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Combinations of policy instruments to decrease the climate impacts of housing, personal transport and food

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Abstract

Policy instruments and measures already target the global warming impacts of housing and transport in many countries, although instruments not being originally developed for the purpose. However, the challenge of climate change calls for better and more innovative instruments that address consumption across the entire product life cycle, recognize the links between different consumption sectors, and identify and strengthen synergies between the various policy instruments. In the present study, existing policy instruments in Finland targeting housing, passenger traffic and food were evaluated, and were shown to have large impacts on greenhouse-gas emissions. Then packages of instruments were developed to more effectively mitigate the climate impacts of private consumption. During the composition of the policy packages special attention was given to the minimisation of negative interference between instruments and to enhancement of synergies and complementary effects. The potential impacts of the policy packages on the greenhouse gas emissions of private consumption were assessed. By 2020, the emission reduction in housing and passenger traffic was estimated to be more than 4 million tonnes (Mt), which is significant compared with Finland's total emissions of 70 Mt and emission reduction targets. The emission reduction of policy instruments associated with food was estimated to be 0.3 - 0.5 Mt. The assessment of the policy packages showed that the efficiency of the measures can be increased. When a set of instruments is examined as a whole, the synergy benefits between measures can be reinforced and hence overall effectiveness can be improved. In practice, this would require improved co-operation in the state administration. This could be facilitated through common policy programs and objectives for all the ministries in the sectors of housing, traffic and food. Acceptability of the policy instruments was found to be a prime issue, and good implementation of each policy measure plays a crucial role for acceptability. Long-term consistency and evidence of the effectiveness of the measures are essential both for the success and for the acceptability of climate policy. The results of the project were used in the preparation of the updated program for sustainable consumption and production in Finland.

Keywords
consumption, housing, personal traffic, food, greenhouse-gas emissions, policy instruments

1. Introduction

Consumption offers a powerful lever for environmental policy (Tukker et al. 2008). This is all the more so in countries where environmental policy concerning point-source emissions from industry and urban agglomerations is well developed. Changes in consumption patterns – i.e., patterns of demand – can offer a cost-effective way to significantly reduce life-cycle wide greenhouse gas emissions of products and services (EC COM 2008), and hence, offer a promising approach to climate policy. The challenge of climate change calls for better and more innovative instruments that address consumption across the entire product life cycle, recognize the links between different consumption sectors, and identify and strengthen synergies between the various policy instruments. However, steering consumption is complex and requires an extensive knowledge base for policy making.

A focus on consumption suggests a new approach to the calculation of greenhouse gas emissions in climate policy development. The standard approach is to calculate the emissions arising within the borders of that nation (i.e., the direct emissions or territorial emissions), which form the basis of the annual national greenhouse gas inventories and the international climate negotiations. In a small, open economy, trade flows also entail large flows of "embodied emissions", i.e., greenhouse gas emissions from the production of goods that are imported or exported (e.g. Mózner 2013). The consumption-based emissions can be termed the 'carbon footprint' of a nation (Peters and Solli 2010), i.e., they consist of the sum of greenhouse gas emissions from domestic production consumed in the country, imports into the country, and domestic investments. In this study we also use the term 'life-cycle based emissions' for clarity, as the word 'consumption' is reserved for household consumption here.

A focus on consumption also suggests a new approach to examining the outcomes of policy instruments. These are traditionally divided into regulatory, economic and informative instruments (Vedung 1997), which are often even administered by different ministries and government agencies. From the perspective of the global climate and national climate policy, however, the important questions pertain to the outcomes and impacts (Vedung 1997; Neij and Åstrand 2006) of the entire instrument package or mix directed at a certain issue. When evaluating or anticipating these, we need to account for interactions between different instruments (Vedung 1997).

There is widespread agreement that interactions among policy instruments are important, since separate instruments can be mutually reinforcing, or merely overlapping and hence redundant (Bye and Bruvoll 2008; Harmelink et al. 2008); in the worst case, they might even have contradictory effects. However, there is as yet no commonly agreed on method to analyse policy instrument interactions. A widely used approach is to develop matrices of interaction effects in order to examine potential complementarities and antagonistic effects (Sorrell 2003; Simoes et al. 2005; Boonekamp 2005; Child 2008). For example, Simoes et al. (2005) used a matrix to examine the interactions between pairs of policy instruments, examining whether the objectives are complementary or antagonistic, whether there is co-ordination between the mechanisms used in the instruments, and whether the steering effects of the instruments are complementary or antagonistic.

In Finland, several policy instruments have been introduced over the years, which have influenced greenhouse gas emissions from consumption. Regulations have been used, for example, to set standards on the specific energy consumption of new buildings and energy using products. Urban

planning is another regulatory instrument, which has an impact on energy used in transport. Economic instruments such as energy and carbon taxes have been deployed in order to raise the price electricity, district heat and fuels, as well as to influence the demand for vehicles with different levels of energy performance. Informative instruments aim to inform the public of the energy and environmental performance of products and thus enhance the transparency of markets. Recently, new proposals have been made for climate-related instruments such as carbon footprint labeling of products and related incentive systems for consumers (Perrels et al. 2009).

