Finnish Climate Change Strategy

Juha Honkatukia

Finland is about to join the few countries that have defined a climate change strategy. The Finnish government has just presented the strategy to the parliament, where it is to be debated. The strategy is based on extensive surveys of the current situation with respect to greenhouse gas emissions in Finland as well as the mitigation measures necessary for meeting the Kyoto target. The costs of GHG restrictions are evaluated for comprehensive programmes comprising abatement measures, economic instruments, and investments in both renewable energy and cleaner, conventional electricity generation. The costs of Kyoto in Finland turn out to depend crucially on the source of new electricity generation capacity and, to a lesser extent, on the comprehensiveness of economic measures used in the implementation of the emission reductions.

The Kyoto Protocol defines binding GHG reduction targets for developed countries and the transition countries of the former Soviet Union. The emission targets for individual EU countries are defined by the burden-sharing agreement of the European Union. Most of the EU countries are not expected to meet these targets without taking additional emission restriction measures. Yet only a few of the EU countries have prepared comprehensive strategies to meeting their targets to date.

The countries that have introduced Climate Change Strategies include Denmark, France, Luxembourg and the Netherlands. Strategies are also being prepared in the UK.

The Finnish target for GHG emissions is 1990 levels. Currently, Finnish CO_2 emissions meet this target, but this situation is unlikely to be sustained during the Kyoto commitment period 2008-2012 without further measures. There are several reasons for this. There has been a marked reduction of GHG emissions from new gases, which has contributed to the decline in overall GHG emissions during the 1990s, but is not likely to contribute to further reductions prior to the Kyoto commitment period. The demand for energy, particularly electricity, is also anticipated to increase, which, if met with the currently idle coal-fired generation capacity will lead to increased GHG emissions. Finally, unusually high imports of electricity have been contributing to the low level of emissions, but it is questionable whether imports can remain at their current level in the long run. Meeting this demand with other means will necessarily involve investments in new, cleaner generation capacity – such as renewable-based, gas-fired or nuclear – combined with energy saving measures in most sectors of the economy.

Presently, the draft of the Finnish climate change strategy combines the measures and investments in broad policy packages and evaluates their cost-effectiveness, enabling the government to define a definite strategy after a parliamentary survey of the pros and cons of the alternative packages. The draft strategy evaluates the policy packages by comparing them with a very detailed Business-As-Usual (BAU) scenario for the development of the Finnish economy. The effectiveness of various measures is studied both in terms of changes in energy-efficiency and in terms of tonnes of reduced emissions. The strategy also discusses certain key uncertainties that might affect the BAU scenario.

BUSINESS AS USUAL FOR FINLAND

Economic Growth

The draft climate change strategy takes as its starting point very detailed scenarios for the growth rates of production, productivity and energy efficiency. The growth scenarios span the next 25 years and are based on the fore-

casts of several Finnish research institutes as well as the views of various ministries. The scenarios' first years conform roughly to the medium-term forecasts of the Research Institute of the Finnish Economy; since no forecasts for a 25 year period are published, the scenarios take a fairly conservative view on development during the second and third decade of the new millennium. Since the policy analyses presented in the draft strategy focus on the Kyoto period, the assumptions concerning the latter period are probably fairly immaterial.

Up to 2010, current trends are broadly assumed to continue. Industrial production, on the whole, is projected to grow at the rather brisk average annual rate of 3.3 per cent between 2000 and 2010. There are great differences between industries, however. For example, the regional concentration of the population towards growth centres is expected to continue, resulting in strong demand for construction and a decline in rural activities.

The most rapid growth is expected to take place in the manufacture of electronics and electrical goods, where the annual growth rate is placed at some 7-8 per cent. Most of this growth is due to telecommunications technology manufacturing. The output of other metal products will also increase at a rapid pace – explained by electrical equipment, shipyards and also energy technology. There has been some concern about the lack of skilled labour in these sectors, but thus far these concerns have failed to materialise and are unlikely to do so in the baseline scenario.

Basic metal industries are expected to grow by 2.5 per cent annually up to 2010, after which growth is projected to decelerate.

Growth is expected to be more moderate in the paper industry but to remain close to 2 per cent annually up to 2010 nevertheless. The chemical industry is projected to grow almost as fast, driven by demand from the paper industry. Growth in the rest of the industry is expected to be more moderate, ranging from the practical slump projected for oil refining to the average annual rate of 1 per cent for food industries.

