What role subsidies? A CGE analysis of announcement effects of future policies on the development of emissions and energy consumption in Finland

Juha Honkatukia

1 Introduction

The European Union has committed to cutting its greenhouse gas emissions by 20 per cent by the year 2020. In addition, there is a commitment to increasing the share of renewable energy to 20 per cent of energy consumption, also by the year 2020. These average targets are to be allocated to the member states in cooperation with them. This study evaluates the long-run effects of abatement of green house gases from the Finnish point of view.

The study utilises both an energy sector approach and an economic approach. The effects of specific policy measures on the choice of fuels is evaluated with the POLA model, while the effects on the economy are studied with the VATTAGE model, based on the well-known MONASH-model (Dixon and Rimmer, 2002).

We have studied two alternative scenarios, the first with a 7 per cent increase from current share of renewables, the other with an EU-wide 11.5 per cent flat rate increase. In the simulations, it is assumed that feed-in tariffs can be used to increase wind power generation as well as the use of wood fuels in energy generation. Furthermore, it is assumed that refining capacity exists to produce both transportation fuels and bio-oil from imported palm oil, to replace refined mineral oil products. It is also assumed that imported pellets can be used as a substitute for solid fossil fuels. Wood could be also used for producing transportation fuels but the processes are less effective than using wood directly as a solid fuel to substitute for fossil fuels.

The study is organised as follows. Section two deals with the baseline, while the policies are analysed in section three. Section three concludes.

Baseline and methodology

2.1 Methodology

In this section, we study the dynamics of long-run emission targets. The study uses VATTAGE, 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 any 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.

The VATTAGE model 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.

2.2 The baseline

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 sloghtly 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.

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.

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.

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.

3 Economic effects of RES and 2020 emission targets

3.1 Modelling the policies

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. Second, some increases in energy taxes are likely to take place already in 2007. Third, during the Kyoto period, we assume that ETS emission permit prices will gradually rise to hit 20 euros per tCO_2 by 2012. Fourth, by 2020, when the target is tightened to 20 per cent below 1990 GHG levels, we follow the European Commission and assume a CO_2 price of 44 euros per tonne CO_2. Finally, 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.

POLA, an engineering model of the Finnish energy system, provided the starting points for the economic analysis. The model takes into account the possibilities for fuel switching from fossil fuels (solods and biofuels) to renewable energy in the energy system, as well as the possibility for increased use of wind power. The main effects in the energy system are:

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 pellets are used in coal-fired CHP-plants
3. In other industries than wood processing industry pellet firing displaces heavy fuel oil fired boilers. Reduction in oil use is 40%.
4. 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.
5. Light fuel oil use is partially replaced by bio-based product in agriculture or in other sectors.
6. In wood processing industries the large scale production of pellets increases fuel demand as the drying energy demand increases compared to the base case.

We study the policies in several steps. The starting point for the simulations is in the requirements of the Kyoto Protocol. Next, we impose the 2020 target for renewables in addition to the Kyoto target. Finally, we consider the combined effects of the 2020 RES and GHG targets under two alternative RES targets, the first with a 7 per cent increase from current share of renewables, the other with an EU-wide 11.5 per cent flat rate increase.

In the policy scenarios, we impose the changes in renewable energy obtained from the POLA model results with the help of economic measures. 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. Grandfathering of permits is also assumed, whence emission trade does not affect energy tax revenues.

3.2 Effects on the macroeconomy

The main macroeconomic results are shown in figures 1 to 3 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 increased CO2 cost is driving the results. If the GHG targets only involve the Kyoto Protocol, the imposition of a 7 per cent increase in the share of renewables involves a further drop in GDP of some 0.2 percentage points. With a -20 per cent GHG target and a 7 per cent RES target for 2020, the GDP is almost 1.6 per cent below baseline in 2020. This increases by another 0.1 percentage points if the tighter 11.5 per cent RES target is adopted.

