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Energy related emissions reduction through life style change

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ABSTRACT

Reaching the goals of the Paris Agreement will require large changes in the energy system. Until now, most of the attention in order to realize a climate neutral energy system has been directed towards energy efficiency, renewable energy, CCS and nuclear energy. Of these, only energy efficiency has an effect on the magnitude of final energy consumption.

Apart from the question which combination of these four solutions to choose, it may be necessary to go a step further than mainly dealing with the symptoms of our energy consuming activities. Energy efficiency measures aim to reduce the energy consumed by all kinds of activities (per unit of activity), but not to reduce the quantity or change the kind of energy consuming activities. Although it will no doubt be controversial, reducing and/or changing energy consuming activities to a level deemed sufficient to live a comfortable life may well be necessary to reach the agreed emission reduction targets. This is why a broader scope for energy policies and related monitoring is proposed.

If the idea of sufficiency and related policies will become accepted, a broader range of energy policies aimed at energy consumption reduction will have to be monitored using a broader range of indicators. This discussion paper shows some examples of life style changes that have a significant effect on greenhouse gas emissions and what this means for energy consumption monitoring and policy evaluation data needs.

Introduction

The development of the level of energy consumption is routinely explained as the result of volume and structural effects in addition to saving effects. Volume and structural effects are however mainly studied to separate energy savings from other drivers behind energy consumption developments. The focus on energy savings when aiming for energy consumption reduction is understandable from a political point of view, as applying energy saving measures means that energy consuming activities can continue mostly the same way as before.

Policy measures targeting the amount of energy consuming activities will become visible in volume effects, and policies aiming to change the kind of activities will become visible in structural effects. Some existing energy efficiency policies also have an effect on volume and structure, like energy taxes: in transport for example it reduces the number of kilometers driven and it incentivizes switching to less energy consuming modes of transport like public transport and bikes.

Energy efficiency is an important way to limit energy consumption, but in the past and in many scenarios it 'only' prevents further growth of the final energy consumption instead of significantly reducing it, as efficiency apparently just about counters the effect of increasing energy consuming activities in society; see figure 1.

