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AN INTEGRATED TOOL TO ASSESS THE CLIMATE AND HEALTH BENEFITS OF URBAN STRATEGIES AND MEASURES

Niko Karvosenoja[1], Ismo Hämäläinen[1], Santtu Karhinen[1], Mikko Savolahti[1], Ville-Veikko Paunu[1], Janne Pesu[1], Jaakko Kukkonen[2], Timo Lanki[3,4]

[1] Finnish Environment Institute (SYKE), Helsinki, Finland
[2] Finnish Meteorological Institute, Helsinki, Finland
[3] Finnish Institute for Health and Welfare (THL), Kuopio, Finland
[4] University of Eastern Finland, Kuopio, Finland

Abstract: Climate change mitigation experts and policy makers need tools to quantify the impacts of climate measures on air pollution, human health and costs to the society. We have developed a harmonized tool ALasSken-ihQ (Impact Assessment Tool for Climate Measures in Cities), that enables the assessment of climate measures' effect on GHG emissions and PM2.5 induced health impacts and costs in an integrated manner. We will present the main features and demonstrate the use of the tool.

Key words: *greenhouse gases, climate, fine particles, emissions, human health, costs*

INTRODUCTION

Climate change mitigation actions are needed at all levels of society. Decisions are made at cities concerning many major greenhouse gas (GHG) emission sources, e.g. urban transport and residential heating. Often such local emission sources cause, in addition to GHGs, emissions of air pollution harmful to human health, such as fine particles (PM2.5).

Experts and policy makers who prepare city level strategies call for tools to assess the efficiency of climate mitigation measures in terms of potential to reduce GHG emissions. In addition, they wish to obtain information about the side-effects of the climate measures to the society, especially impacts on human health. To match the needs for the capabilities to assess the health externalities caused by various local air pollution emission sources, a health damage cost tool for city experts (ihQ) was developed in an earlier project (Karvosenoja et al., 2021).

However, the ihQ tool provides only limited information about the efficiency of actual climate or air pollution measures to reduce emissions. According to the interviews of city experts on the use of the ihQ tool, the main limitation of the use of the tool is, how to estimate air pollution emission changes due to different climate or air pollution measures. Therefore, we have now integrated the ihQ tool within the city level ALasSken scenario tool that allows users to interactively study the implementation of individual climate measures on-line.

In this text, we will present a harmonized tool, ALasSken-ihQ (Impact Assessment Tool for Climate Measures in Cities), that enables the assessment of climate measures' effect on GHG emissions and PM2.5 induced health impacts and costs in an integrated manner. We will demonstrate the architecture and functionalities of the tool user interface.

METHODOLOGY

The ALasSken-ihQ tool combines the functionalities of the regional GHG emission scenario calculation ALasSken and municipality health damage cost tool ihQ. The following chapters present the main features of both.

ALasSken

The ALasSken tool has been developed to support the planning of municipal climate roadmaps that identify measures to reduce regional GHG emissions. As a starting point for each individual municipality, the tool includes a Baseline scenario with existing measures that depicts exogenous GHG reductions resulting from national roadmaps, strategies, and subsidy mechanisms. Thereafter, user of the tool can define additional measures in each emission sector (see e.g., Karhinen et al., 2021) to examine a set of action sets, by which one can achieve the regional emission reduction targets. The action set can include, for example, reduction in oil heating, changing the fuel mix in district heat generation, and improving the accessibility of different services within the municipality.

ihQ

The ihQ tool assesses the effect of changes in air pollution emissions originating from different emission source sectors on human health impacts attributed to the $PM_{2.5}$ concentrations for selected municipalities. The modelling covers both primary $PM_{2.5}$ and secondary formation from main inorganic PM precursor gases. The health impacts are expressed as monetary values, i.e. health damage costs, based on Nordic Value of Statistical Life (VSL) estimates. The modelling set-up and the use of the IhQ tool have been reported in detail in Karvosenoja et al. (2021) and Kukkonen et al. (2020).