However, until now, most of these policy instruments have been developed for other reasons than to reduce greenhouse gas emissions, and there has been no integrated overview of their combined effects. This situation set the stage for the KUILU project, which aimed to investigate the possibilities to improve the policy mix so as to enable a more effective reduction of greenhouse gas emissions.

The present study demonstrates a process for informing and developing effective policy instruments to decrease greenhouse gas emissions from housing, personal traffic and food consumption. This has been done by (1) evaluating the existing policy instruments in Finland targeting the greenhouse-gas emissions from housing, passenger traffic and food, and (2) developing packages of instruments that would improve the effectiveness of greenhouse gas mitigation from private consumption compared to current instruments. Moreover, (3) when developing policy packages, special attention was devoted to the enhancement of synergies and complementary effects and to the minimisation of negative interference between instruments.

This paper is organized as follows. The following section introduces the context of the study, i.e., greenhouse gas emissions of Finland. We then introduce the material and methods of the study. The results are presented in section 4, whereas section 5 offers a discussion of these results and their policy implications.

2. Context of the study: greenhouse gas emissions of consumption in Finland

Finland is the northernmost country in the European Union, with an average temperature of +6 degrees Celcius in the south and 0 degrees in the north of the country. The cold climate and dark winter time is reflected in large consumption of energy for residential heating and lightning. Finland is a sparsely populated country, with only 18 inhabitants per square kilometer, which is reflected in long transport distances and large fuel consumption in private car drive.

Sustainable consumption can play a central role in the reduction of greenhouse gas emissions, which in Europe are largely due to fossil fuel consumption. In practical policy, instruments and measures directed at consumption can be particularly important for reducing emissions outside the emissions trading sector, the emission trading sector addressing mainly large industrial emitters[1].

[1] The EU emission trading scheme works on the 'cap and trade' principle. A limit is set on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. Within the cap, companies receive or buy emission allowances which they can trade with one another as needed, and they can also buy limited amounts of international credits from emission-saving projects around the world. After each year a company must surrender enough allowances to cover all its emissions. The scheme currently covers about 45% of the EU's greenhouse gas emissions, and limits emissions from heavy energy-using installations in power generation and manufacturing industry as well as flights to and from the EU and EFTA countries.

Finland has a target of reducing greenhouse gas emissions by 16% by 2020 outside the emission trading sector, which includes e.g. agricultural food production and direct fuel use in households and passenger traffic. Within the emission trading sector, Finland is part of a joint emission reduction target of 20%.

In the Finnish context, more than 55 % of greenhouse gas emissions arise from housing, food and personal car transport (Figure 1). The total emissions per person on a territorial basis, which are the basis for official greenhouse-gas emission inventories, were 13.0 tons in 2005 (Seppälä et al. 2009), which is clearly among the largest values both in EU and globally. The emissions from household consumption were 8.8 tons (Seppälä et al. 2009 and Figure 1), and when including also individual public services 9.9 tons.

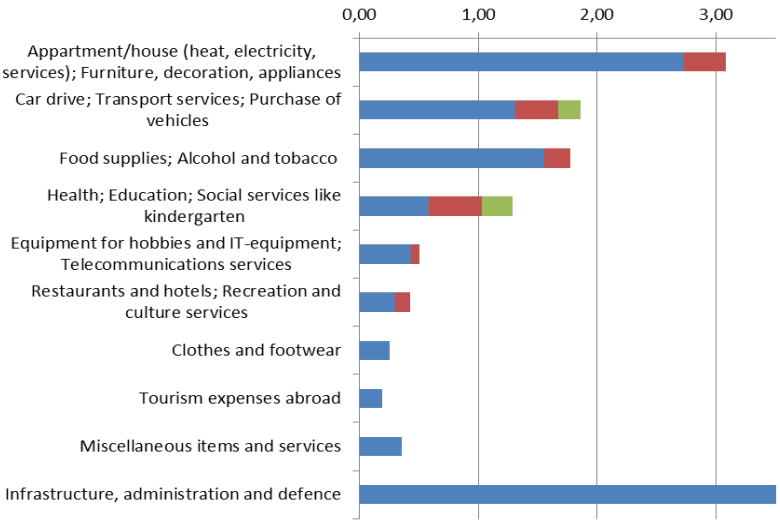

Fig. 1. Greenhouse-gas emissions in year 2005 from private consumption in Finland. Health, education, and social security services take also into account individual public services. Based on data from Seppälä et al. 2009.

Comparing consumption-based and territorial emissions, Peters et al. (2012) found that the consumption-based ones were on average 15 % larger than territorial-based in developed countries. In Finland, the ENVIMAT study indicated that they were quite close each other, the territorial emissions being 70 Mt and the consumption-based emissions as 68 Mt (Seppälä ym. 2009 However, a recent study by Peters and Solli (2010) suggested that ENVIMAT-study had large cut-offs of emissions due to using life cycle assessments instead of input-output method for many of the imported products and estimated that consumption-based emissions are larger than territorial ones in Finland as well, thus corresponding to situation in most western countries.