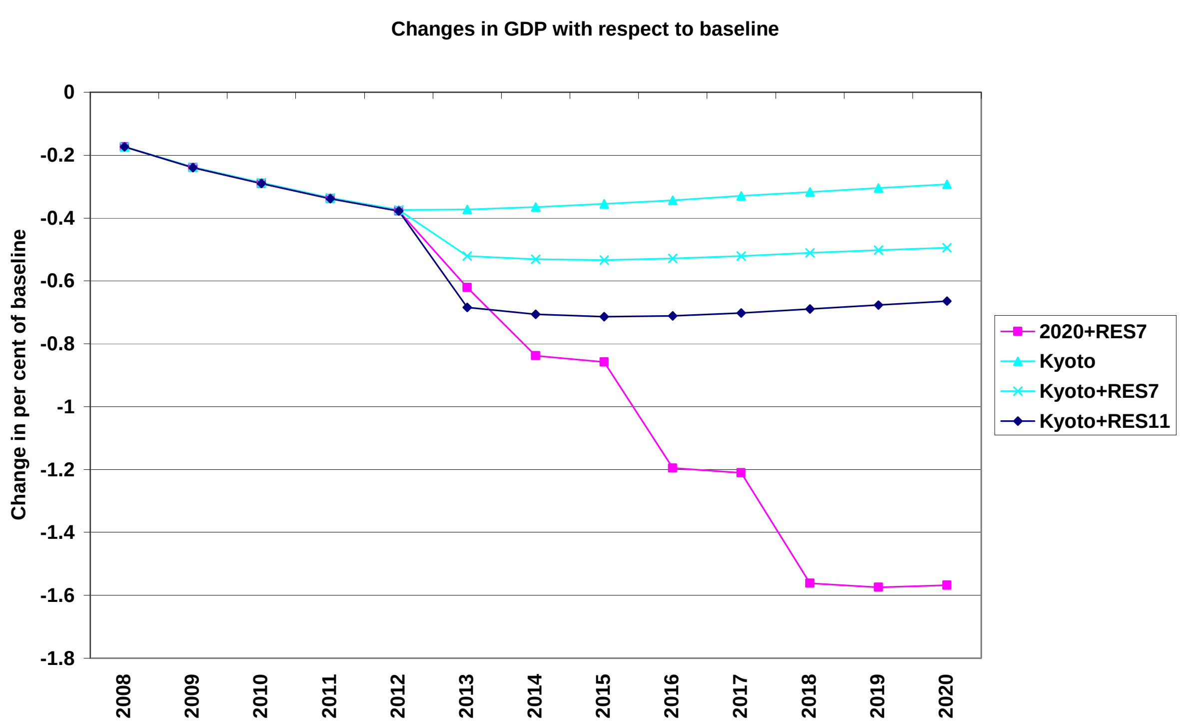


Figure 1. Effects on GDP

From figure 2, it is clear that private consumption has to fall markedly as a result of the policies. There are three reasons for this. First, increased energy costs cut the purchasing power of consumers directly. Second, falling demand for labour 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.