Services, on the other hand, are projected to grow fast, led by telecommunications at an annual rate of 6 per cent. Transport services, housing and other private services are also projected to display rapid growth, with output increasing at an average annual rate closer to 3 per cent. Public services are projected to grow moderately for the first few years of the millennium, but growth is assumed to pick up thereafter as a result of growing demand for services in response to the ageing of the population.

Some sectors of the economy will not expand at all, according to the projections. Agriculture is projected to display a growth rate of -0.6 per cent annually and mining and quarrying is also projected to remain stagnant. Forestry, on the other hand, is expected to continue growing at almost 2 per cent annually.

Labour Force and Productivity

The size of the labour force is currently probably close to its peak. However, the participation rate, which declined in the aftermath of the early 1990s recession, is still low. As a result, there is a strong potential for employment to grow over the next decades, despite the ageing of the population. The overall economy is not expected to bottlenecks due to any shortage of labour, if productivity growth continues at present rate. However, the supply of skilled workers may become stretched in the fast-growing high-tech industries.

Energy and Emission Policies in the Rest of the World

The baseline scenario for world energy prices is based on the IEA World Energy Outlook 2000. The prices of crude oil and natural gas are assumed to grow slightly faster than in the IEA forecasts, reflecting growing demand. The price of electricity is also expected to rise. While these assumptions partly reflect an expectation that climate change policies in the rest of the world will affect energy prices, the baseline prices are not altered in the policy evaluation.

Technological Change and Energy Efficiency

The potential for improving energy efficiency in different sectors of the economy has been evaluated by the respective sector ministries. The Ministry of Trade and Industry has reviewed the industry, construction and energy sectors, as well as the demand for energy by services and

households. The Ministry of Environment has studied housing, urban planning and waste management. The Ministry of Transportation has evaluated the transport sectors. Finally, the Ministry of Agriculture has reviewed forestry and agriculture. The basic assumptions in the review work have been based on the baseline scenario for economic growth and population growth, but existing national strategies and EU directives that are already in place have been taken into account.

Technological change is assumed to continue trend growth in most of the sectors. Broadly, average fuel efficiency is taken to increase by slightly less than 2 per cent per year up to the year 2010 in most sectors of the economy. Traffic and energy sectors make an exception. In the transportation sectors, the voluntary agreement between the European Union and car manufacturers is supposed to lower average fuel consumption by close to 40 per cent. Consequently, there will be a marked improvement in the average fuel consumption of passenger cars in Finland as well – even though the average age of the stock of passenger cars in Finland is currently approximately 10 years. In the energy sectors, fuel efficiency is not expected to grow by much, but technology is expected to favour electricity generation in combined heat and power (CHP) plants, which will tend to increase the efficiency of heat and power generation as a whole.

Energy efficiency in housing is expected to improve as a consequence of tighter requirements for new houses. EU directives on electric appliances are assumed to lower the specific consumption of electricity. Existing energy saving agreements between the state and industry and municipalities are also assumed to be effective.

The supply of electricity in the baseline scenario is, to a large extent, based on existing capacity. The aggregate consumption of electricity in 2010 is forecast to grow to 85 TWh, up 7 per cent from 80 TWh in 2000. The potential for increased hydropower remains limited at its current level of 13 TWh for environmental reasons. Nuclear power is not assumed to increase from the present level of approximately 22 TWh either. However, electricity supply from industrial CHP is expected to increase as a result of technological change, as is supply from district heating CHP plants, which in the south of the country are expected to switch from coal to natural gas. The construction of wind power is expected to continue at the rapid pace of 10 per cent a year up to 2020, providing 0.4 TWh of electricity by the year 2010. Imports of electricity have been high for the past half a decade, with 6 TWh being imported from Sweden and Norway and 5 TWh from Russia in 1999. It is considered unlikely that this high a level can be maintained in the future. There are two reasons for this. Demand for electricity is anticipated to grow in the neighbouring countries. The latter part of the 1990s was also unusually rainy, which contributed to exceptionally high hydro-power generation in Norway and Sweden. Thus, much of the supply of electricity has to be provided by domestic condensation plants. Most of this capacity is already in place, but has been little used during the past years because of the availability of inexpensive imported electricity. In 2010, condensation plants are projected to generate 19 TWh. Close to three quarters of this generation will stem from current coal-fired plants, one TWh from peat-fired plants, and almost half of the remainder will come from current and another half from new natural gas-burning plants. The use of renewables is expected to grow significantly as a result of current policies, but most of this growth will take place in CHP plants and is either directly or indirectly connected to growth in the forest industries.