Integrated ALasSken-ihQ

The harmonized open-access ALasSken-ihQ tool will present on-line GHG emissions as well as $PM_{2.5}$ emissions and their health impact induced damage costs of the studied measures. First, the tool was developed for measures in the road transport sector to examine, e.g., how improvements in service accessibility, public transportation and light traffic network would decrease passenger car driving distances, and thus, reduce the GHG and exhaust and non-exhaust primary $PM_{2.5}$ emissions. The first version of the ALasSken-ihQ tool does not include the calculation of secondary PM.

USER INTERFACE AND BASELINE SCENARIO

ALasSken-ihQ is to be developed for an on-line open-access tool. As for autumn 2022, the development is still partly in progress. An english demo-version with functionalities for health damage cost calculation only in the road traffic sector can be found in https://ihq-demo-harmo.netlify.app/. The final version will be launched at the end of 2022. The following will present the main features and the use of the ALasSken-ihQ tool.

The user of ALasSken-ihQ first selects the city in question from the list of 310 Finnish municipalities. The tool opens a Baseline scenario for the city in 2030 that includes already decided climate actions. This stage is depicted for Helsinki as an example in Figure 1. For Helsinki the Baseline scenario includes, e.g., phase-out of coal in district heat production, promotion of energy renovations in public buildings and measures to promote public transport (e.g. City of Helsinki, 2018).

The user view shows GHG emission reductions in the Baseline scenario in 2030 compared to the reference year 2007 (-55.1% in case of Helsinki), and the gap still remaining to reach the goal which is 80% GHG emission reduction (876.3 kilotons of CO2 equivalents). User can also change the assumption of emission reduction target using the respective slider.

The lower part of Figure 1 shows the different activity sectors where it is possible to vary the extent of how different climate measures are used. The view shows also how much GHG emissions are reduced in the Baseline scenario 2030 compared to 2007 in each of the sectors (i.e. 61.0% in Buildings: Energy use, 41.1% in Road Traffic and 44.0% in Other sectors). The following chapter describes the way these climate measures in Road Traffic sector can be studied and the results as impacts on GHG emissions, PM2.5 emissions and health damage costs.