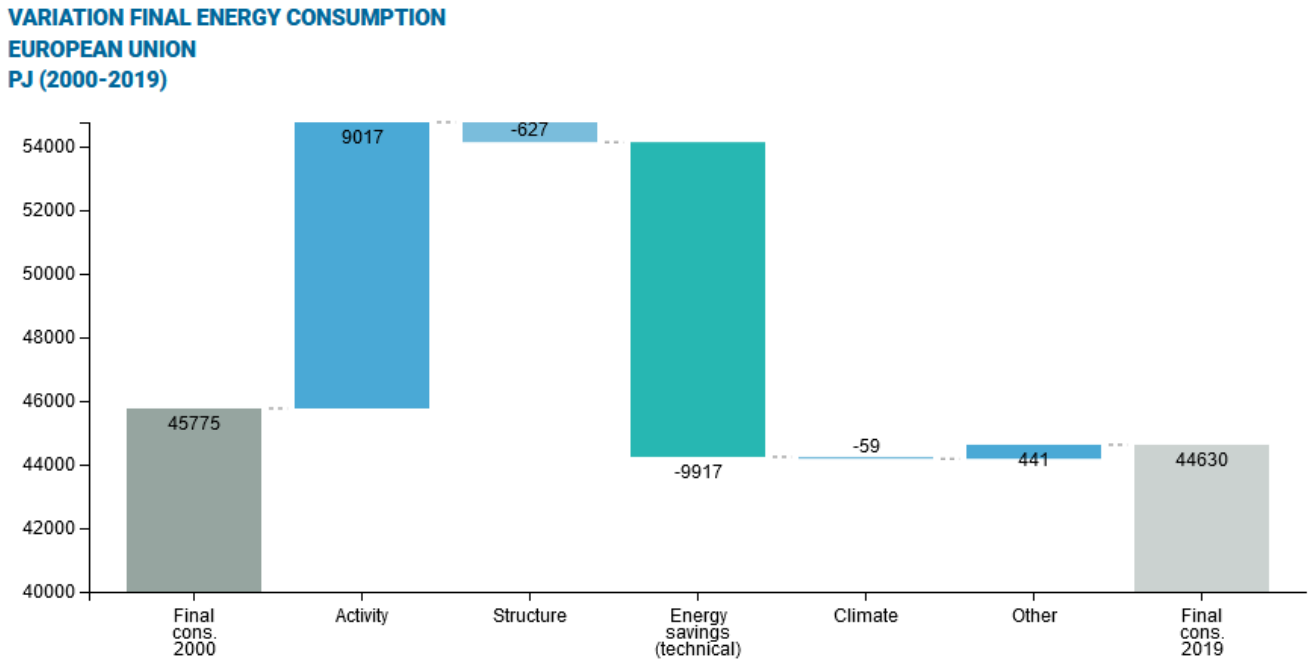

Figure 1 – Decomposition of final energy consumption by the EU member states (source: https://www.indicators.odyssee-mure.eu/decomposition.html)

As the gap between the greenhouse gas emission reduction needed to reach the target agreed in the Paris Agreement remains large, it may be necessary to look beyond the traditional means to reduce energy related greenhouse gas emissions, and consider other means for reducing energy consumption than by applying efficiency measures.

The aim of this discussion paper is to explore the potential for significant energy consumption reduction in activities that can be reduced without sacrificing wellbeing. This is related to the emergence of proposals to look beyond GDP[1] as a measure of wellbeing, and to the concept of sufficiency. Still, some resistance may be expected, which will be addressed in the next section.

A useful starting point for identifying suitable options to reduce energy consuming activities is studying the potential of volume and structural changes. This means reducing the volume of energy intensive activities or, when focussing on structural change, continue the energy consuming activity, but in a different way that results in less energy consumption and/or lower emissions per unit of activity. Transport can be used as an example. Volume effects equal traveling a shorter distance. Structural effects occur when travelling the same distance while using a means of transport that uses less energy and/or emissions per kilometre, like switching from a car to public transport or a bike (modal shift). The principle is simple, but how to successfully achieve it requires more analysis that is only briefly discussed in this article.

Societal acceptance

When implementing volume and structural policy measures, some resistance should be expected, as it could be experienced as restricting people's freedom. For these types of measures to be considered, they should have a significant effect in order to prevent people from getting the impression that 'nothing is allowed anymore' without a valid reason. Holding people responsible for the effect of all of their individual actions, however small, will probably be counterproductive. There are however trends in society that suggest support for these types of

[1] See for example http://www.oecd.org/social/beyond-gdp-9789264307292-en.htm

measures could be gained, like the already mentioned idea of focussing on sufficiency, focusing on wellbeing instead of prosperity and the worldwide protests for more ambitious action to combat climate change. Volume and structural measures will require lifestyle change. Of course it has to be taken into account that activities are not suitable for emissions reductions by volumetric measures beyond a certain point, because they provide basic needs, like a sufficiently high room temperature.

Fortunately, options do exist to mediate possible resistance. It has been found that a correlation exists between measures that are perceived as having a significant effect, that are applied fairly and that fit within existing cultural ideas of what is right and their acceptance (Dreijerink and Peuchen 2020). It seems wise to not impose volume or structural policy measures unless prior research has been done to verify societal acceptance, or using the results of deliberative sessions of citizens in which the volume and structural measures to be applied are selected by a representative group of participants. Information about the level of public support for different types of policy measures targeting the volume and structure of activities is not part of this article.

Delineation of the targeted emissions

In the end, all emissions resulting from activities in the entire economy can be attributed to individuals, be it in their role as consumer or as citizen. It is the individual as citizen that profits from infrastructure, hospitals, schools, defence et cetera. This is why the focus in this analysis will be on the effects of the actions of individuals. Also, the idea is to identify activities with a high reduction potential when applying volume or structural measures. The emissions related to collective activities by the government which can be influenced by citizens by voting are left out however. The largest share of remaining greenhouse emissions result from individual actions and originate from energy consumption in dwellings, transport, food and the emissions caused by the manufacturing of products. Actually, more than half of greenhouse gas emissions from private consumption is related to food and products (see for example Ala-Mantila, Heinonen and Junnila 2014). To bring some focus and stick to the topic of energy evaluation, the very diverse indirect emissions from energy use by manufacturing of consumer products are left out of the analysis, as are emissions from agriculture which consist mainly of methane instead of CO_2 caused by energy consumption. This leaves emissions from dwellings and transport as the topic for the analysis. All data and examples are based on the Netherlands.

