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MĀJSAIMNIECĪBU IETEKME UZ KLIMATU LATVIJĀ: OGLEKĻA PĒDAS RĀDĪTĀJS

HOUSEHOLD CLIMATE IMPACT IN LATVIA: MEASURING CARBON FOOTPRINT

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Introduction

The study is based on hypotheses that the responsibility for carbon emissions from economic activity lies with people's attempts to satisfy certain functional needs and desires, which are expressed in the consumer demand for goods and services. Production processes and use of these goods consume resources and emit pollutants – including carbon dioxide and other greenhouse gases. To help us understand the link between the household consumption and carbon emissions, and to evaluate the scale of carbon reductions that are required, this study has raised the following question. How much carbon is attributable to which kinds of needs (housing, mobility, food etc)?

To answer this question we used Carbon footprint (CF) analyses. With carbon footprint we understand the overall amount of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions associated with a product (both goods and services), along its supply-chain and sometimes including from use and end-of-life recovery and disposal. Causes of these emissions are, for example, electricity production in power plants, heating with fossil fuels, transport operations and other industrial and agricultural processes.

People more and more recognize climate change as one of the main environmental problems and the term carbon footprint has become popular and is now in widespread use. In this study CF concept has been applied to analyse per capita direct and indirect household GHG emissions in Latvia. We explore household CF in housing, transport and food sectors, which are the main household environmental pressure areas and partly also cover service sector, but ignore carbon embodied in fixed capital (plants, machinery & equipment, infrastructure etc).

Methodology

Calculating the total household resource use impacts (the "Footprint") has to fulfil certain requirements. It must take into account the 'on-site' impacts such as direct emissions from heating premises, for example. And it must also take account of indirect impacts that are embodied in the products and services purchased by the individuals, for example food.

There are 2 dominant approaches in carbon footprint calculations: bottom-up, based on Process Analysis and top-down, based on Environmental Input-Output analysis. Both methodologies need to strive to capture the full life cycle impacts [1].

Input-output tables are economic accounts providing a picture of all economic activities at the meso (sector) level [2]. In combination with consistent environmental account data they can be used to establish carbon footprint estimates in a comprehensive and robust way taking into account all higher order impacts and setting the whole economic system as boundary. Unfortunately there are no recent input-output tables for Latvia produced.

Process analysis has been developed to understand the environmental impacts of individual products from cradle to grave. The bottom-up nature of process-based life-cycle assessments (PA-LCAs) means that they suffer from a system boundary problem - only on-site, most first-order, and some second-order impacts are considered [3]. If PA-LCAs are used for deriving carbon footprint estimates, a strong emphasis therefore needs to be given to the identification of appropriate system boundaries, which minimise this truncation error. Estimates can be derived by extrapolating information contained in life-cycle databases, but results will get increasingly patchy as these procedures usually require the assumption that a subset of individual products are representative for a larger product grouping and the information from different databases, which are usually not consistent, has to be used [4].

In this study we have used hybrid approach, where the process analyses and input-output methodologies are integrated. Such a method, embedding process systems inside input-output tables, is the current state-of-the art in ecological economic modelling [5, 6]. We have been using national statistics data and household survey data on household consumption patterns in Latvia from Latvia's Central statistic office, data from Road Traffic Safety Directorate (RTSD) on car and fuel

use, and data from LCA studies on carbon emission factors. National data on household consumption are divided per capita and multiplied by relevant GHG emission factors.
There is an argument that all government and fixed capital expenditure is made in support of households [7, 8, 9] and therefore analyses sometimes allocate these expenditures to households. However, in order to draw direct policy implications with regard to households this allocation has not been carried out in the current study. Due to limited size of paper the calculations done by authors in following paragraphs are not shown in details, only the final results of them are presented.

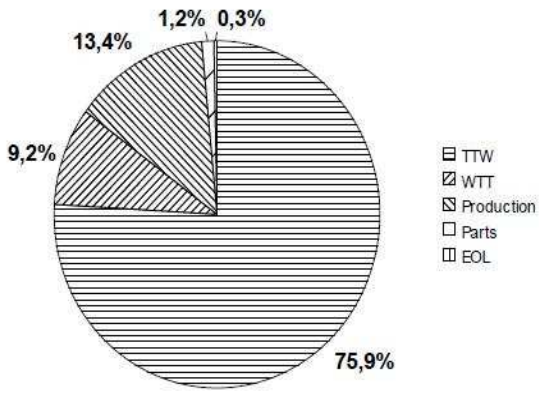

Fig. 1. CO_2 emissions from car use (% CO_2e), calculated by authors.