In Finland the greenhouse gas emissions from housing and passenger traffic, as summed up, were almost equally divided in 2009 between the ETS and the non-ETS sectors. The estimated emissions for each of these sectors was about 9 million tons (Table 1). Most of the emissions occurring outside the emission trading sector were due to direct fuel use in space heating and road vehicles. The household emissions that occurred in the ETS sector were mainly due to electricity and district heating consumption in dwellings, and to a lesser extent, to electricity use for rail transport.

It does not make sense to examine the direct emissions for food, since almost all emissions are indirect; hence all emissions from consumption are considered together (Table 1). The emissions from food include emissions from agricultural production (and it's inputs like fuels and fertilizers) through to distribution up until the point of sale.

Table 1
Greenhouse-gas emissions from housing, personal traffic and food in Finland in years 2005 and 2009. Unit is million ton (Mt) CO_2 equivalents per year. Life-cycle based emissions have so far been assessed only for year 2005 (Seppälä et al. 2009 and 2011).

	2005 Housing	2005 Personal traffic	2005 Food*	2009 Housing	2009 Personal traffic
Territorial emissions	9.6	7.5	-	10.6	7.4
- of which in ETS-sector	7.2	0.6***	-	8.3	0.7***
- of which in non-ETS-sector	2.4	6.9	-	2.3	6.7
Life-cycle based emissions	16.5**	9.9****	8.5*****	-	-

* Food corresponds here the food supplies consumed in households, but not services like restaurants.
** Of this, 14.6 Mt was caused by the upkeep of the appartment (heat, electricity, and services like property management and janitorial service), and 1.9 Mt by purchase of furniture and other decoration items and appliances.
*** Air traffic included in ETS-sector, although this will be valid only in year 2012.
**** Of this, 7.0 Mt was caused by drive with passenger cars and other personal vehicles, 1.9 Mt was caused by different transport services like public transport, and 1.0 Mt by the purchase of vehicles. Dividing the transport services, transport services by bus, metro, tram and taxes caused altogether 0.65 Mt, and transport services by flight and ferries and package tours altogether 1.25 Mt.
***** Of this, emission in Finland was 59 % (4.9 Mt), and 41 % (3.6 Mt) was abroad.

3. Material and methods

3.1. Research process

The development of genuinely policy relevant results calls for a multidisciplinary research approach. In the KUILU project, knowledge from environmental science, economics, consumer studies and policy studies has been combined to provide an evaluation and research-based proposal for improvements in climate policy instruments for sustainable consumption. Moreover, the study has combined research knowledge with insights gained from policy makers in two workshops.

The research design of the project included the following steps: (1) the identification and screening of existing instruments targeted at the climate impacts of consumption; (2) evaluation of of the impacts of the policy instruments; (3) identification of suitable policy packages in a workshop with policy makers; (4) evaluation of the impacts of the policy packages; and (5) a final workshop with policy makers to develop recommendations.

In the first two phases of the project, 20 existing policy instruments affecting the greenhouse gas emissions of housing, passenger traffic and food were pre-selected and assessed in terms of the following criteria: steering mechanisms, scale of influence, impact on greenhouse gas emissions, other environmental impacts, potential side effects, transparency, durability of impacts and acceptability (Heiskanen et al. 2012).This analysis was largely based on existing research, statistical data, and straightforward calculations of the greenhouse-gas emissions savings due to the assumed steering effect of each policy instrument.

These results were used to support the identification of suitable policy packages (phase 3). This was done with the help of a workshop with 25 invited policy makers and experts from Finnish ministries and government agencies. The participants received the assessment of existing policy instruments described above. They were also asked to fill in a questionnaire before the workshop on their views on the effectiveness and efficiency of the 20 identified policy instruments. At the workshop, they were asked to identify the strengths and weaknesses of current policies, and to make suggestions for improvements in existing policies for housing, personal transport, and food.

The feedback obtained from the questionnaire and from the workshop was then used to develop the policy packages further. This was supported by constructing matrices of the interactions between each pair of policy instruments (Appendix 1 in Nissinen et al. 2012). Potential direct and indirect impacts of the instruments were examined in terms of conditionality, complementarity, overlaps and contradictions (phase 4). On the basis of this analysis, five policy packages were finally developed: two for housing, two for food and one for personal transport. The aim was to avoid antagonistic effects, add missing instruments and construct policy instruments that support and amplify each other's effects.

In the second workshop (phase 5), the policy instrument packages developed were presented and discussed with policy makers and experts invited from the same group as participated in the first workshop. The instrument packages were specified and improved, and practical issues of implementation were taken into account. Moreover, areas for further research and development were identified.

3.2. Analysis of the interactions between policy instruments

In the analysis of the interactions between each pair of policy instruments, the following classification was used (Table 2).

Direct interaction:
Instruments can reinforce each others' effects or reduce them as the mechanisms of such instruments are downright supportive or conflicting. For example, introduction of strict energy efficiency norms for a product leaves little remaining potential for a tax with the same purpose. Another kind of interaction shows when the existence of some instruments is a prerequisite for the effective use of another instrument or at least greatly facilitates the functioning of another instrument.

