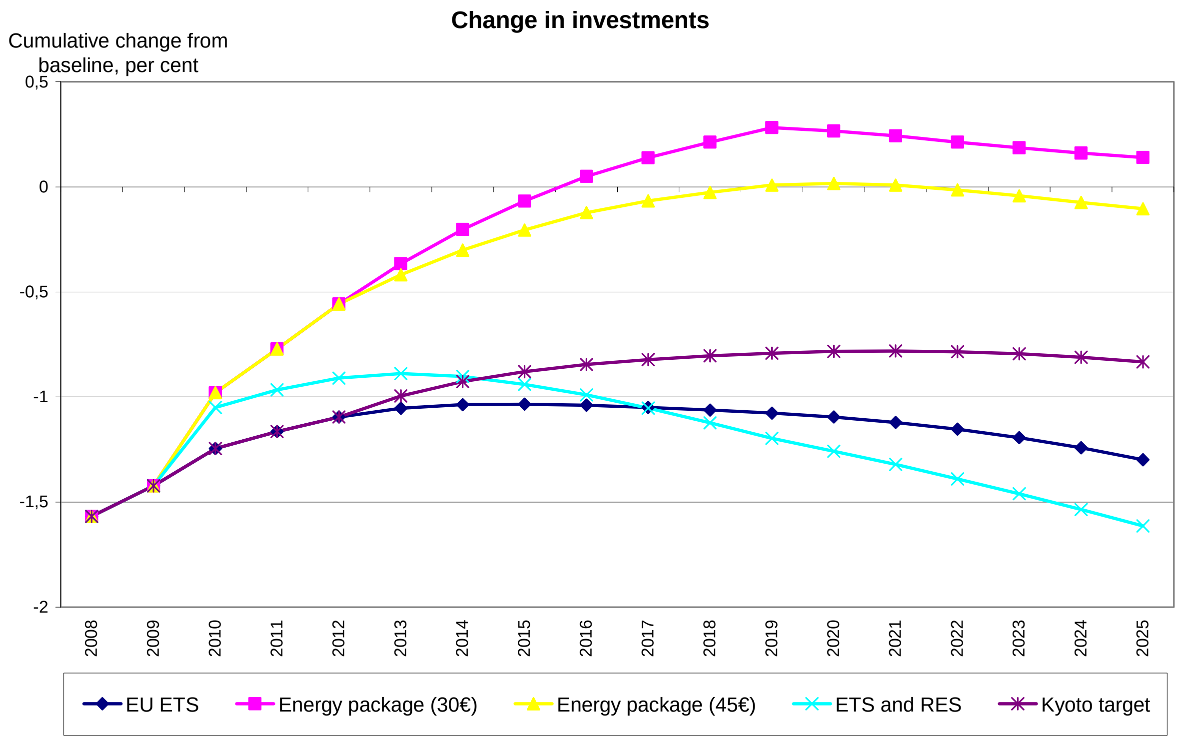


Figure 7. Effects on Investment

Investment responds to falling rates of return caused by the increase in costs. In the short run, the fall in employment lowers the productivity of capital, but as employment recovers so does investment. It is noteworthy that the energy package contains many investment-boosting elements. These stem from the compulsory investment in renewable energy capacity but also from energy saving measures.

3.4 Effects on industries, regions, and income distribution

The implementation of the 2020 target would put pressure on the structure of the economy. This is illustrated in figure 8, which shows changes in production by sector in 2020. The figure shows the large effects on energy intensive industry and power generation. These sectors contract substantially and free up labour force for the rest of the economy. The service sectors are less affected by the rising energy prices, as are labour intensive industries, and absorb some of the labour force made redundant elsewhere. Were the labour-intensive sectors of the economy to be able to compensate for the loss of production in the energy-intensive, export-oriented industries, they would have to become more competitive than before. To an extent, this happens in our simulations, where world market prices for labour-intensive exports are assumed not to change. This favours the industries producing machinery and equipment, but their expansion is not large enough to compensate for the losses in the rest of the economy. In the long run, the rise in energy prices exerts an upward pressure on living costs, which has usually resulted in claims for compensating wage rises in the labour market, aggravating the difficulties in adjustment. It is also notable that the changes also affect the service sectors negatively. It is apparent that the service-oriented structural change may take place through a slowing down of growth in industries rather than increased growth in the service sectors.