Mobility

In this study we have included 3 traffic modes: private car, land public transport and aviation. According to the RTSD data [10], number of cars in Latvia is gradually increasing. There is one car in technical order per 4.8 people and this car on average drives 16 550 km a year with average fuel consumption of 8.9 l per 100 km. So the direct car emissions from fuel consumption are 3.14 tons CO_2 a year or 0.189 kg CO_2 per km. But per capita emissions also depend on number of passengers in the car. In Latvia it is 1.3 persons. This means that one person on average emits 150 g CO_2 per 1 km driven by car.
However CO_2 emissions from car accrue also upstream – so one has to take into account the emissions during the fuel and car production and also car service and utilization. IMPRO-car study [11] commissioned by European Commission has calculated these emissions for the average EU car and they are used in this study.

Total CO_2e emissions (see Fig. 1) from the car use equals 579 kg CO_2e per capita in year 2006. The biggest part (76%) of this is from the fuel use (Tank-To-Weal emissions), then followed by embodied emissions from car production – 13.5%, from fuel production (Well-To-Tank emissions) 9%, car repair (1%) and end of life (0.5%) emissions.
Public transport is also contributing to climate change. On average one person in Latvia drives 1200 km a year by bus and 400 km by train. Buses even with higher fuel consumption (20 – 40 l/100 km) compared to cars usually are much more climate friendly, mostly thanks to their capacity (see table 1.). It is assumed that bus manufacturing, maintenance and end-of-life emissions provide additional 15% of CO_2e emissions [12]. Total emissions from the use of public transportation accounts for additional 219 kg CO_2e annually per capita.

Table 1.

CO_2 emissions per passenger-kilometre, by mode

Transportation mode	**kg CO_2e emissions per passenger-km**
Plain	0.160 – 0.250 (depending on the distance)
Car	0.151
City buses	0.062
Trams and trolleybuses	0.042
Train	0.040
Long distance bus	0.027

Aviation is fast growing transportation sector in Latvia. Passenger-km travelled have increased 7.3 times over the last 10 years and now are exceeding distance travelled by buses. Because of the high passenger-km emissions aviation accounts for the significant and increasing share of the total transportation GHG emissions and now makes 256 kg CO_2e emissions per capita annually. Nevertheless 76% of people in Latvia have never been flying.

Food

To understand the total food consumption climate impact we used the data on food consumption patterns in Latvia [13, 14], multiplying them with the emission factors for
particular food product [15, 16, 17]. On average one person in Latvia consumes 2600 kcal of food per day [14]. However food production is very energy intensive and can consume more energy than produce [18, 19]. From the food products highest global worming potential is to beef which could range from 15 to 32 kg CO_2e per kg [15], depending on intensity of farming. But there is possibility for substitution as, for example, every gram of beef releases nearly 5 times the amount of GHG into the atmosphere compared to an equivalent amount of chicken. Also dairy items have high emissions per unit of product, signifying that cows are the largest direct source of emissions from food. But also other animal products have high carbon intensity. Cereals, fruits and vegetables have consistently lower emissions per gram of product (see Fig. 2.).

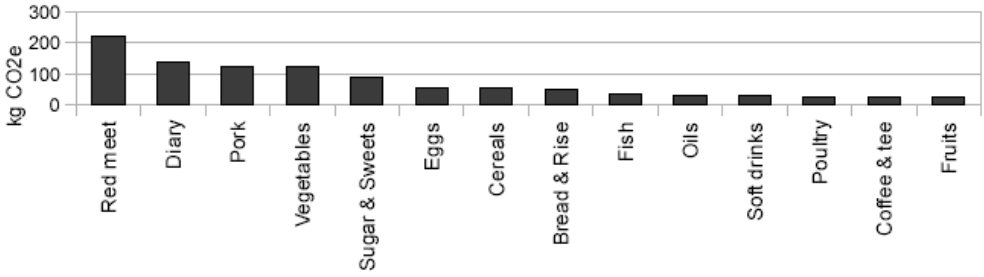

Fig. 2. Annual per capita CO_2e emissions from food consumption (calculated by authors)

Our calculations suggest that annual per capita GHG emissions from food consumption in Latvia are 1025 kg. Most of which comes from consumption of beef and other animal based
products. However also vegetables, sweets and cereals account for significant climate impact.