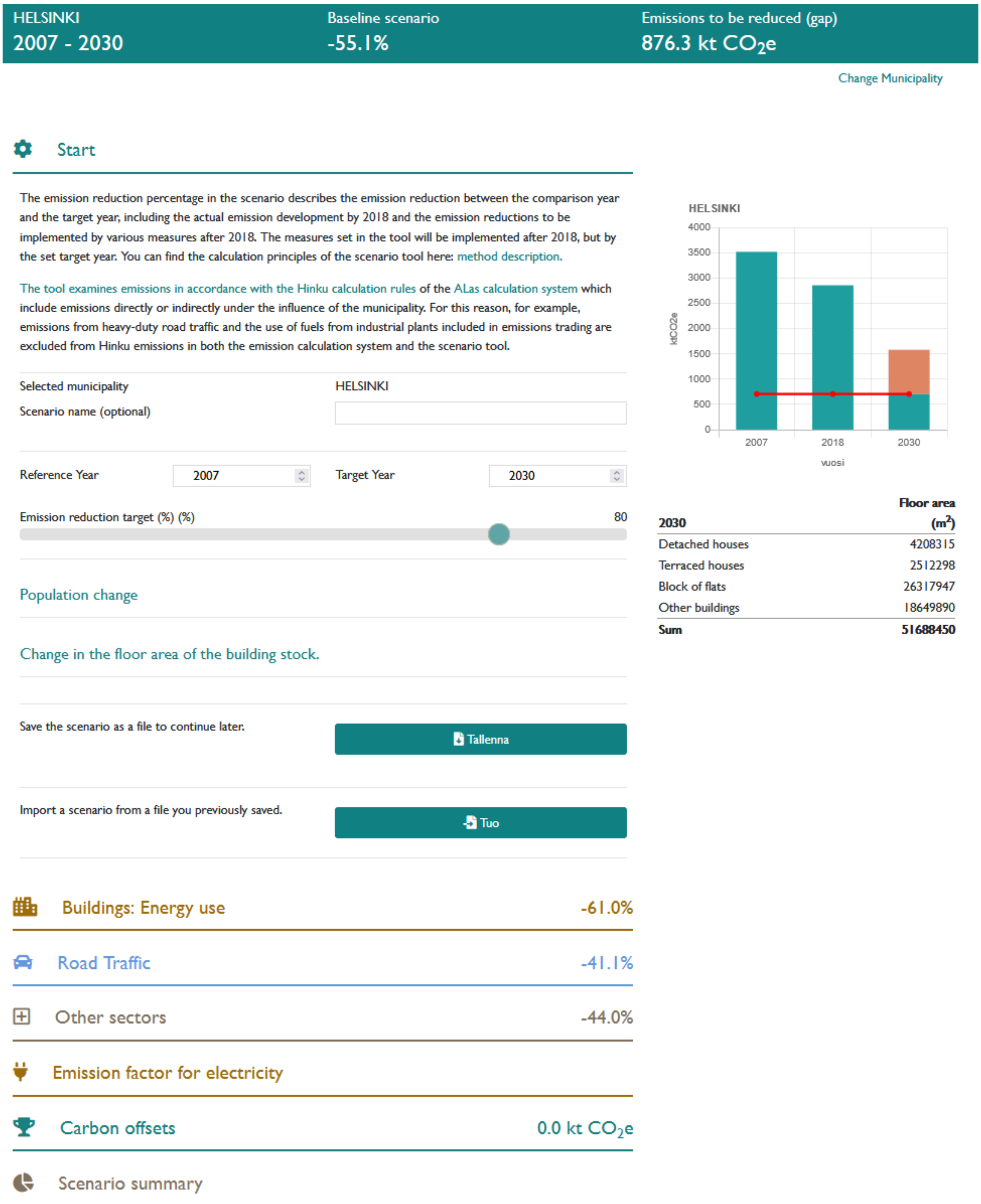


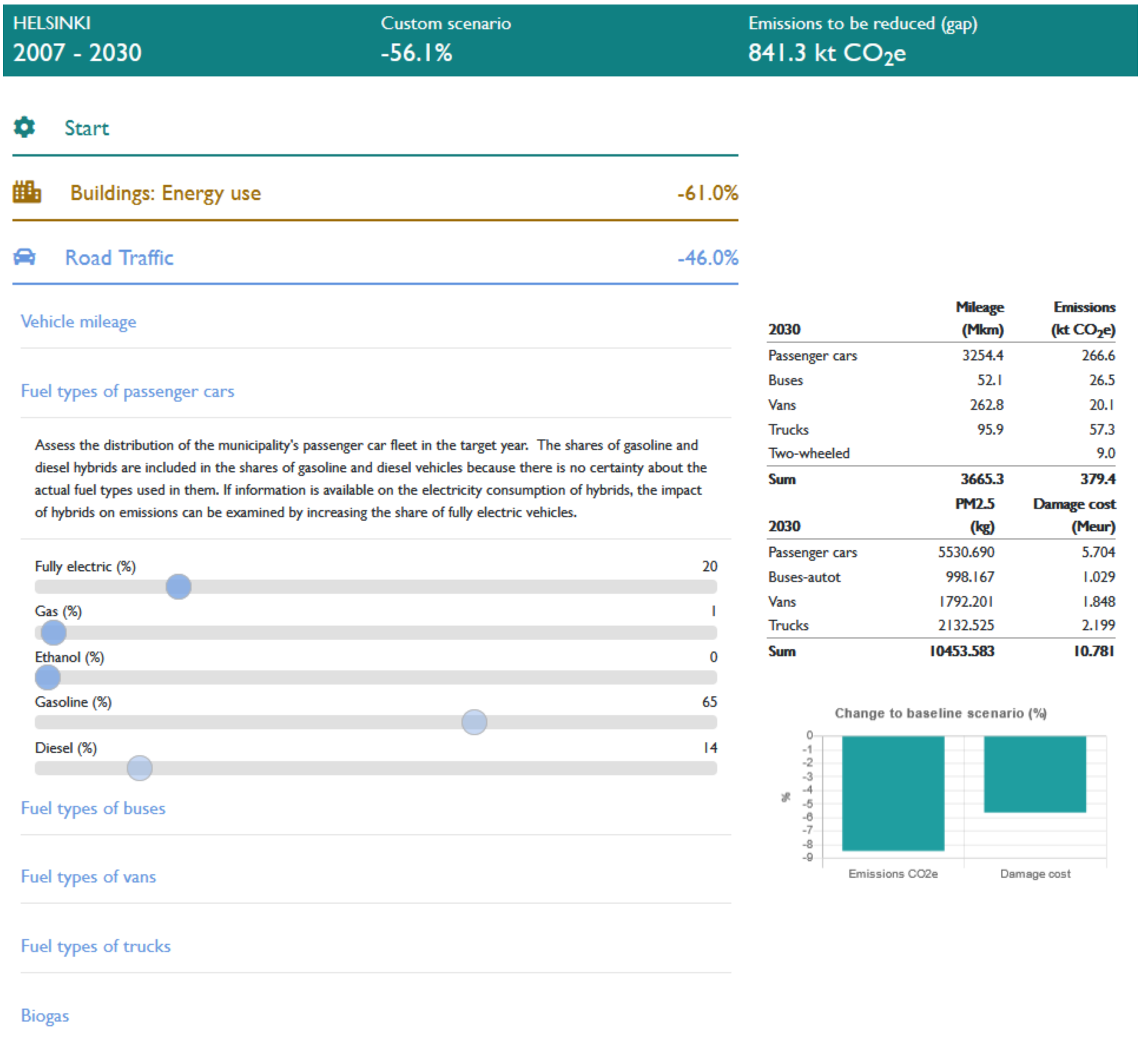
Figure 1. User interface of ALasSken-ihQ with the Baseline scenario for Helsinki