Emissions in the Baseline Scenario

The Kyoto commitment is not met in the baseline scenario. Emissions from fossil fuels are expected to be close to 70 Mt of CO_2 in 2010, whereas the Finnish commitment level, if reached by CO_2 reductions alone, would be 54 Mt of CO_2. The baseline thus anticipates a significant need for further measures.

Policies to Reach the Emission Target

The draft climate change strategy combines additional GHG reduction measures in two broad programmes. These are the energy conservation programme and the programme for renewable energy sources. While these programmes are by themselves not sufficient for meeting the reduction commitment, they are assumed to be part of the overall policies in all cases.

Energy Saving

The energy conservation programme consists of measures in all sectors of the economy. In traffic, it is estimated that fuel efficiency can be increased by 2 per cent by additional vehicle tax measures, which could take the form of creating a connection between fuel consumption and motor vehicle taxes. In heavy traffic, energy saving agreements are also expected to provide some additional fuel conservation potential. The most significant potential, however, is estimated to stem from the housing sector and from electricity consumption. By introducing stricter energy efficiency requirements, new and refurbished older houses are expected to become significantly more energy efficient than most of current houses. Because of the slow turnover of the housing stock, stricter requirements will provide an increase of only a few percentage points in the average fuel efficiency of housing by 2010, but the effect will increase over time. Within service sectors, energy saving agreements are expected to contribute importantly to energy savings as well. To further decrease the growth of electricity consumption, insulation requirements could be made stricter for new installations of electric heating. It is also estimated that the efficiency of electric appliances could be increased by stricter norms, both in household applications and, more significantly, in the service sector. The combined effects on energy efficiency of the energy saving programme are presented in the table below.

Energy Saving Programme

	Efficiency gain by 2000, %	Cost 2010 Mill. FIM/a
Fuel consumption in traffic	4	0
Electric heating	11	314
Other heating	9	0
Household electricity consumption	2	101
Services' electricity consumption	3	89
Industrial electricity consumption	1	99
Industrial fuel consumption	0.40	471

Renewable Energy

There is already a national programme for encouraging the use of renewable energy. This programme takes the form of promoting investments in renewable energy sources by granting them subsidies and tax exemptions. These subsidies are especially important for investments in wind power. Renewable fuels are indirectly promoted by the current energy taxation, which exempts them from the carbon tax. They are, furthermore, promoted by a refund of the electricity tax, when used for electricity generation. This double tax redemption has already showed up in increased use of wood, much at the expense of peat. However, with current combustion technologies, the emissions of other GHGs from the burning of wood are reduced if peat is mixed with wood. Thus, it is unlikely that wood will completely replace peat. There are also other limits to the extent to which wood use can be increased. Currently, much of the use of wood as a fuel is based on the availability of wood waste from the forest industries. Thus, increases in wood fuel's use are dependent on the growth of the forest industries. Logging for fuel purposes could put wood fuels in direct competition with the forest industries. Altogether, the growth potential for wood-based CHP is estimated to be 15 per cent, and the potential for wood-based heat generation 75 per cent from current levels. The combined growth potential of hydro- and wind power are estimated to be 15 per cent by 2010. The targets of the renewable energy programme are summarised in the table below.