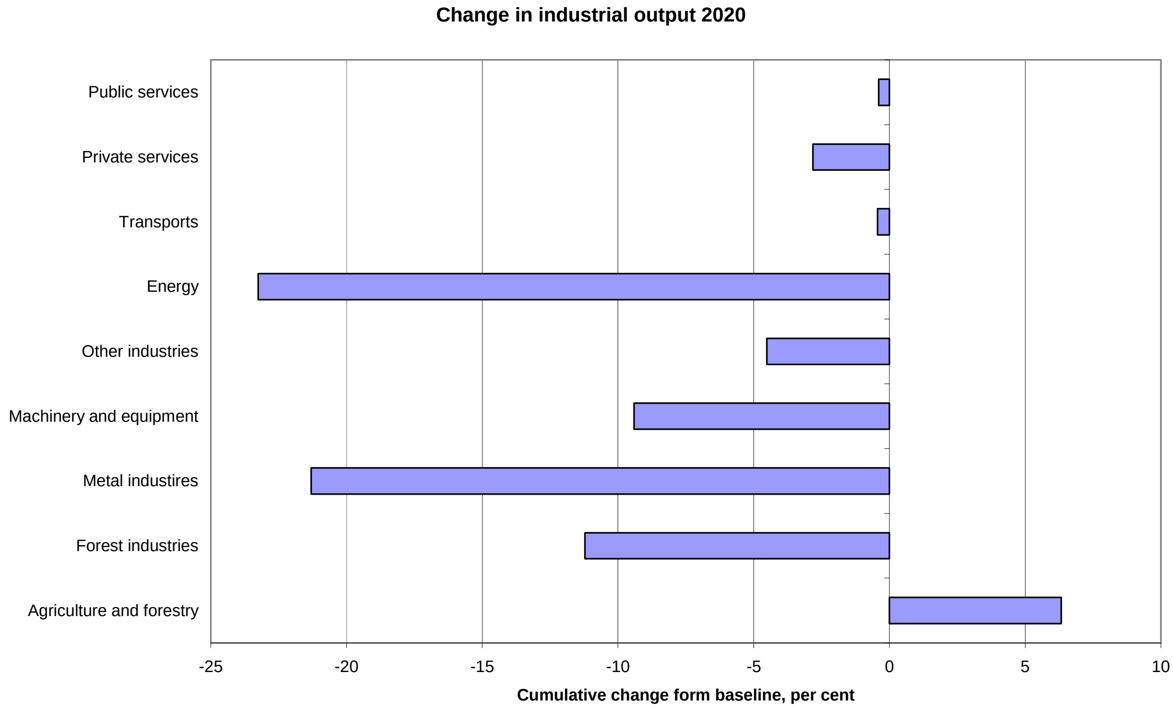


Figure 8. Change in industrial output

Regional effects reflect the importance of energy intensive industries. For example, forest industries account for a vey large share of the regional GDP in South-Eastern Finland, which is facing a marked fall in GDP. In the North-Western part of the country, metal industries are causing a similar effect on regional GDP. The positive effects on forestry is helping many regions, but not by enough to offset the negative effects.