Selecting appropriate target uses for volume and structure policy measures

There is quite some variation in energy consumption from dwellings and transport. The most consuming dwelling type in the Netherlands consumes 2.7 times more natural gas for heating than the least consuming one. Travelling alone by car causes 7 times more CO_2 emissions than travelling by train. 8% of Dutch people are responsible for 40% of the flights of all Dutch people (KiM 2018). Two people going on holiday by car instead of by plane and traveling a 40% shorter distance avoid about two thirds of CO_2 emissions. Air travel is a good example of volume effects that more than eliminate efficiency gains.

As mentioned before, the aim is to focus on measures with a significant effect, which means it should not just reduce energy consumption and related CO_2 emissions for individuals with a meaningful amount, but it should also be applied by many people as to result in a meaningful macro effect. This means the measures should not just be effective on an individual level, but also have sufficient public support.

The first step is finding out what the largest contributions to greenhouse gas emissions due to energy consumption by individuals from dwellings and transport are. The results for the Netherlands are as depicted in Table 1. It also includes possible volume and structural measures.

Table 1. Average energy consumption and related CO_2 emissions of dwellings and transport per household in the Netherlands and possible energy use reduction options by life style change (average occupation of 2.2 persons per household, average amount of air travel per household)

	energy application	energy consumption [GJ/year]	CO_2 emissions [ton CO_2]	example volume measures	example structural measures
Dwellings	heat, of which	43,4	2,46		
	space heating	34,8	1,97	lower room temperature, smaller dwelling	different room heating technology
	hot water	7,7	0,44	shorter shower, water saving shower head	solar collector, electric water heater
	cooking	0,9	0,05		electric cooking
	electricity	25,5	3,21	less electrical equipment	use laundry drying rack
Transport	car	32,1	2,34	work from home, car holiday closer to home	modal shift, smaller car, carpooling
	public transport		0,15	work from home	modal shift to bike
	air travel, of which		0,98		
	business trips		0,23	less business trips	modal shift to train
	holidays		0,75	less holidays by plane	modal shift to train or car
Dwellings + transport			9,14		moving to urban area with high quality public transport

Sources: CBS (Statistics Netherlands), Odyssee-Mure, KiM (Netherlands Institute for Transport Policy Analysis), RVO (Netherlands Enterprise Agency), PBL (Netherlands Environmental Agency)

The second step is selecting activities which are candidates for measures targeting volumetric or structural change that also have a sizable effect. It is clear that space heating, electricity consumption, car traffic and flying are responsible for a large share of the energy related emissions. Space heating in existing buildings however is only a candidate for volume measures up to a certain minimum temperature level; beyond this, structural measures (switching to heating systems with lower emissions) and efficiency measures are the most appropriate ones. New dwellings do provide more options for volume measures by building smaller houses and for structural measures like building stacked dwellings, but depending on newly built dwellings takes more time than actions that can be applied in existing dwellings. Hot water consumption can be addressed by taking shorter showers which is a volume measure. The possibilities in transport seem more promising on a shorter timescale,

like switching from commuting by car to public transport or by e-bike, and from holiday travel by plane to car or train.

An interesting case is lowering the combined energy related emissions from dwellings and transport by applying spatial planning policies that target an increase in urban living. This because urban dwellings are smaller and stacked and thus use less energy for heating, and the distance to work for at least one of the occupants is probably smaller and easily reachable by public transport. Table 2 contains the same list of emissions as Table 1, with a few selected potentials for emission reduction measures targeting volume or structure as examples.

Table 2. Average energy consumption of dwellings and transport per household in the Netherlands with some selected example reduction potentials by life style change actions

	energy application	**CO_2 emissions [ton CO_2]**	**example volume measures**	**example structural measures**	**emission reduction potential [ton CO_2]**	**assumed participation rate**	**Resulting emission reduction [ton CO_2]**
Dwellings	heat, of which	2,46					
	space heating	1,97	1 °C lower room temperature		0,24	20%	0,05
	hot water	0,44					
	cooking	0,05					
	electricity	3,21		use laundry drying rack	0,13	25%	0,03
Transport	car	2,34		75% modal shift to e-bike	0,64	25%	0,16
	public transport	0,15					
	air travel, of which	0,98					
	business trips	0,23		25% teleconference	0,06	50%	0,03
	holidays	0,75	40% shorter distance	car instead of plane	0,26	25%	0,07