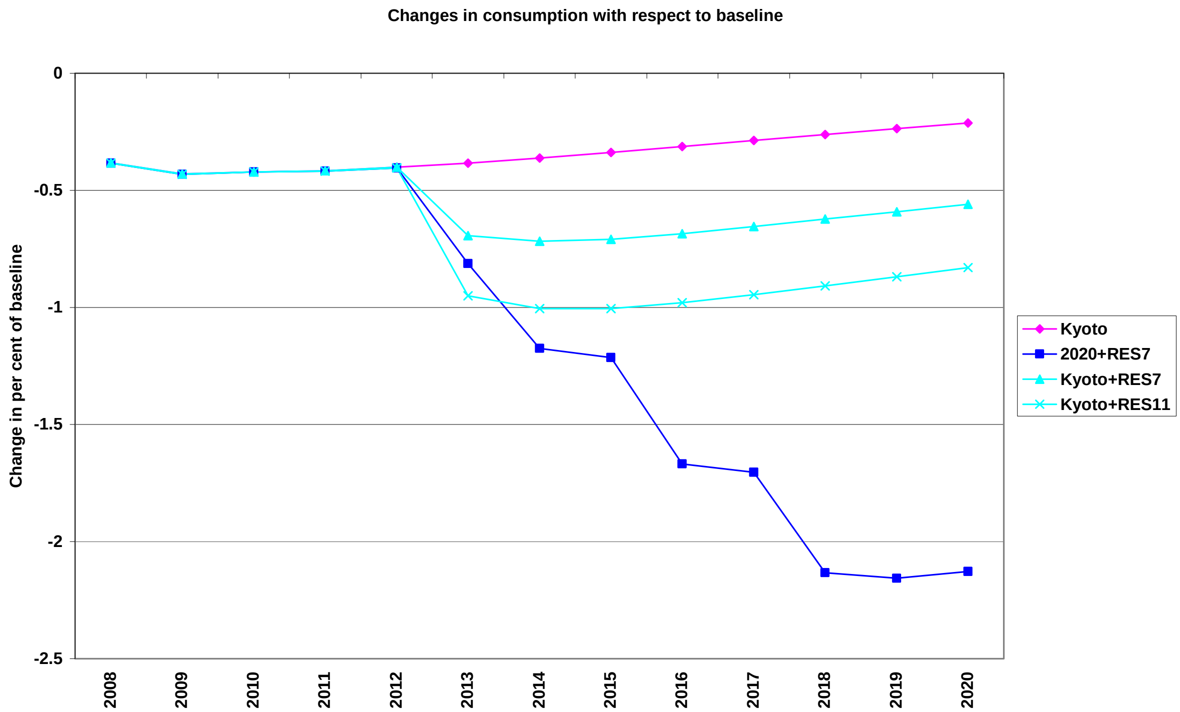


Figure 2 Effects on private consumption

Figure 3 shows the effects on employment. It is evident from the figure that it takes time for employment to return to its equilibrium level after a large structural shock. By 2020, employment is still recovering from Kyoto, but when additional cost shocks due to rising emission quota prices face the economy, there is a sharp drop in employment each time, increasing unemployment further.

