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Perspectives into topical issues in society and ways to support political decision making.

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Cost-effectiveness of transport emission reduction measures

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The purpose of the project was to produce a generally usable systematic methodological framework and recommendations on the coverage and assessment of the economic impacts of transport emission reduction measures. The results include models and guidelines for passenger and freight transport that are suitable for a comprehensive evaluation of the cost-effectiveness of climate policy measures in the transport sector. The usability of the calculation models has been tested by applying them to the cost-effectiveness assessment of possible emission reduction policy measures.

Assessment of transport emission reduction measures

In 2020, greenhouse gas emissions from transport accounted for one-fifth of Finland's total emissions, around 10.5 million tonnes of carbon dioxide. Of this, 95 % was caused by road transport, and within road transport, passenger cars account for more than half, lorries for about a third, vans for about 10 % and buses for about 5 %. In 2021, the Government approved a roadmap for fossil-free transport, according to which carbon dioxide emissions from transport should be halved by 2030 and completely eliminated by 2045. The national transport system plan, on the other hand, sets the objective of mitigating climate change, improving the possibilities of choosing sustainable transport modes, ensuring the accessibility of the whole of Finland and improving the socio-economic efficiency of the transport system.

Choosing cost-effective emission reduction measures is important

Transport is essential for the well-being of people and the operation of businesses, but at the same time inevitably causes harmful externalities that citizens and businesses will not take into account in their transport choices unless the externalities are made visible. The target-based benefit-cost analysis of societal decision-making that reduces emissions must be based on a comprehensive assessment of public intervention costs and the negative and positive cost impacts faced by consumers, businesses and the public sector. Comprehensive economic considerations also help to determine the correct sizing and effective targeting of public interventions.

Previous impact assessments have been incomplete

A key objective of the roadmap for fossil-free transport has been to plan and select actions that are as cost-effective as possible, but the cost impact assessments of the measures have not been in line with the scientific literature and the recommendations of the Finnish Climate Panel. The summary of the assessment of the roadmap for fossil-free transport presents quantitative estimates of the emission reductions of the measures in 2030 and the cumulative costs to the state by 2030, as well as verbal estimates of the costs to municipalities, businesses and households. Based on quantitative data, a €/t of CO_2 emission reduction cost-effectiveness estimate is presented for some of the measures. But those are incorrect in two ways in relation to the Finnish Climate Panel's recommendations: 1) the emissions reduction effect is only the 2030 emissions reduction, and not the cumulative reduction, 2) the cost impact includes only the direct public sector costs (subsidies and tax changes) and no cumulative economic impact on households and businesses.

The project developed tools for a comprehensive assessment of cost effects

The purpose of the project was to produce a generally usable systematic methodological framework and recommendations on the coverage and assessment of the economic impacts of transport emission reduction measures. The end result of the project was to create models for calculating passenger and freight traffic suitable for a comprehensive examination of the cost impacts and cost-effectiveness of climate policy measures in the transport sector, as well as guidelines for performing the calculations and comparing measures. The functionality of the calculation models has been tested by applying them to the evaluation of the cost impacts of possible policy measures to reduce emissions.

Research material and methods

The tools created in previous studies by the Finnish Climate Panel (Liimatainen et al. 2015) and Transport Research Centre Verne (Viri et al. 2021) were further developed. In the project, the tools were updated and methods for assessing the economic impact were developed on them. The basis for the methodological development was a literature study looking into both the initial data used in the calculation, such as the costs, benefits and emission impact assessments of transport emission reduction measures, as well as the calculation principles, for example the terms of the allocation and limitations of benefits and costs. The usability of the methodological framework developed in the study was assessed in a stakeholder workshop.

Implementation of the principles of cost-effectiveness assessment in the developed tools

Based on the research literature, cost analyses of measures to reduce emissions are carried out in different sectors at very different scales. There is no normative recommendation in the literature on the scope of the analysis that would be the most optimal for benefit-cost considerations of reducing transport emissions. As such, the research topic is broad, as the transport sector is a very important part of the national economy. It is a key sector in the energy market and the services it provides affect the success of other industries as well. The road transport sector also generates a number of externalities. In addition to reducing greenhouse gas emissions, the development of mobility and transport services and transport infrastructure involve, among other things, changes in the quality of the air we breathe, noise, congestion and traffic accidents. Reducing greenhouse gas emissions through different methods of implementation also has different effects on these externalities. The models that have been developed in this study look at changes in direct vehicle costs in transport. External costs, such as the health costs or benefits, are not addressed. An exception is the unit cost of CO_2 emissions, which is taken into account as a benefit item in the calculations.