Indirect interaction:
Instruments may significantly reduce or increase the potential for another measure, without as such affecting the mechanism of the other instrument. To some extent this effect always occurs when adding instruments meant for the same consumption category. Also more subtle mechanisms may be in effect. For example, congestion charging reduces the inflow of cars into the city, but that may mean that the prices of parking places go down, which makes it easier for employers continuing to offer free parking benefits, albeit for a smaller number of beneficiaries.

Table 2

Interactions between policy instruments, and codes used in the matrices of the instruments.

Direct (D) Interaction				**Indirect (I) Interaction**		**Fundamental mismatch (F)**
prerequisite D|P	supportive D|S	replacing D|R	conflicting D|C	increased potential I/P	reduced potential R/P	F
+ weak	+ weak	+ weak	- weak	+ weak	- weak	
++ moderate	++ moderate	++ moderate	- - moderate	++ moderate	- - moderate	
+++ strong	+++ strong	+++ strong	- - - strong	+++ strong*	- - - strong*	
0 none	0 none	0 none	0 none	0 none	0 none	

*) less likely to occur

Fundamental mismatch:
This aspect refers to conflicting underlying philosophies of approaches. For example, if a choice is made to handle an environmental target by means of a quasi market (tradable certificates), then it would be mainly disturbing to introduce a tax with the same purpose. Another example is the variabilisation of road transport related taxes (i.e. through kilometer charge) as distinct from raising fuel taxes and differentiating car purchase taxes. The latter two can be bundled, but are fundamentally conflicting with an all-inclusive kilometer charge.

3.3. Analysis of greenhouse-gas emissions

In the analysis of the greenhouse-gas emission decrease due to each policy instrument and policy packages related to housing, many calculations were based on the consumption of electricity and district heating. Because these average emissions of these two energy forms, expressed as kg CO_2eq per kWh, vary a lot between years and are quite close to each other (benefit allocation method), we used the same emission coefficient value 230 g CO_2eq / kWh for electricity and district heating. The estimates for year 2020 have been done with the same coefficient value (additional analyses with scenarios for change in energy production system were done but are not shown here). For wood the coefficient was 20 g CO_2eq / kWh and for light fuel oil 267 g CO_2eq / kWh (Statistics Finland 2011).

Tighter energy standards in the building code for new buildings were estimated for the period 1976-2008. However, for making a new estimate for year 2020, we considered that a balanced calculation would require data regarding the additional resource use and emissions attributable to the production of energy efficient solutions (extra insulation, low-energy windows, airtightness, heat recovery). Such data was not readily available. Also the change in living area and demolition of the worst residential buildings should be considered in this connection. This is why the impact for year 2020 is not shown in this study, although the tighter requirements obviously decrease greenhouse-gas emissions.

Energy statistics (Statistics Finland 2011) was the basic source for the information about the energy consumption in housing, and results from several Finnish studies were used to assess the energy use impacts of renovation activities for residential buildings in Finland (details of the methods and

sources, as for personal traffic and food, are found in Nissinen et al. 2012). The life cycle -based emissions of different materials and products were recalculated mainly from the material of the input-output study by Seppälä et al. 2009 and 2011.

For the analysis of the greenhouse-gas emissions from passenger traffic, a simple model that describes the transport performance of private cars, public transport and walking and cycling and the resulting emissions was developed by Adriaan Perrels. It takes into account amongst other things the prices of driving, vehicle purchase price, the supply of public transport, and possibilities for walking and cycling. Lipasto database by Mäkelä and Auvinen (2011) as well as a study on car tax differentiation based on emissions (Perrels and Tuovinen, 2012) was used as the basic information.

For the food policy package, a 'services for low-carbon diets' lunch plate approach, developed by Saarinen et al. (2012), was used. Their values for greenhouse-gas emissions of four typical meat-based lunch plates served at schools were used, replacing them with four typical vegetable food based lunch plates. For food policy package 'revaluing food', decrease in greenhouse-gas emissions due to less food waste was assessed. Also decrease in car drive due to more local food system and change in waste treatment system to produce bio-gas or bio-ethanol were assessed.

4. Results

4.1. Greenhouse-gas savings due to existing policy instruments

Existing instruments have already had a non-negligible impact on greenhouse gas emissions from consumption in Finland, according to the data collected and calculated for our study (Table 3). However, the existing data pertain to different time periods, and hence the emission reductions are not comparable as such. Energy requirements in the building code have been in place since 1976, and table 2 presents the emission reductions achieved between 1976 and 2008. In 2008, 4 million tons of greenhouse-gas emissions were saved annually compared with a situation in which the properties of the residential buildings would correspond to those of year 1976. This is equivalent to 0.8 tons per person.

For some of the more recent instruments, available evaluations pertain to the immediate impact right after the introduction of the instrument (immediate impact). For other instruments (e.g. instruments the impact of which is dependent on investment cycles), the annual reduction in environmental impacts has been evaluated in terms of the expected impact by 2020 or 2030. For example eco-design directive has been estimated to decrease emissions by 340 000 tons in 2020, i.e. 0.07 tons per person and year in 2020.

Table 3
Estimated annual decrease in greenhouse-gas emissions due to various policy instruments. The year, for which the estimate was done, is given in the right-hand column. Part of the estimates are from literature, part of them were (re)calculated for this study. For more details see Heiskanen et al. 2012.