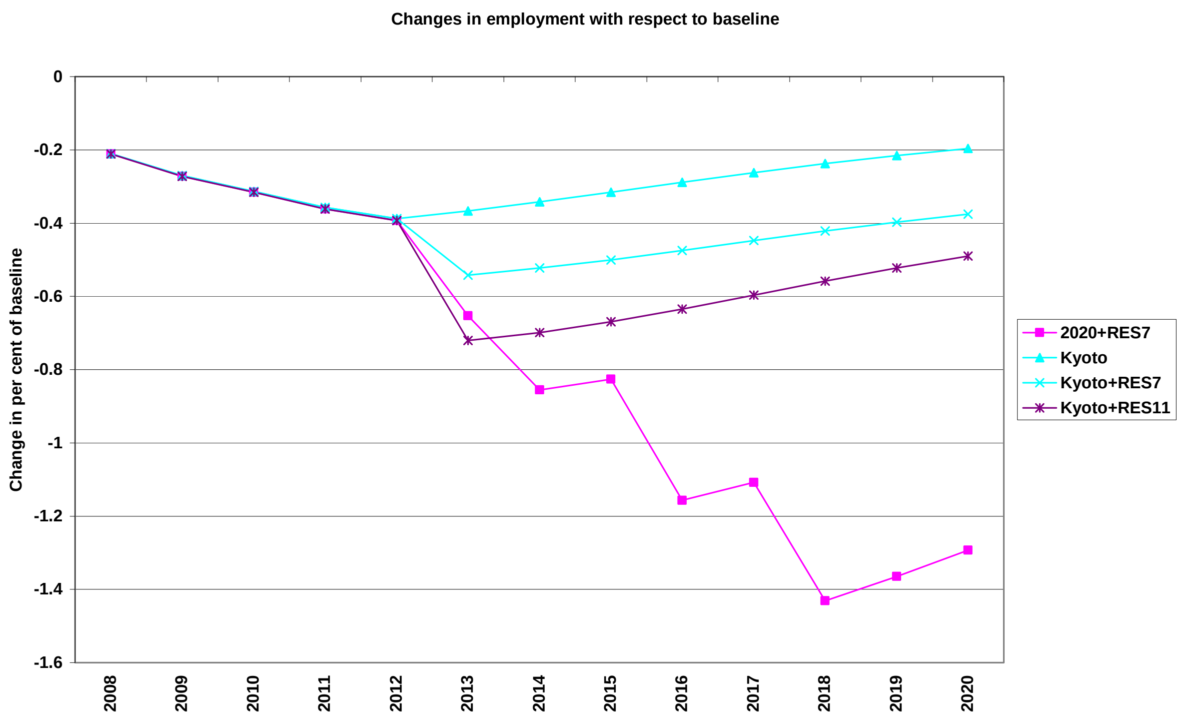


Figure 3. Effects on Employment

3.3. Effects on emissions and industries

The implementation of the 2020 target would put pressure on the structure of the economy. This is illustrated in figure 4, 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.

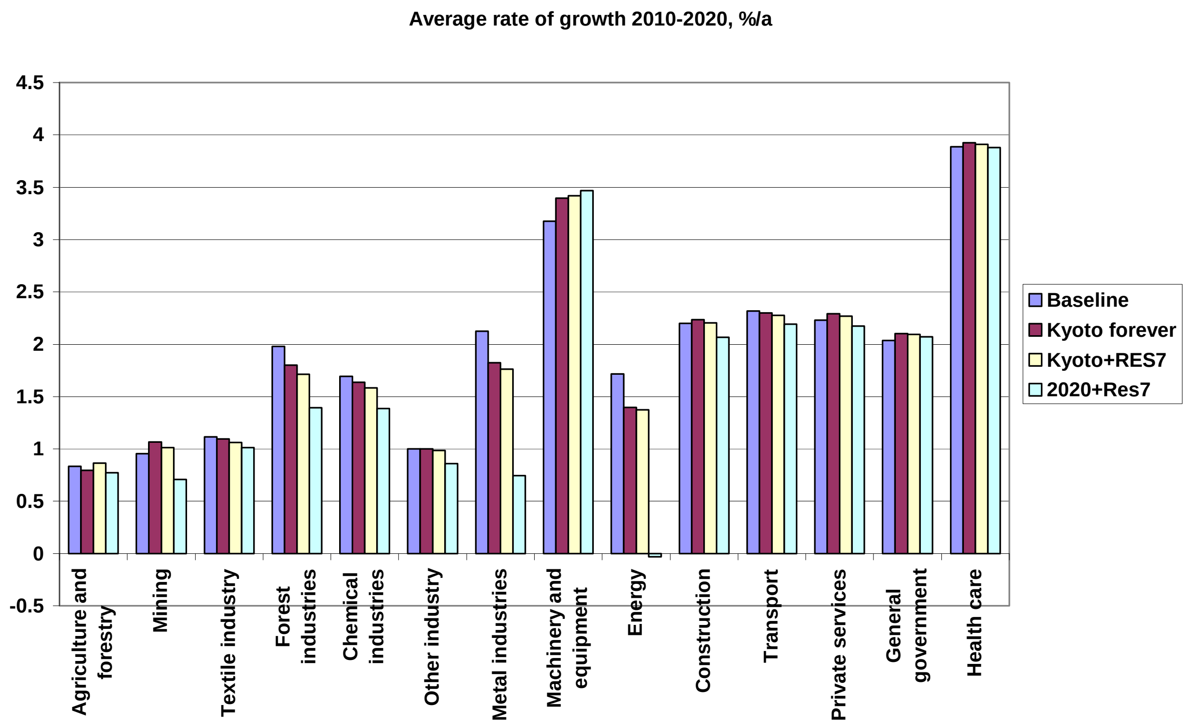


Figure 4 Effects on production in 2020

Figure 5 shows the effects of the policies on domestic emissions. The figure shows how emission targets and renewable energy targets affect emissions from domestic sources. From the figure it is clear, first of all, that emission trading will be necessary to reach even the Kyoto targets. When the Kyoto emission targets are combined with a 7 per cent increase of renewable energy share, domestic emissions are still above the 1990 levels. With an 11 per cent target, emissions are significantly lower, but as section 2 shows, the increase from 7 to 11 per cent can only be achieved by replacing light fuel oil entirely with imported biofuels. A similar result is obtained in the case of the 20 per cent GHG target for 2020. With domestically achievable increases in the share of renewables targets emission cut fall short of the 20 per cent target. Only with significant increases in imports of biofuels are these targets met.