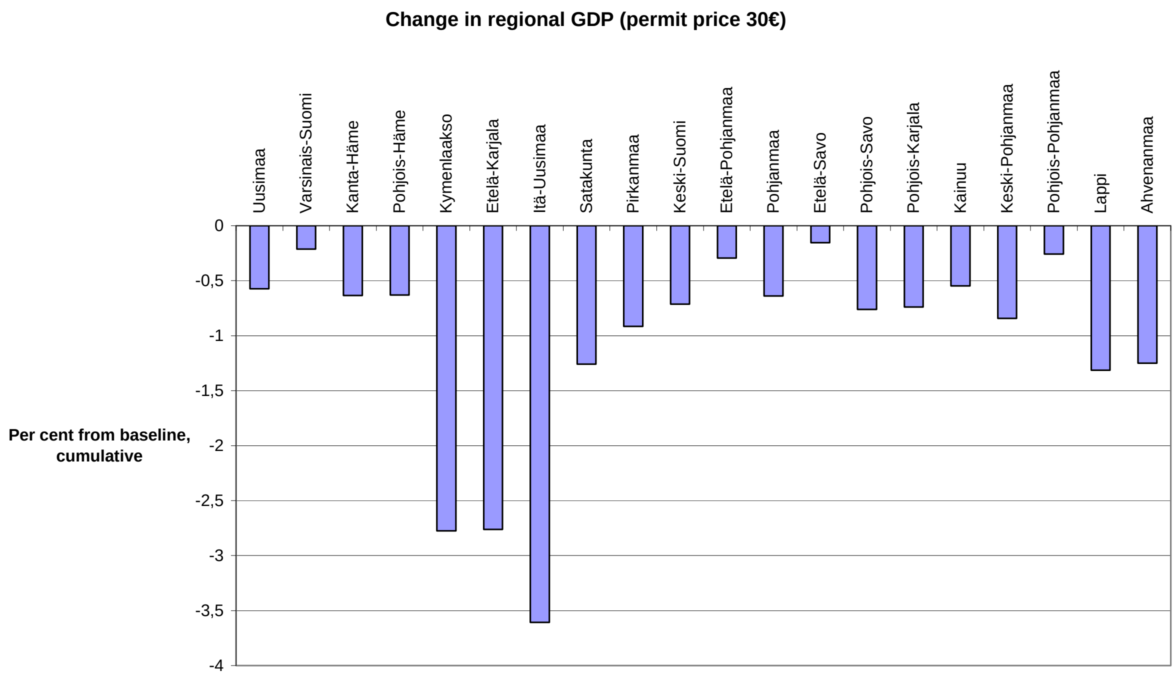


Figure 9. Change in regional GDP

Figure 10 shows the effects of the energy package on income distribution. Surprisingly, the overall effect does not appear strikingly regressive, as has often been found in the case of energy taxes. The reason for this is that while energy may have a higher share in the budgets of low income groups, higher income groups consume relatively more of many energy intensive services, such as housing or travel. The prices of these services are also affected by the comprehensive package.