Housing

Housing energy consumption on average in Latvia is comparatively high - 308 kWh/m_2 [20]. According to the data from Construction, Energy and Housing State Agency, most of the energy (78.8%) is used for the space heating purposes, but rest for the water heating, cooking and electrical appliances.

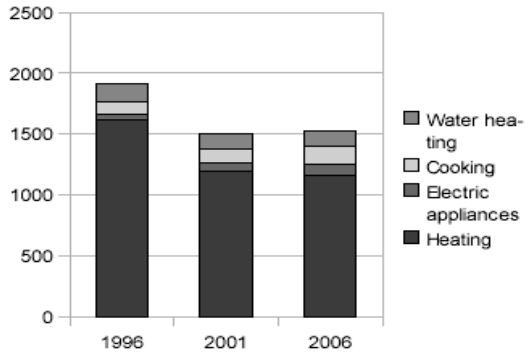

Fig. 3. GHG in housing sector (kg CO_2e), calculated by authors

There are 25.5 m^2 living space per capita in Latvia [13]. Most of the energy to heat this space comes from district heating, however also decentralized heating systems running on fuel wood, natural gas and solid and liquid fossil fuel are wide spread. Share of electricity in housing GHG emissions over the last 10 years has increased from 8% to 16%. Households now use electricity not only for lighting and some basic electric appliances, but also for cooling (and in some cases heating), and increasingly for cooking and entertainment. Thus share of district heating systems in GHG emissions has decreased from 74% in 1996 to 58% in 2006.

Totally housing sector in 2006 emitted 1,528 kg CO_2e per capita. This amount includes direct GHG emissions from fuel production and use in housing sector, as well as housing sector related energy consumption and energy losses. Fuel mix for district heating and electricity has been used by authors for GHG emission calculations, however these calculations do not cover in housing infrastructure embodied GHG emissions.

Other sectors

Also consumption of goods and services are contributing to the climate change. GHG emissions from the service sector over the last 10 years have significantly decreased (see Fig. 4), mostly because of more efficient energy production and heating systems.

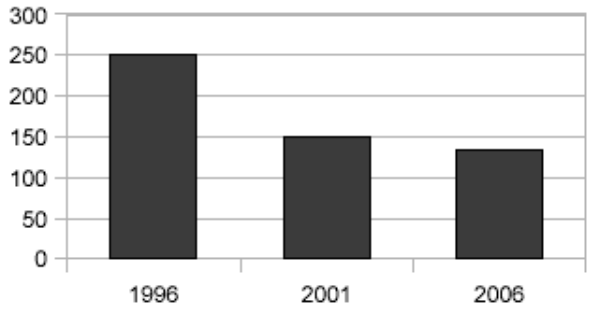

Fig. 4. Annual per capita GHG emissions from service sector (kg CO_2e), calculated by authors

Compared to food products, goods on average have higher GHG emission factors per kg of product since not all food items require heavy energy inputs, compared to manufactured goods [21, 22]. But per capita consumption of goods produce only 358 kg CO_2e per capita annually as most of the goods are lasting for more then one year, and 54% of it attributed to the paper products and written media. Clothing is responsible for 21% of GHG emissions from consumption of goods, but electronics and equipment for 14%.

Equal share

According to the IPCC to ensure sustainable climate balance, worldwide average temperatures must remain as far as possible below 1.5–2.0ºC above pre-industrial levels. To have an approximately 50 percent chance of keeping warming below that level, atmospheric greenhouse gas concentrations must stabilize below 450 parts per million [23]. To keep the carbon level at 450 ppm, the global accumulative pollution between now and 2050 should be maximum 1,700 gigatons CO_2e [24]. To stay within safe to achieve net zero emissions as quickly as possible as recommended by the IPCC [25] and noted at Bali, a possible trajectory for GHG reductions are showed in Fig. 5. This is a 9% annual cut and represents a total of 325.4 billion Pollution Allocation Permits for the period 2010 to 2040 and may prevent temperature rises above 2ºC [25].