Targets of the Renewable Energy Programme

	Increase, %	Subsidies by 2010
Wood CHP	15	240
Wood district heating	75	400
Wind and water	15	1400

Two Energy Strategies

Increased energy saving and further use of renewable energy sources are not expected to suffice in meeting the emission target. Thus they

are to be combined with increases in energy taxes. One of the findings of the evaluation process was, however, that a proposed doubling of current surtaxes on electricity, combined with a 75 % increase in carbon dioxide taxes – currently 102 FIM per tonne – and a significant increase in other fuel taxes would not induce a sufficient reduction of emissions. It was estimated that there would be a need to replace – or displace – coal in electricity generation and to an extent also in heat generation, that is, both in condensation and CHP plants. This could take place by significantly increased use of natural gas or by building a new nuclear plant. Since these are major undertakings that would also affect the need for economic measures and involve a political decision – licensing nuclear plants requires a parliamentary decision in Finland – the strategy draft recognises and considers two alternative ways to proceed. Economic measures are considered separately for each of these cases. Finally, the climate strategy report also recognises that changes in energy taxes will have an effect on tax revenue and income distribution. Since the strategy is intended to be revenue-neutral, several recycling possibilities were considered. It was also studied whether the target could be met without raising fuel taxes, mainly because these would hit the sparsely populated areas harder than urbanised areas and thus have adverse effects on regional income distribution. Finally, a command-and-control alternative was studied where energy taxes would not be raised at all but efficiency requirements and investment subsidies would be used instead. In this case, the policies would be revenue-losing and would have to be financed by raising other taxes.

Evaluation of the Costs of the Climate Change Strategy

ETLA collaborated with the Technical Research Centre of Finland (VTT) to evaluate the economic effects of the climate change strategies. The study, commissioned by the Ministry of Trade and Industry, utilised a computable general equilibrium model of the Finnish economy to simulate the policy packages. The model combines a top-down description of the economy with a bottom-up approach to power generation, and also contains a bottom-up description of the key energy-intensive sectors. This facilitated the introduction of technology-specific scenarios of both the baseline scenario and the "with-measures" alternatives.

A major part of the evaluation was the simulation analysis of the extent to which energy taxes would have to be raised to reach the emission target. These were calculated for both the natural gas and the nuclear strategies separately. The target emission level was about 22 per cent below the baseline level. Revenue recycling alternatives were also studied, ranging from lump-sum transfers to reductions of employers' social security contributions and income taxes.

The basic findings of the study were that the energy conservation programme and the renewable energy programme would not, even when combined with the proposed energy tax increases, suffice to bring emissions down to their 1990 level. When combined with new natural gas-based generation capacity and a phasing out of coal-based condensation plants, the target would, however, be reached and, in fact, be slightly overshot. If electricity generation capacity were based on a new nuclear plant, the target would not only be met, but significantly overshot. Therefore, the proposed energy tax increases would not be necessary if new generation capacity were to emerge, as assumed in the programmes. In the case of natural gas, the necessary taxes would be 10 to 20 per cent lower, whereas in the case of a nuclear plant, taxes 30 to 40 per cent lower than in the original proposal would suffice.

Reaching the target would nevertheless impose a cost on the economy. In the natural-gas case, the cost would be 0.5 to 0.7 per cent of 2010 GDP if energy taxes were to be used, and would be more than one per cent of the GDP if command-and-control policies were to be used. In the nuclear option, GDP losses would be 0.2 to 0.5 per cent of GDP with energy tax increases and 0.7 per cent without them. Thus the nuclear option would be cheaper in terms of GDP regardless of other policies. The reason for this is that electricity generation would take up less of the emission quota in the nuclear option and would not necessitate as severe reductions in other sectors, which would thus not face as high abatement costs as in the natural gas option. In both cases, the lowest costs would, however, be obtained without raising the motor fuel taxes. This reflects the baseline

assumption of high fuel efficiency improvements – further increases would be difficult to obtain. The costs are also marginally lower when combined with recycling via social security payments and income taxes. The effect is small because the increase in energy tax revenue is modest in comparison to the revenue from the other sources – the scope for a "green tax reform" would be modest.

From the point of view of consumers, the differences between the natural gas and the nuclear option are larger. In the natural gas option, consumption demand would be 0.9-1.4 per cent lower than baseline, whereas it would be 0.4-0.9 per cent lower in the nuclear case. Consumption would decrease more if motor fuel taxes are raised, which is explained by the fact that most of the incidence of these taxes is on consumers. Revenue recycling via lowering social security payments and income taxes, benefit consumers, and employment is also improved by these measures. While the effects are small, they are interesting in so far as they point to a weak double dividend.

The macroeconomic results of the background study are presented in the table below.