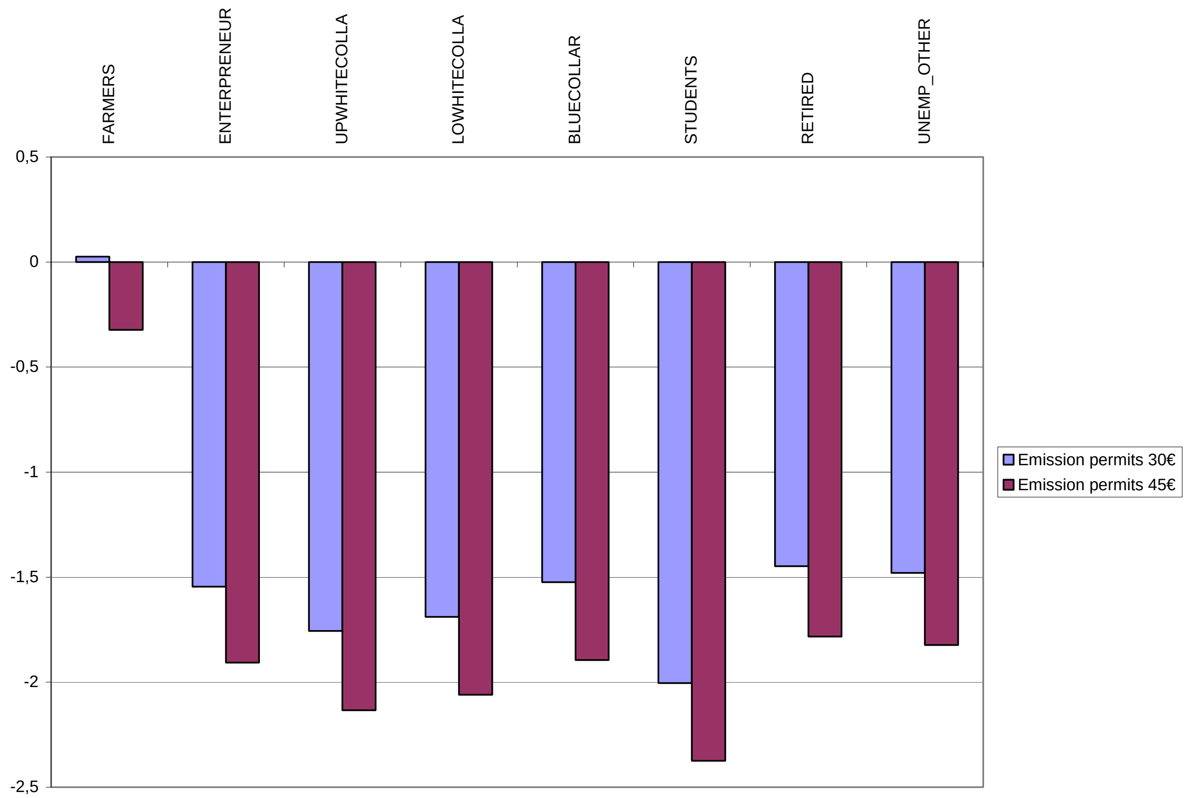


Figure 10. Distributional Effects

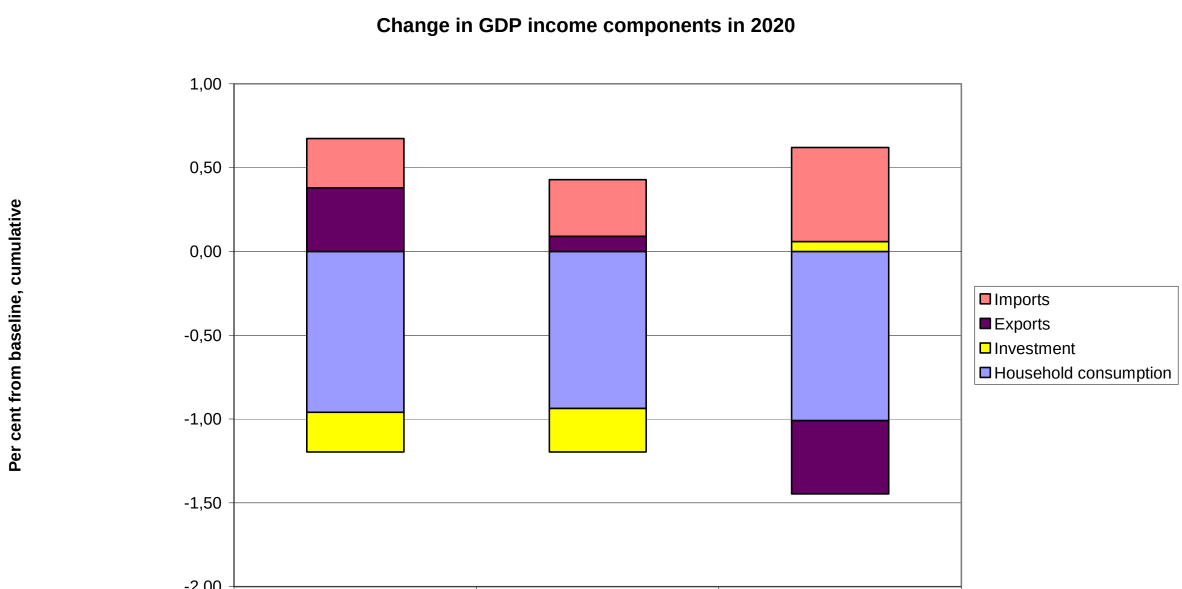
4. Conclusions

This study has evaluated the effects of the EU energy package on the Finnih economy. Our results suggest that the package will have the effect of lowering Finnish GDP by about 1 per centage point in the year 2020, compared to a baseline scenario. The main reason for this lies in the overall rise in energy costs that affects most sectors of the economy. For some sectors, the energy package will definitely bring good news in the form on increased demand. This is first and foremost the case with forestry, which sees demand for wood increase significantly. Domestic investment is also increased by the requirements of the renewable energy and energy saving targets.