The tools developed enable evaluation of cost changes from the perspectives of households, businesses and public finances

The models developed in the project focus on the internal impacts of the transport sector and are best suited for assessing the impact of a single measure with wide-ranging effects. Such measures include, for example, emissions trading and tax changes and changes in the biofuel distribution obligation. However, the model is also suitable for assessing the impact of limited measures, such as subsidies for the purchase of new cars that have been in use for a few years. The calculation of the passenger transport tool is done from the point of view of households and the calculation of truck traffic from the point of view of transport companies, but both calculations also distinguish various tax components. Thus, the tools make it possible to examine the allocation of cost changes by measures between households, businesses and the public sector.

The modelling behind decision-making contains a lot of uncertainties. For example, the present value of alternative propulsion investments is influenced by uncertainty about the elasticities that model the behaviour of consumers and companies, uncertain trajectories of different fuel prices, and uncertainties related to the discount rate. In this case, the studies may rely on sensitivity analyses to test the effects of changes in exogenous values on the results. The tools make it possible to manage uncertainties related to cost uncertainties with the simple formation of scenarios with different assumptions. Future cost changes are discounted to the present and the discount rate can be freely changed.

The developed tools guide the user to consider how actors adapt to the changing operating environment

The method of calculating the cost impacts of measures to reduce emissions depends on the scope of the asesssment. The literature does not provide an unambiguous recommendation for the scope or method of the review. Different methods have their own advantages and limitations, as the modeling of each method requires different assumptions of the object of study to be made. The tools developed in this study make it possible to assess the impact of both wide-ranging and limited measures. The assessment of the effects of large-scale measures has often been a mechanistic calculation based on price elasticities of transport performance. The tool also enables this, but guides the user to consider thoroughly, which impact mechanisms occur in the transport system, i.e. what ways actors use to adapt to the changing operating environment. The results of the tools can be used as input data for macroeconomic models.

Example calculations

Emissions trading in road transport

As the first calculation example, the effects of the EU emissions trading scheme for road transport on emissions and costs of passenger transport in Finland are examined. The EU is about to start emissions trading in road transport in 2027, and emissions trading is estimated to increase fossil fuel prices by 7–8 %. Based on this, an increase of 13 cents/l is estimated as a change in energy taxes for petrol and an increase of 14 cents/l for diesel from 2027 onwards, which will have a direct impact on the price of fuel. From the results of the passenger transport calculation tool developed in the project, it is estimated that emissions trading scenario will achieve CO_2 emission reductions of 0.29 megatonnes between 2022 and 2030 compared to the baseline scenario, but at the same time the total costs increase by approximately EUR 0.29 billion (in the present value of 2022), which means that the cost-effectiveness of the measure with taxes and subsidies will be EUR 1 028 per tonne of CO_2 emissions reduced and 293 €/t without taxes and subsidies. The total costs are increased by the impact of emissions trading, which leads to behavioural changes in the model, the reduction in emissions and vehicle taxes and energy costs, on the one hand, and the increase in the cost of purchasing cars, on the other hand. A significant impact will be the more efficient use of the car fleet, as expensive fuel prices will steer users more and more to electric and plug-in hybrid cars from 2027 onwards. In the emissions trading scenario, there will be 49,126 electric cars more in the fleet in 2030 and 28,359 plug-in hybrids more than in the baseline scenario.

In terms of freight transport, the rising energy price due to emissions trading in road transport will lead to an improvement in the efficiency of road freight transport and possibly to a modal shift in the calculation tool developed in the project. However, these changes are not sufficient to prevent a significant increase in freight transport costs. In 2030, according to the calculation model, the tax-free energy costs of transport companies will be 21 million € lower, but energy taxes 70 million € higher than without emissions trading. The total cumulative freight transport costs for 2023–2030 are 144 million € higher than in the baseline scenario and the cumulative emission reductions are 0.09 Mt, so the cost-effectiveness of the measure per tonne of emissions reduced is 1 583 € with taxes and subsidies and -1 068 €/t without.

> ***The cost-effectiveness of emissions trading in road transport is low, and it is very important to pursue a modal shift before the start of emissions trading.***

The freight calculation tool models that the efficiency of freight transport will improve gradually from 2023 onwards, even though emissions trading will not affect the price of fossil diesel until 2027. This can be interpreted as modelling the possibility for companies to adapt in advance to cost increases when a regulatory change is known. If it is possible to adapt to emissions trading with a modal shift from road transport to rail and water transport, and the transition is started gradually already from 2023, the cumulative total costs of freight transport will even decrease and the overall impact of the measure will be positive for the economy, with a cost-effectiveness value, with taxes and subsidies, of -382 €/t and -1 208 without. The sensitivity analysis shows the great importance of long-term and predictable climate policy for the cost-effectiveness of transport emission reductions.