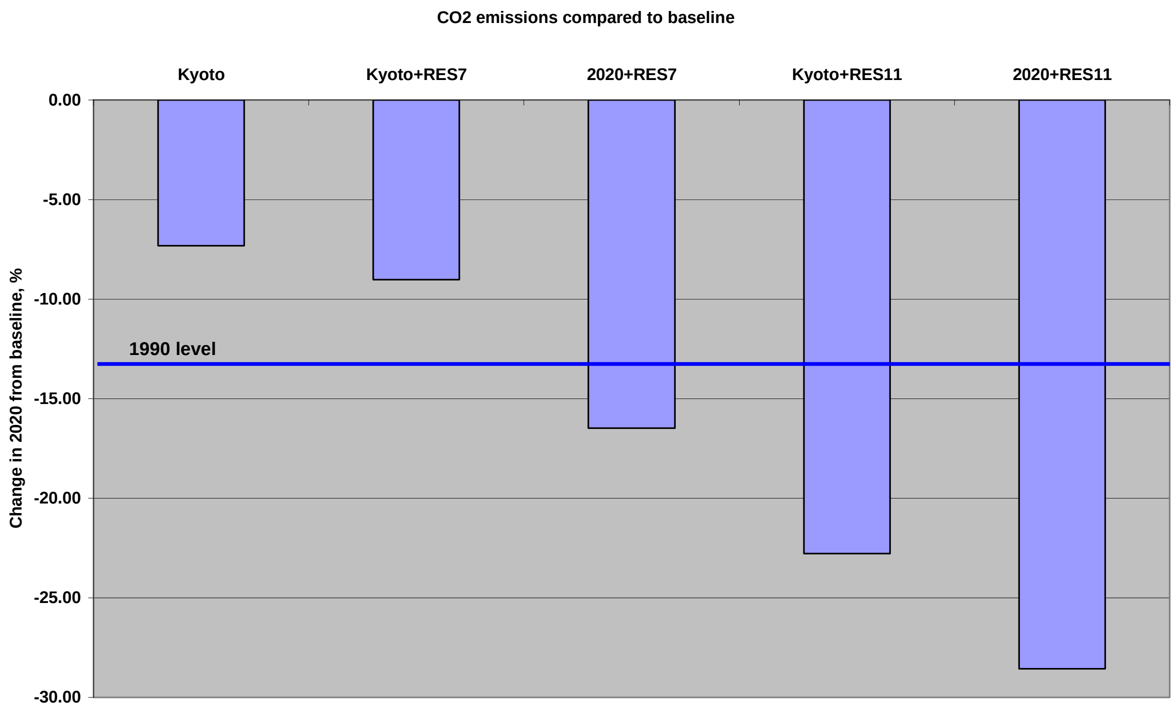
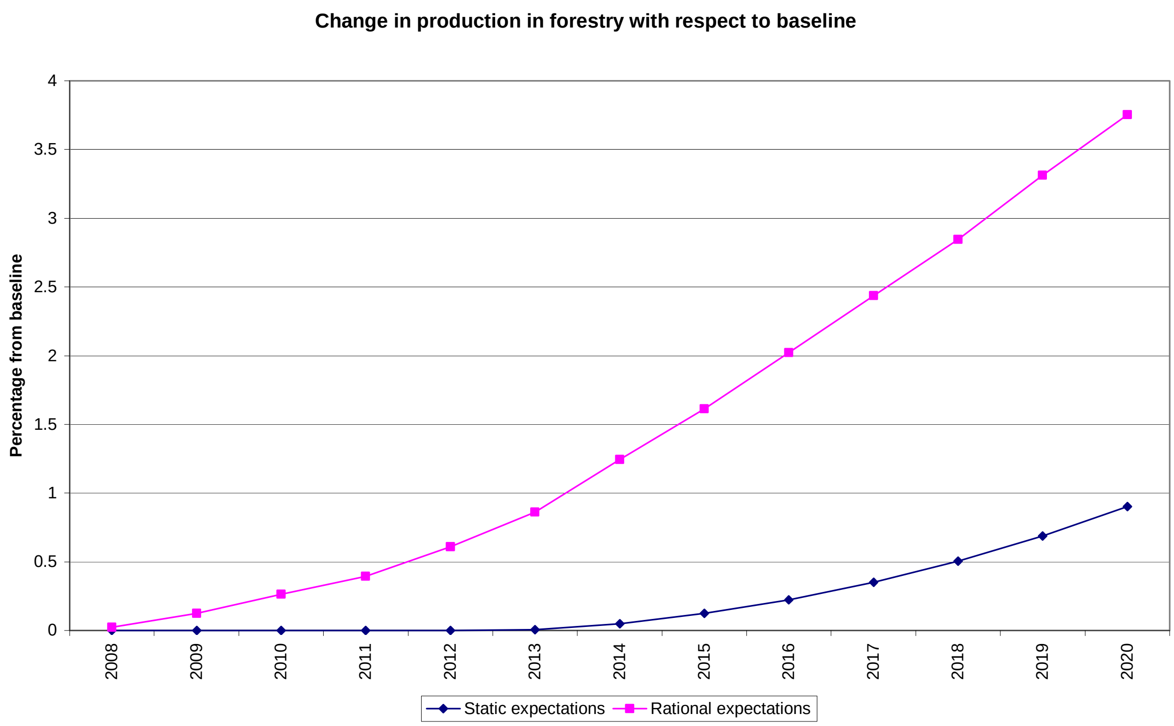