The implementation of the 2020 target would put pressure on the structure of the economy. The energy intensive industries contract substantially. The service sectors are less affected by the rising energy prices, as are labour intensive industries, and they can absorb some of the labour force made redundant elsewhere. Their expansion, however, is not large enough to compensate for the losses in the rest of the economy.

We conclude the paper by pointing out some key mechanisms behind the results.

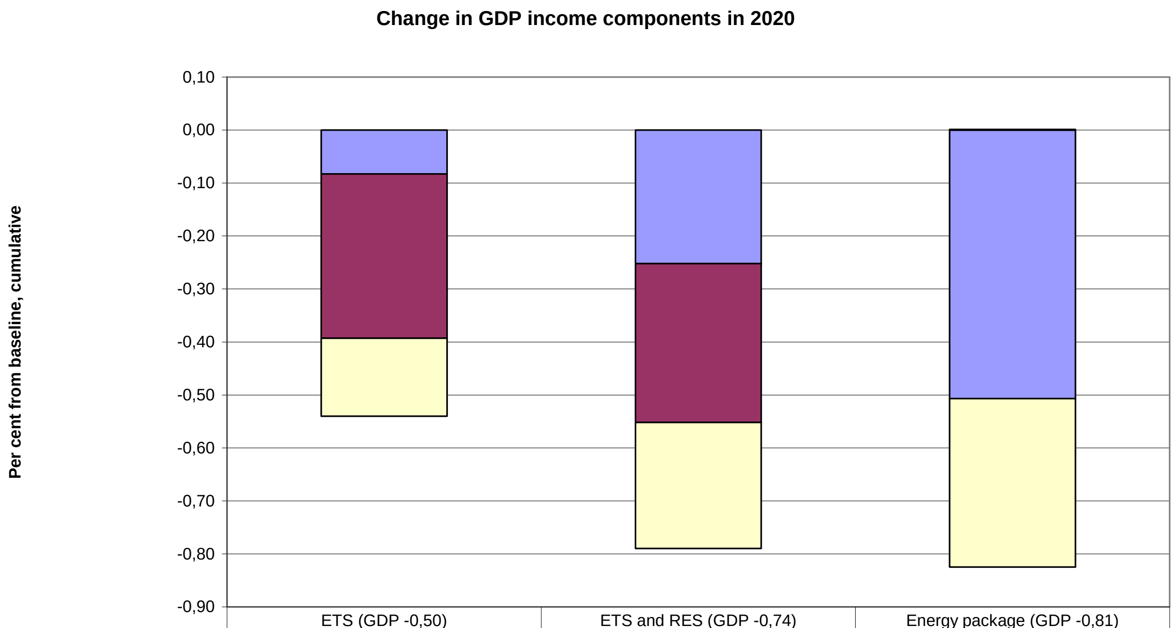
Most of the change in GDP can be traced to the effects on consumption and exports. Figure 11 below shows the contribution of demand components to GDP in the year 2020. It is fairly clear from the figure that the rising costs lead to lower consumption. The rise on domestic costs has an impact on exports as well. In our model, we distinguish between EU and non-EU exports; it is especially the latter that is hurt by the rising Finnish cost level.



	ETS (GDP -0,50)	ETS and RES (GDP -0,74)	Energy package (GDP -0,81)
Imports	0,30	0,34	0,56
Exports	0,38	0,09	-0,44
Investment	-0,24	-0,26	0,06
Household consumption	-0,96	-0,94	-1,01

Figure 11. The contribution of expenditure aggregates on GDP change

Figure 12 shows the effects of income components on GDP. It can be seen that the switch to cleaner but more expensive energy technology comes with a price: the effect of investments in renewables and energy saving is to lower overall productivity.