Policy instrument	**Estimated decrease in emissions [t CO_2e/a]**		**Further information**
Building code for new buildings, energy efficiency requirements	4 000 000		Decrease in year 2008. Requirements were introduced to the building code in year 1976.
EU Energy label	170 000		Decrease in year 2010. The labelling was started in year 1994.
Policy instrument	**Estimated decrease in emissions [t CO_2e/a]**		**Further information (see more in Heiskanen et al. 2012)**
	Shortly after the introduction of the instrument	**In year 2020 or 2030**	
Effects of eco-design directive on appliances at households		340 000	In year 2020.
Taxes on energy	340 000		During a couple of years after increased taxes in year 2011.
Subsidies for choice or renewal of heating system, blocks of flats	40 000		In year 2007.
Subsidies for choice or renewal of heating system, houses	25 000		In year 2007.
Tax deduction for repair work	(25 000)		Estimated to be at the same level as subsidies, no separate statistics.
Energy experts in block of flats	1 400		In year 2005.
National energy guidance		40 000	In year 2020.
Energy certificate		700 000	In year 2030.
Real-time metering of electricity consumption		60 000	In year 2020.
Land use planning for more compact community structure		36 000	In year 2020.
Road pricing / Road user charges		140 000 (700 000)	In year 2020, when 20 % of traffic in the priced roads. (In parenthesis if all roads involved).
Taxes on fuels	180 000		In year 2010, with 10% increase in price and 2,5% decrease in traffic.
Public transport ticket for employees as a part of the salary	430		In year 2000.
Dependence of purchase tax and annual tax on the CO_2 emission of the vehicle		800 000	In year 2020.
Promotion of sustainable development in the restaurants of the public sector (lunch meals in schools, kindergartens etc.)		62 000	In year 2020, assuming one vegetarian lunch per week, and subsequent increase of 10 % at homes.
Separate collection for biowaste	73 000		In year 2009.
Beverage packaging tax	57 000		In year 2009, beer.

4.2. Combinations of policy instruments for housing

When attempting to address the emissions from energy use in housing, we considered it important to focus on existing buildings, since the renewal rate of building stock is low (about 1.5% per year) and there are fairly stringent energy efficiency requirements on existing buildings. The aim of the policy instrument package (Figure 2) targeted at housing was to:

A. Extend the scope of regulatory instruments (energy efficiency requirements on renovation of existing buildings and stricter requirements concerning energy performance certification of buildings);
B. Create incentives for energy renovations and climate-friendly user behavior (by influencing energy price expectations, and through energy taxes, a differentiated property tax, subsidies for energy efficiency investments and a tax deduction for energy renovations);
C. Offer guidance and advice for energy renovations and climate-friendly user behavior (energy advice, mandatory advice connected to building permits and energy renovation subsidies, as well as improvements in the so-called energy expert scheme, i.e., the use of voluntary residents trained to offer energy advice to their neighbours);
D. Enhance supply-side capacities to design and implement energy renovations (technology programmes and training).