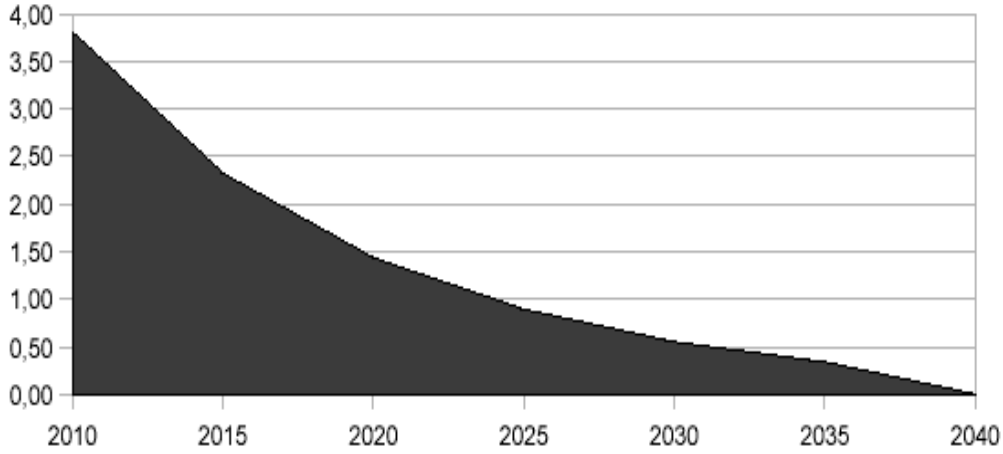

Fig. 5. Annual GHG emissions per person (tons)

Results

Results from the study suggest that average Latvian exceeds its global fair share of the GHG emissions and its carbon footprint is at 4.1 t CO_2e per capita in 2006. From which housing is responsible for the highest amount of CO_2 emissions – 1.53 t CO_2e per capita, followed by transportation – 1.05 t CO_2e and food consumption - 1.03 t CO_2e. But climate impact of goods and services are comparatively smaller, jointly emitting 0.49 t CO_2e. Emissions from food have been relatively stable over the years and housing emissions have significantly decreased, however carbon emissions from car use over the last 10 years has increased by 39%. These findings are in line with a number of other studies which have indicated that housing, transport and food are the three most significant consumption sectors [4].

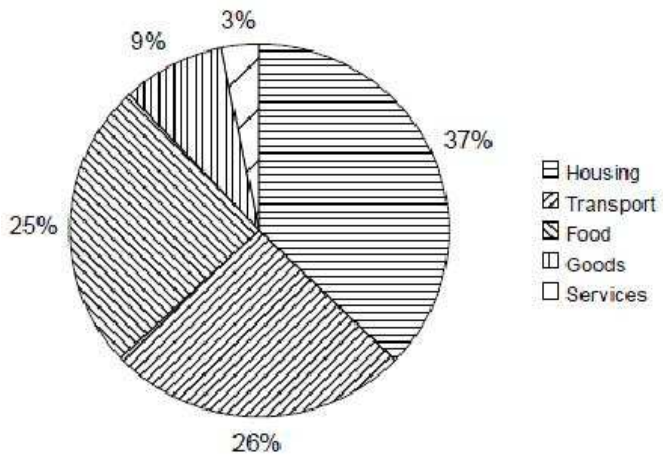

Fig. 6. Share of consumption areas in total per capita carbon emissions (calculated by authors).

The findings also indicate that policies should be targeted at the segments in society responsible for the highest carbon footprints, i.e. food, mobility and housing. However consumers have only two options to reduce their environmental impact directly: either consume less, or switch to less carbon-intensive products. Yet, eliminating anything from an individual's lifestyle can involve difficult trade-offs. That's why this study emphasizes that attention must be paid not only to lifestyles, but also to infrastructure and institutions that result in considerable amounts of carbon being locked up in the household activities through which people meet their everyday needs for subsistence, protection, and communication.

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Jānis Brizga, Ivars Kudreņickis, Latvijas mājsaimniecību ietekme uz klimatu Latvijā: oglekļa pēdas rādītājs