The effects on industry are very straightforward. Production decreases in energy-intensive industries, as does employment, and increases in labour-intensive industries. The hardest-hit industries are the basic metal, chemical and paper industries. There is a clear difference between the natural gas and nuclear alternatives, with clearly smaller effects in the latter case.

On the whole, the cost estimates in the background report are lower than in many previous studies. On the other hand, ETLA estimated earlier that costs could be even lower in the nuclear option. The background report's estimates can be regarded as more accurate than those of previous studies, at least in the sense that they are based on the latest available data, which contain more information about the change in Finnish energy structure than was previously available. During the 1990s, there was a significant drop in the use of coal, which studies like Honkatukia (2000) were unable to take into account due to the unavailability of data. There was also a very significant increase in the production of non-energy intensive electronics industries. However, it is likely that many of the baseline assumptions also contribute to the low cost estimates. The baseline growth rates of energy-intensive industries are conservative, and Finnish industries have already pointed out that significantly higher growth seems likely in the light of existing investment decisions. Higher growth would raise baseline emissions and make abatement more costly. There has also been concern about the baseline assumptions about the availability and price of gas. If natural gas were to be more expensive, it is unlikely that there would be much private investment in new gas-fired capacity in the deregulated energy markets. In fact, the economic incentives in the draft strategy are estimated to be insufficient for inducing private investment in natural gas-based capacity, unless connected with CAC-policies directly restricting coal-fired generation. This, in turn, raises

Abatement Costs in a Representative Case

	Natural gas, all energy taxes increased	Nuclear, all energy taxes increased	Natural gas, motor fuel taxes not raised	Nuclear, motor fuel taxes not increased	Natural gas, no tax increases	Nuclear, no tax increases
GDP	-0.57	-0.35	-0.46	-0.23	-1.4	-0.72
Private consumption	-1.05	-0.68	-0.84	-0.43	-1.41	-0.89
Investment	-0.28	-0.09	-0.28	-0.09	-4.87	-1.91
Employment	-0.35	-0.17	-0.24	-0.1	-0.31	-0.48
Imports	-0.55	-0.92	-0.21	-0.64	-0.82	-1.25
Exports	-0.27	-0.51	-0.18	-0.39	-0.57	-1

further questions concerning stranded costs, which are not dealt with in the background study.

Conclusion

The background study for Finnish climate change strategy is based on a comprehensive review of emissions and abatement possibilities in the Finnish economy. It aims at giving a realistic base for the political debate on the strategy. Thus it gives a cautious view of baseline growth in the economy. On the other hand, if the study is conservative in its assumptions about economic growth, it is reserved also in its assumptions about most technological possibilities and the availability of energy imports. The report also recognises the many uncertainties that exist concerning its basic assumptions.

The economic cost estimates in the background study are based on independent evaluations computed by ETLA and VTT on the one hand, and the Government Centre for Economic Research (VATT) and VTT on the other. These estimates are based on different methodologies, with ETLA and VTT utilising an integrated technological-economic CGE-model, and VATT and VTT using an econometric macroeconomic model iteratively with a bottom-up model. The two studies obtain very similar results, and thus there is little doubt about the overall sensibility of the cost estimates.

The main findings of the studies are very clear. The nuclear option is clearly cheaper than the natural gas option in both macroeconomic terms (GDP and private consumption) as well as at the industry level. Thus the decision on future electricity supply is decisive for climate change policy as well. The second important finding is that a strategy comprising economic measures is significantly cheaper than a strategy relying on CAC policies. And finally, it appears that raising motor fuel taxes is undesirable, if vehicle fuel efficiency is raised already in the baseline.

References

Forsström, J. and Honkatukia, J. (2001): The Costs of Finnish Climate Change Strategies, from the forthcoming ETLA Discussion Paper.

Gielen, D.J. & Koutstaal, P.R. & Kram, T. & van Rooijen, S.N.M. (1998): Post-Kyoto. Effects on the Climate Policy of the European Union, ECN, June 1998.

Honkatukia, J. (2000): The Effects of Abatement Policies on the Finnish Economy, in Pirilä Pekka (ed.) (2000): Climate Change, Edita, Helsinki.

EU COM (2000) 749: Report for a Monitoring Mechanism of Community Greenhouse Gas Emissions.

IEA (2000): World Energy Outlook.

Pirilä, Pekka (ed.) (2000): Climate Change, Edita, Helsinki.