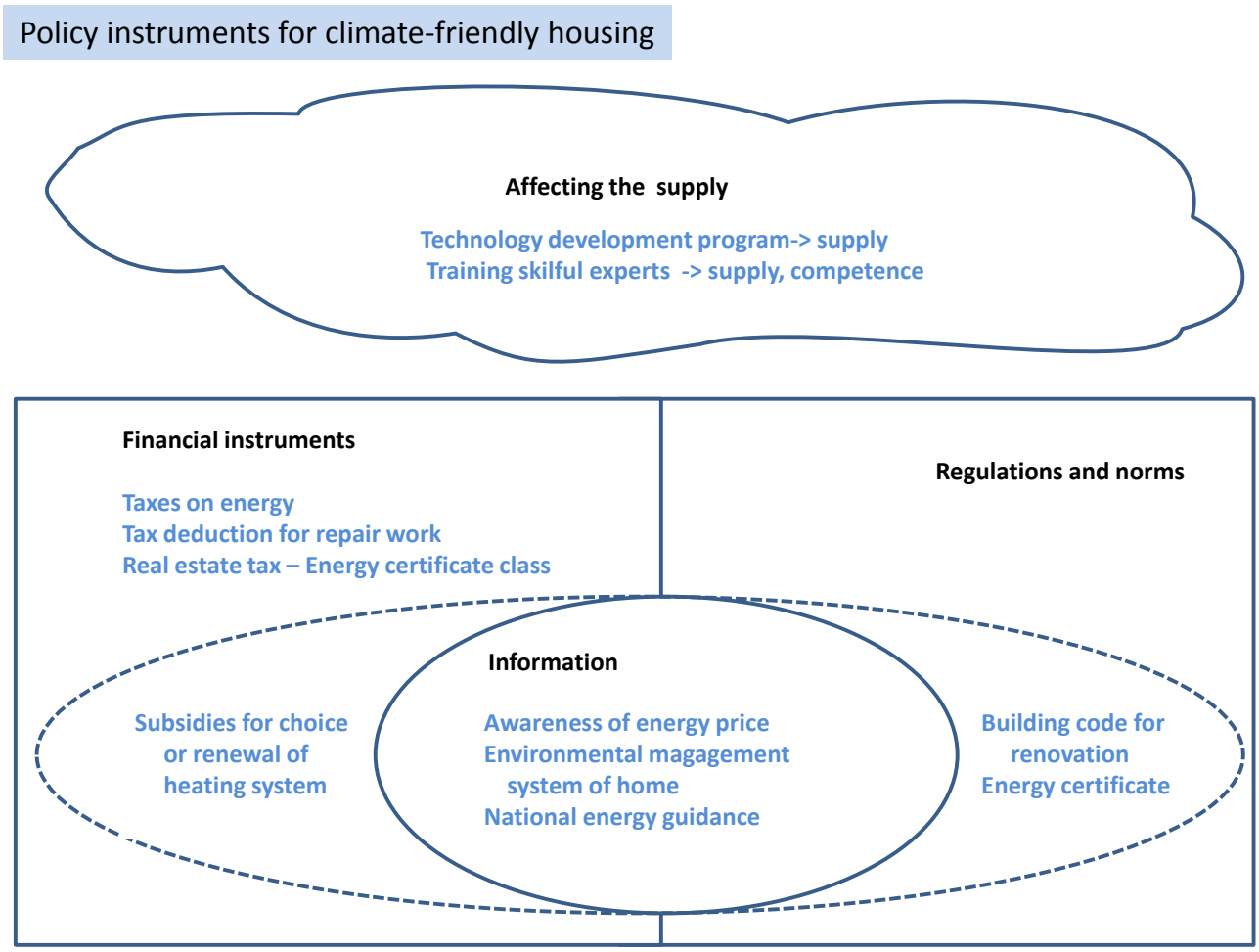

Fig 2. Package of policy instruments for climate-friendly housing.

The emission reductions to be gained from the policy instrument package targeted at housing were estimated to be 2.0 million tons. This consists of 1.3 million tons of reductions gained through heating systems replacements and improvements (replacement of oil heating and central electric heating with ground-source heat pumps and pellets and improvement of room-based electric heating with air-to-air heat pumps and solar water heaters) and energy renovations of building envelopes and technical systems. More energy efficient user behavior was estimated to result in 0.36 tons of greenhouse gas emission reductions and more energy efficient household appliances were estimated to bring an emission reduction of 0.34 million tons.

4.3. Combinations of policy instruments for personal traffic

The policy instrument package to reduce greenhouse gas emissions from passenger traffic consists of three basic elements (Figure 3):
A) Improvement of the supply and mutual compatibility of public transport and cycling;
B) Reform of the taxation of cars and vans;
C) Continuation and improvement of informative instruments.