	ETS (GDP -0,50)	ETS and RES (GDP -0,74)	Energy package (GDP -0,81)
Product taxes	-0,15	-0,24	-0,32
Primary factors	-0,31	-0,30	0,00
Total factor productivity	-0,08	-0,25	-0,51

Figure 12. The contribution of income aggregates on GDP change

The results in section 3 depend very much on the assumption that labour markets return to the initial growth path. If this is not the case, the effects on the economy can be larger than stated above. Figure 13 shows how assumptions about the wage mechanism affects the results on GDP. With changes in structural unemployment, the change in GDP can be almost twice as large as in the main case (figure 4).

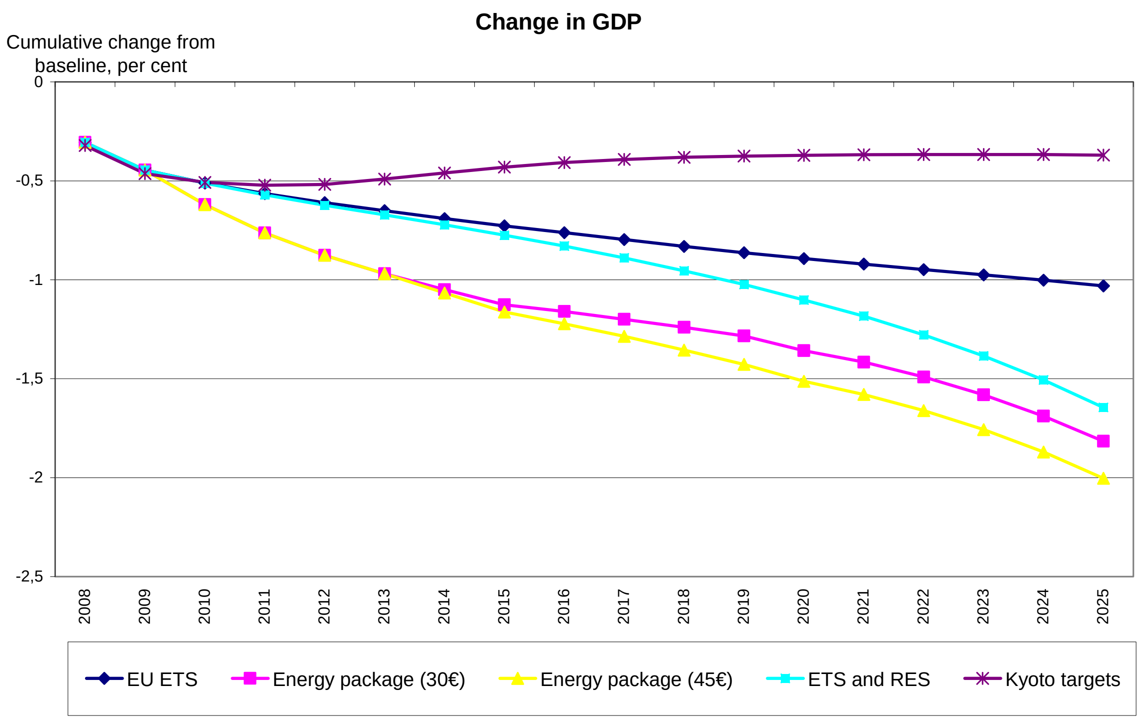


Figure 13 Change in GDP with less-elastic wage setting

References:

Alho, K.E.O. (2002): The Equilibrium Rate of Unemployment and Policies to lower It: The Case of Finland. Keskustelualoite 839, ETLA, Helsinki.

Dixon, P. – Rimmer, M. (2002): Dynamic General Equilibrium Modelling for Forecasting and Policy. North-Holland, Amsterdam.

Honkatukia, J. (2009): VATTAGE – a Dynamic, AGE Model of the Finnish Economy. VATT, Helsinki.

Nordhaus, W (2007): Critical Assumptions in the Stern Review on Climate Change. Science, July 2007.

Perrels, A. – Rajala, R. – Honkatukia, J. (2005): Appraising the Socio-Economic of Climate Change in Finland. Discussion paper 342, Finnish Environmental Institute, Helsinki.

Stern, N. (2006): The Stern Review of the Economics of Climate Change. HM Treasury, London.