ADDITIONAL CLIMATE MEASURES AND HEALTH DAMAGE COSTS CAUSED BY $PM_{2.5}$

The basic idea of the ALasSken-ihQ tool is to enable user to study the introduction or the rate of the use of individual climate measures. By clicking the sectors, the tool will open the selection of sub-sectors, and further the selection of measures. Figure 2 shows as an example the selection of varying the rate of different fuel types of passenger cars in the Road Traffic sector. In addition to fuel types of different types of vehicles, other measures in the Road Traffic sector include mainly measures related to vehicle mileage (e.g. accessibility of grocery stores, schools, public transport etc., congestion outside the city, shares of public transport and other transport modes, improvements of cycling infrastructure etc.).

In Figure 2, the user has changed the share of fully electric passenger vehicles to 20% (instead of 6% in the Baseline scenario), which increases the total GHG emission reduction in Helsinki by 1%-unit compared to the Baseline scenario, to 56.1% from 2007. Respectively, GHG emission reduction in the Road Traffic sector increases from 41.1% to 46.0%.

The detailed results as vehicle mileage, GHG emissions, PM2.5 emissions and health damage costs due to PM2.5 are shown on the right-hand side of the user view. In addition, the bar figure below the tables shows the relative change compared to Baseline scenario. As the user applies the sliders, the numbers and bars changes simultaneously, which makes quick, screening-type studying of the measures practical.



2030	Mileage (Mkm)	Emissions (kt CO2e)
Passenger cars	3254.4	266.6
Buses	52.1	26.5
Vans	262.8	20.1
Trucks	95.9	57.3
Two-wheeled		9.0
Sum	**3665.3**	**379.4**

2030	PM2.5 (kg)	Damage cost (Meur)
Passenger cars	5530.690	5.704
Buses-autot	998.167	1.029
Vans	1792.201	1.848
Trucks	2132.525	2.199
Sum	**10453.583**	**10.781**

Figure 2. User interface of ALasSken-ihQ with one additional measure on road traffic (higher percentage of fully electric passenger cars) on top of the Baseline scenario for Helsinki

CONCLUSIONS AND NEXT STEPS

The ALasSken-ihQ is an open-access, user-friendly web-based assessment tool. It provides opportunities for municipality and city level experts to quickly evaluate the impacts of various climate measures on both (i) GHG emissions and (ii) the health impacts and costs attributed to the $PM_{2.5}$ pollution.

In the first phase the tool was developed to include only measures in the road transport sector. In the future, it will be extended to cover other sectors relevant to urban air pollution, especially residential heating and machinery. In addition, the modelling framework will be further developed to include investments and other costs of climate measures, as well as macro-economic effects to the society, in order to enable performing more complete cost-benefit analysis. The tool could be extended to function also for other countries, if the underlying emission and dispersion computations would be available for the region.

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