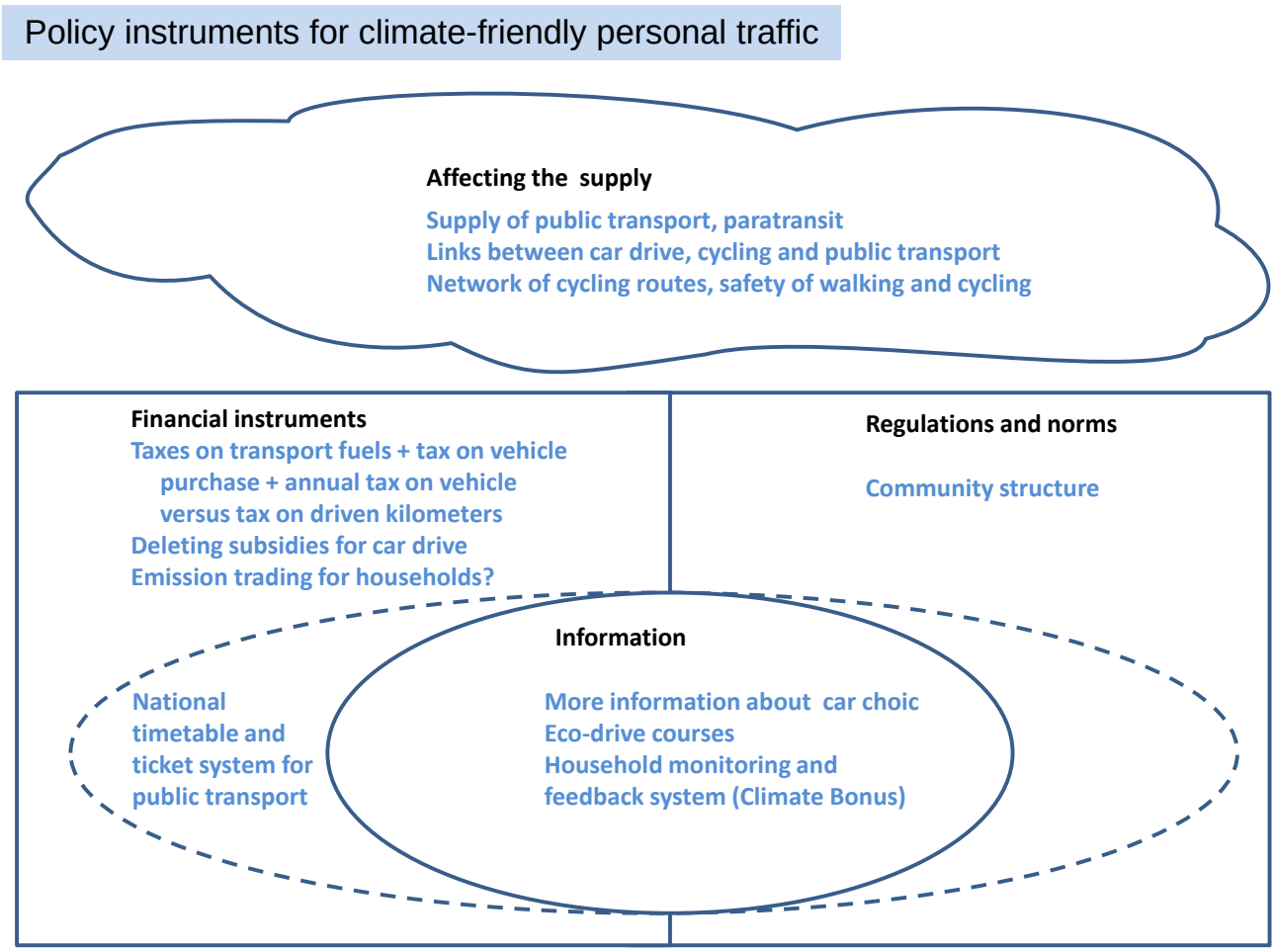

Fig 3. Package of policy instruments for climate-friendly personal traffic.

The greatest reductions in greenhouse gas emissions, 2.1 million tons, are obtained by increasing the level of automotive fuel taxation and by introducing a road charge. In order to make these taxes and charges acceptable to the public, it is crucial to simultaneously improve access to alternative modes of transport by increasing public transport services and by facilitating and promoting cycling and walking.

4.4. Combinations of policy instruments for food

Two packages of policy instruments focusing on the demand-side were developed to reduce the climate impacts of food. The package "services for low-carbon diets" enhances the existing policy steering public catering and extends it into the private sector. Another policy instrument package "revaluing food" aims to reduce the wastage of edible food as part of a broader regionally sensible food system that supports the local economy. The combination of these instruments is depicted in Figure 4, which combines regulatory, financial and informative instruments with improvements in supply-side capacities.