Sources: CBS (Statistics Netherlands), Odyssee-Mure, KiM (Netherlands Institute for Transport Policy Analysis), RVO (Netherlands Enterprise Agency), PBL (Netherlands Environmental Agency), MileuCentraal.nl

The column with emission reduction potentials contains the effect if the described measure is taken by a household. The relative effect on CO_2 emissions if all measures are taken in a household is 7% for dwellings, 28% for transport and 15% for dwellings and transport combined. If this would be applied by all 7.8 million households in the Netherlands, the total avoided CO_2 emissions would add up to 10,4 Mton on a total of 67 Mton for dwellings, cars and air travel. As it cannot be assumed that all households will apply every measure, a participation rate has been estimated by the author. After applying this rate the resulting emission reduction is as shown in the rightmost column. The avoided emissions in this case would be 2,6 Mton, 4% of the 67 Mton of dwellings, car and air travel. The effect of switching to urban living has not been calculated, but can be estimated by assuming a 30% lower emission from space heating when moving from an average dwelling to an apartment and the effects of modal shift from car travel to public transport or cycling.

Types of policy measures

There is a broad range of policy measures on energy efficiency that have been evaluated extensively, for example as part of the Odyssee-Mure project. Measure types addressing energy efficiency as covered by the Mure database on energy efficiency policies (Odyssee-Mure 2020) are co-operative measures, grants and subsidies, taxes, information and norms. As mentioned before, some of these efficiency policy measures also have volume or structural effects. Examples are road taxes that have a diminishing effect on the amount of travel or make people choose a different mode or transport, and energy taxes on natural gas and electricity that make some people lower the room temperature or reduce the use of electrical equipment. Information campaigns and norms will be useful for realizing volume and structural changes as well.

Not included in Mure however are facilitating policy measures. Structural changes like modal shift in transport can be achieved effectively by means of facilitating measures. Examples are high quality public transport, high quality infrastructure for bikes, like separate and broad cycle lanes and bike parkings at railway stations, cycling highways as an alternative for cars for medium distance commutes using regular or e-bikes.

Spatial planning will allow targeting emissions resulting from dwellings and transport in a combined way. Urban dwellings are often smaller and stacked, which results in lower energy consumption for room heating. Travel and goods transport distances in urban areas are lower, and public transport, cycling and walking are a good alternative for cars. A policy measure addressing spatial planning is building new dwellings mainly in urban areas. Information measures could stimulate urban living by showing the advantages of urban living: better facilities like shops, bars and restaurants, cultural institutions and schools and hospitals in close proximity.

Which policy measures are most fitting for targeting the energy uses addressed in this article has not been determined, although it seems probable that facilitating and spatial planning policies will have a large contribution.

Data requirements for new types of monitoring and evaluation

A lot of data required to evaluate volume and structural measures is often already available from the established monitoring and evaluation of energy savings on the national and sometimes regional level, like the number of and energy consumed by dwellings, kilometres travelled and energy consumed by different means of transport. For most European countries these data can be found in the Odyssee database (Odyssee-Mure 2020). To be able to reliably estimate the emission reduction potential of modal shift it is necessary to have a detailed overview of the location of dwellings, the transport infrastructure and commuting distances. If local public transport or cycling infrastructure is not of high quality, there is a lot to be gained by improving these; if it is already well developed the potential will be in the location of new dwellings. Some of this type of information is available for the Netherlands in a national buildings database (BAG 2020). GIS tools have a large potential for analysing emission reduction potential as well as monitoring and evaluation of volume and structural changes based on detailed geographical data on buildings and transport.

Recommendations

These are the recommendations that follow from the above:

- Consider the application of policy measures targeting volume and structural changes as an additional way to reduce energy consumption and the related greenhouse gas emissions
- Select the larger energy uses of individuals for which this type of policy is applicable and make sure the macro effect can be sufficiently large due to a high participation rate

- Improve the availability of detailed geographical data on buildings and transport infrastructure to enable emission reduction potential estimates and monitoring of volume and structural measures
- Take into account public support before implementing volume or structural policies
- Acquire information about public support from surveys or from deliberative polling / citizen assemblies

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