Cilvēki arvien vairāk un vairāk atzīst klimata izmaiņas kā vienu no galvenajām vides problēmām un "oglekļa pēda" ir kļuvis populārs un plaši lietots termins. Šajā rakstā ir pielietota oglekļa pēdas metodika, lai analizētu vidējās Latvijas iedzīvotāja gada laikā radītās siltumnīcas efekta gāzu (SEG) emisijas. Šīs emisijas tika analizētas galvenajās patēriņa kategorijās: mājoklis, transports, patēriņš, preces un pakalpojumi, kuras ir arī mājsaimniecību galvenās ietekmes uz vidi jomas. Apskatītas tika gan tiešās, gan netiešās (iegultās) SEG emisijas. Pētījuma rezultāti ļauj secināt, ka vidējais Latvijas iedzīvotājs 2006. gadā ir atbildīgs par 4,35 tonnām CO_2e, un tas pārsniedz globāli pieejamo godīgo emisiju daļu. Lielākā daļa (37 %) šo emisiju saistās ar mājokli, 26 % ar transportu, 25 % ar pārtikas preču patēriņu, bet preces un pakalpojumi kopā rada 12 % kopējo SEG emisiju. Taču šajā pētījumā nav iekļautas kapitālieguldījumos (ceļi, ēkas, infrastruktūra) iegultās SEG emisijas, kas kopējo emisiju apjomu uz vienu cilvēku varētu palielināt par tonnu. Pētījuma rezultāti liek secināt, ka lielākā uzmanība mājsaimniecību ietekmes uz klimatu samazināšanā būtu jāpievērš ne vien dzīvesstilam, bet arī infrastruktūrai un institūcijām, kas, neatkarīgi no iedzīvotāju uzvedības modeļiem, mājsaimniecību ikdienas aktivitāšu rezultātā rada būtisku ietekmi uz klimatu. Pētījumā arī secināts, ka klimata izmaiņu samazināšanas politikai ir jābūt vērstai uz sektoriem, kas atbildīgi par lielāko daļu SEG emisiju, t.i. mājokli, transportu un pārtiku.

Jānis Brizga, Ivars Kudreņickis, Household climate impact in Latvia: measuring carbon footprint

People more and more recognize climate change as one of the main environmental problems and the term 'carbon footprint' (CF) has become popular and is now in widespread use. In this paper, the CF concept has been applied to analyse average per capita household Greenhouse Gas (GHG) emissions in Latvia. We explore household CF in housing (heating and electricity consumption), transport, food and goods and service sectors, which are the main household environmental pressure areas. This paper provides an understanding of both direct and indirect (embodied) GHG emissions. Results from the study suggest that the average Latvian exceeds its global fair share of GHG emissions – the average per capita GHG in 2006 was 4.35 t CO2e. The highest household emissions arise from housing (37%), mobility (26%) and food consumption (25%), goods and services together account only for 12% of total household GHG emissions. This study, however, does not

cover capital investments in infrastructure (roads, public buildings etc.) which could increase total emission by almost a ton. The study emphasizes that attention must be paid to the lifestyles, infrastructure and institutions that result in considerable amounts of carbon being locked up in the household activities through which people meet their everyday needs. The findings also indicate that policies should be targeted at the segments in society responsible for the highest carbon footprints, ie. housing, food and mobility.

Янис Бризга, Иварс Кудриеницкис, Влияние домашних хозяйств на климат в Лавтии: показатель следа углерода

Люди всё больше и больше признают изменение климата как одну из самых главных проблем окружающей среды, и термин след углерода стал популярным и широко используемым. Для анализа средних годовых эмиссий газов с парниковым эффектом (ГПЭ) от одного жителя Латвии, в этой статье использована методика следа углерода. Эти эмиссии анализировались в разных категориях потребления: жилище (потребление тепловой и электрической энергии), транспорт, сектор товаров и услуг, которые являются главными влияющими на среду сферами домашнего хозяйства. Были рассмотрены как прямые, так и косвенные (вложенные) ГПЭ эмиссии. Результаты исследования позволяют сделать заключение, что в среднем на жителя Латвии в 2006 году приходится 4,35 тонн CO_2е, и это превышает глобальнодопустимое годовое значение. Большая часть (37%) этих эмиссий связана с домашними хозяйствами, 26% - с транспортом, 25% - с потреблением продовольственных продуктов, товары и услуги вместе составляют 12% от общих ГПЭ эмиссий. Однако в это исследование не включены ГПЭ эмиссии вложенные в капиталовложения (дороги, здания, инфраструктура), которые могли бы увеличить общий обьём эмиссий на одного человека на одну тонну. Результаты исследования заставляют сделать вывод, что наибольшее внимание в уменьшении влияния домашних хозяйств на климат нужно обратить на стиль жизни, а также инфраструктуру и органы, которые, независимо от моделей поведения жителей, создают существенное влияние на климат многими каждодневными нуждами домашних хозяйств. В исследовании также выведено, что политике по уменьшению изменений климата нужно быть направленной на секторы, которые отвечают за большую часть ГПЭ эмиссий, то есть жилище, транспорт и продовольствие.