Figure 5 Effects on CO2 emissions

3.4 Announcement effects: the role of expectations

The previous section studied energy policy under the assumption of adaptive expectations. While the actual measures are not yet determined, nor is their timing, it is clear that many investors will react even to the news on future policies, provided that these policies are credibly committed to. The effect of the announcement of policies is then to spur reactions from the economy well in advance of the implementation of the policy. This may have large effects on the cost of the actual policies. we demonstrate this effect on the production of timber, which is likely to grow as a result of increased demand for wood for energy consumption. The demand for timber is affected by the subsidies considered above; however, the sector may well be able to increase its produtions if it learns that demand is growing in the future. Figure 6 below shows the difference in the production of timber, when expectations are static and when they are forward-looking.



4 Conclusions

This study has evaluated the long-run effects in Finland of inceasing the use renewable energy sources and of abatement of green house gases.

The share of renewable energy in Finland has been around 24 to 25 per cent of primary energy use, While the domestic sources of renewable energy are considerable, they rely heavily on the use of wood. Here, it is assumed that 80 million cubic metres of wood is available, which necessitates imports of 10 to 15 million cubic metres. The potential for increasing the use of domestic forest residue is also large, and forest residues could account for 22 TWh of energy (12 million cubic metres). 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.

The main result of the study is that while the use of wood can be increased, significant increases in the use of bioenergy is only possible with increased imports of biofuels and possibly of wood pellets or forest residue. By our calculations, not even the +7 % share of the renewables can be fulfilled by domestic resources.

The economic effects of increasing the share renewable energy sources by 7 percentage points impose a cost to the economy that is of the order of some 0.2 percentage points, if it is assumed that GHG emissions are kept at their Kyoto commitment level. With a larger, -20 per cent cut of GHG emissions, GDP is almost 1.6 per cent below baseline in 2020. This increases by another 0.1 percentage points if the tighter 11.5 per cent RES target is adopted.
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.

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.

Forsström, J – Honkatukia, J. (2002). EV-malli. Taloudellis-tekninen tasapainomalli Suomelle. C78, ETLA, Helsinki.

Perrels, A. – Rajala, R. – Honkatukia, J. (2005): Appraising the Socio-Economic of Climate Change in Finland. Working paper 342, Suomen ympäristökeskus, Helsinki.