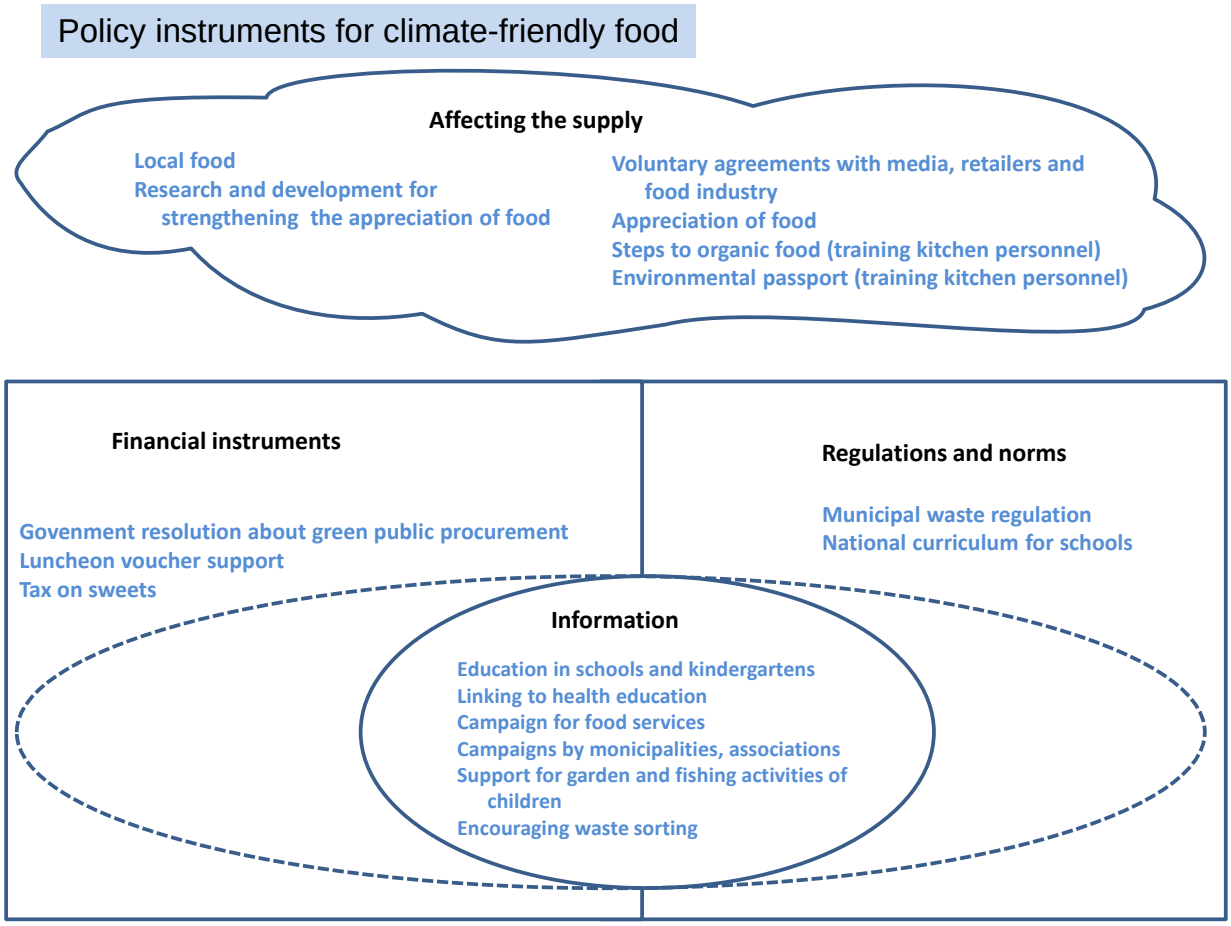

Fig 4. Package of policy instruments for climate-friendly food.

The instruments focusing on food could reduce greenhouse gas emissions in Finland by about 0.3 tons. To attain these effects, it is crucial to extend the existing requirements on public-sector food services to private food services. Other measures were also suggested to 'revalue', or return the

high valuation of food, which has been traditional to agrarian society were food was sometimes scarce. One of the relevant measures is the reduction of food waste.

5. Discussion

5.1. Large emission decrease

Our results agree with Tukker et al. (2008) and EC COM (2008) in showing that policy instruments for consumption indeed can offer new possibilities for mitigating climate change. Several policy instruments already have mitigated the increase in greenhouse-gas emissions substantially. And by policy packages, the emission reduction in housing (2.0 million tonnes, Mt) and passenger traffic (2.1. Mt) was estimated to be altogether more than 4 MT (Mt) in year 2020, which is significant compared with Finland's emission reduction target (e.g. target 20 % of 71 million tonnes corresponds to 14.2 Mt). The emission reduction of policy instruments associated with food was estimated to be 0.3 - 0.5 Mt, but this being life cycle -based value it is directly not comparable with the target.

5.2. Coherent policy combinations effective

As shown earlier e.g. by Bye and Bruvoll (2008) and Harmelink et al. (2008), the assessment of the interactions of policy instruments is crucial when striving for more efficient policies. The matrices of policy instruments developed e.g. by Simoes et al. (2005), showing the interactions with clear codes and supplementary explanations, offered a good starting point and material for workshop kind of working with various experts (e.g. from different ministeries).

The analysis of policy instrument packages in our study proposes that the efficiency of the measures can be increased especially when a set of instruments is examined as a whole: the synergy benefits between measures can be reinforced and hence overall effectiveness can be improved.

In practice, developing policy packages would require improved co-operation in the state administration. This could be facilitated through common policy programs and objectives for all the ministries in the sectors of housing, traffic and food.

We propose that the challenge of climate change calls for better and more innovative instruments that address 1) consumption across the entire product life cycle, 2) recognize the links between different consumption sectors, and 3) identify and strengthen synergies between the various policy instruments. In this study we still mostly fail point 1 for housing and traffic but took it into account for food. Point 2 was considered throughout the study but it is still rather superficially analysed. Point 3 was given a lot of emphasis in this study, but still much more deserves to be done.

5.3. Acceptability crucial, and can be improved by proper design and implementation

Acceptability of the policy instruments was found to be a prime issue, and good implementation of each policy measure plays a crucial role for acceptability. Long-term consistency and evidence of

the effectiveness of the measures are essential both for the success and for the acceptability of climate policy.

The policy instrument packages aim to influence issues that are beyond the control of individual market actors. Even if individual market actors and citizens might be (and often are) very willing to reduce climate impacts, many of the changes needed to reduce energy consumption and greenhouse gas emissions cannot be achieved without societal intervention (Unruh 2000).

5.4. Health and safety aspects as side benefits

In addition to greenhouse-gas reductions, the policy instrument packages entail other benefits. They provide better energy security, anticipatory adjustment to the pending rises in raw materials and energy prices, and improvements in health and safety. In addition, they are designed so as not to cause significant costs or harm.

5.5. Government resolution for sustainable consumption and production

The results of the project were used in the preparation of the updated program and government resolution for sustainable consumption and production in Finland. The program 'More from less – wisely' (May 2012) includes proposals for promoting renovations with new economic financing models, and campaigns for energy efficiency in homes. It proposes replacing car and fuel taxation with road pricing fees in the long run. For food, focus in on developing a plate model for good eating, using public food service as forerunners to promote environmentally friendly eating, and decreasing food spill. The policy package approach exists in the program and resolution, but could be developed further.

6. Conclusions

Existing policy instruments in Finland targeting housing, passenger traffic and food were shown to have large impacts on greenhouse-gas emissions. The assessment of the developed policy packages showed that the efficiency of the measures can be increased. When a set of instruments is examined as a whole, as combinations of policy instruments or 'policy packages', the synergy benefits between measures can be reinforced and hence overall effectiveness can be improved.

Acceptability of the policy instruments was found to be a prime issue, and good implementation of each policy measure plays a crucial role for acceptability. Long-term consistency and evidence of the effectiveness of the measures are essential both for the success and for the acceptability of climate policy.

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