Subsidy for the purchase of electric vehicles

The subsidy under consideration is similar to the one that has been in use in recent years, i.e. 2000 € per new electric car. The effects for a subsidy in place in 2024 and 2025 are calculated. As with previous electric car subsidies, the practice of not receiving subsidy for a car with a price over 50,000 € is applied here. The subsidy increases electric car registrations only slightly and its cost-effectiveness is very low (10 938 €/t with taxes and subsidies, 743 €/t without). There is a slight increase in the passenger car mileage compared to the base scenario, due to the fact that the slightly larger number of electric cars slightly lowers driving costs, and thus, with price elasticity, the demand for car use increases slightly. Despite this small increase in performance, emissions will decrease slightly because there are slightly more electric cars in the car fleet.

Cost-effectiveness is weak due to the fact that in the base scenario approximately 40,000 electric cars will be sold during 2024–2025, and with the help of the subsidy, the number will increase by only 3542 cars, and correspondingly, the share of plug-in hybrids in the subsidy scenario will also decrease by 1785 cars, since those previously chose a plug-in hybrid will end up with an electric car sooner. However, it is estimated that a significant purchase subsidy of 64.52 million € (59.19 million € in 2022 present value) will be paid for these 3542 additional electric cars, as the subsidy will also be paid for the 40,000 electric cars that would have been sold in the base scenario anyway, which will significantly increase the costs of the subsidy. The subsidy cannot therefore be seen as useful in a situation where sales of new electric cars on the market are already at a fairly high level, as the subsidy cannot be targeted only at those 3542 users whose choice of propulsion is affected by the subsidy.

Summary

The following table summarizes the solutions of the project's methodological framework with the principles defined by the Finnish Climate Panel (Ollikainen et al. 2016):

Principles in stages of assessment	Project's methodological framework's solution
Predicting emissions: Predicting the baseline of emissions is essential. A base scenario means development without policy measures.	In passenger and freight transport calculation models, the impacts of the measures are compared with base scenarios, which have been formed by taking into account the policy measures taken, such as the obligation to distribute biofuels, as well as previous projections of, for example, economic and demographic development and transport performance.
Sector-specific measures:The aim is to create a sector-specific model that produces total cost and marginal cost functions in terms of emission reductions, but at least the €/t cost-effectiveness of the measures. Costs are presented excluding taxes and subsidies. Sensitivity analyses are necessary.	The calculation models produce the €/t number for the cost-effectiveness of the measures and the key indicators for passenger and freight transport behind these, which are presented separately from taxes and subsidies. The models also make it possible to carry out sensitivity analyses by changing the initial data and assumptions of the calculation, such as elasticities.
Evaluation of steering instruments: In price control, it is important to assess how the actors react to the steering instrument. The effects of the instruments on the public finances should be assessed.	The actors' response to the steering instruments has been implemented in the calculation models with elasticities based on previous research. The values of elasticity should be viewed critically, as they are not based on Finnish studies, and there is not yet studies on the flexibility of freight transport in which the cross-elasticities of electric trucks in terms of the price of diesel could have been studied. The budgetary effects for the public sector through taxes and investments are included in the calculation model.
Selection of measures: In an ideal situation, affordability is determined by the marginal cost burden, or according to the €/t data. The measures must be in line with the long-term (2050) emissions reduction path.	The calculation models produce €/t cost-effectiveness numbers on the basis of which emission reduction measures can be selected. The freight transport model extends until 2050, and the passenger transport model can be expanded until 2040.
Adequacy and overall effectiveness of measures: The macroeconomic impact of the programme as a whole can be quantified by a macroeconomic model, but this is not a substitute for the analysis of sector-specific costs.	The cost changes produced by the calculation models in different scenarios can be utilised as source data in the assessment of macroeconomic impacts.

Social acceptability: Sector-specific reviews can provide accurate information on social resources in different sectors.	The calculation model for passenger transport produces data on the effects of measures on transport costs in different income brackets and regional divisions. This information can be used, for example, to conduct interviews or surveys in which social acceptability can be investigated.

The calculation example for electric car subsidy is indicative of a detailed analysis that has been difficult to assess using previous methods. The calculation models developend in this study also implement the principles of assessing the impact of measures presented in the international and domestic literature. The tools developed in the project are thus a significant development step in the overall economic assessment of the dimensions of the transport emissions reduction measures. In the future, the developed tools are recommended to be used as a tool for assessing the cost-effectiveness of transport emission reduction measures.

Further reading

Liimatainen, H., Nykänen, L., Rantala, T., Rehuen, A., Ristimäki, M., Strandell, A., & Ollikainen, M. (2015). Need, habits, technology and economic–climate change mitigation measures in transport. Finnish Climate Panel. https://www.ilmastopaneeli.fi/wp-content/uploads/2018/11/Abstract_Need-habits-technology-and-economy-%E2%80%93-climate-change-mitigation-measures-in-transport.pdf

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Viri, R., Mäkinen, J. & Liimatainen, H. (2021). Modelling car fleet renewal in Finland: A model and development speed-based scenarios. Transport Policy, 112, pp. 63-79. https://www.sciencedirect.com/science/article/pii/S0967070X21002432

Further information:

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Government's analysis, assessment and research activities

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