

The background of the slide is a photograph of several large, black, cylindrical pipes or conduits. These pipes are arranged in a parallel fashion, extending from the bottom left towards the top right of the frame. They are partially submerged in dark, still water, which reflects the sky and the surrounding environment. The pipes appear to be made of a dark material, possibly metal or plastic, and have some white markings or labels on them. The overall scene suggests an industrial or urban infrastructure context, likely related to water or heating systems.

Transforming urban heating systems

*The multi-scalar connections for
water use, committed emissions
and energy justice*

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and Edo Abraham
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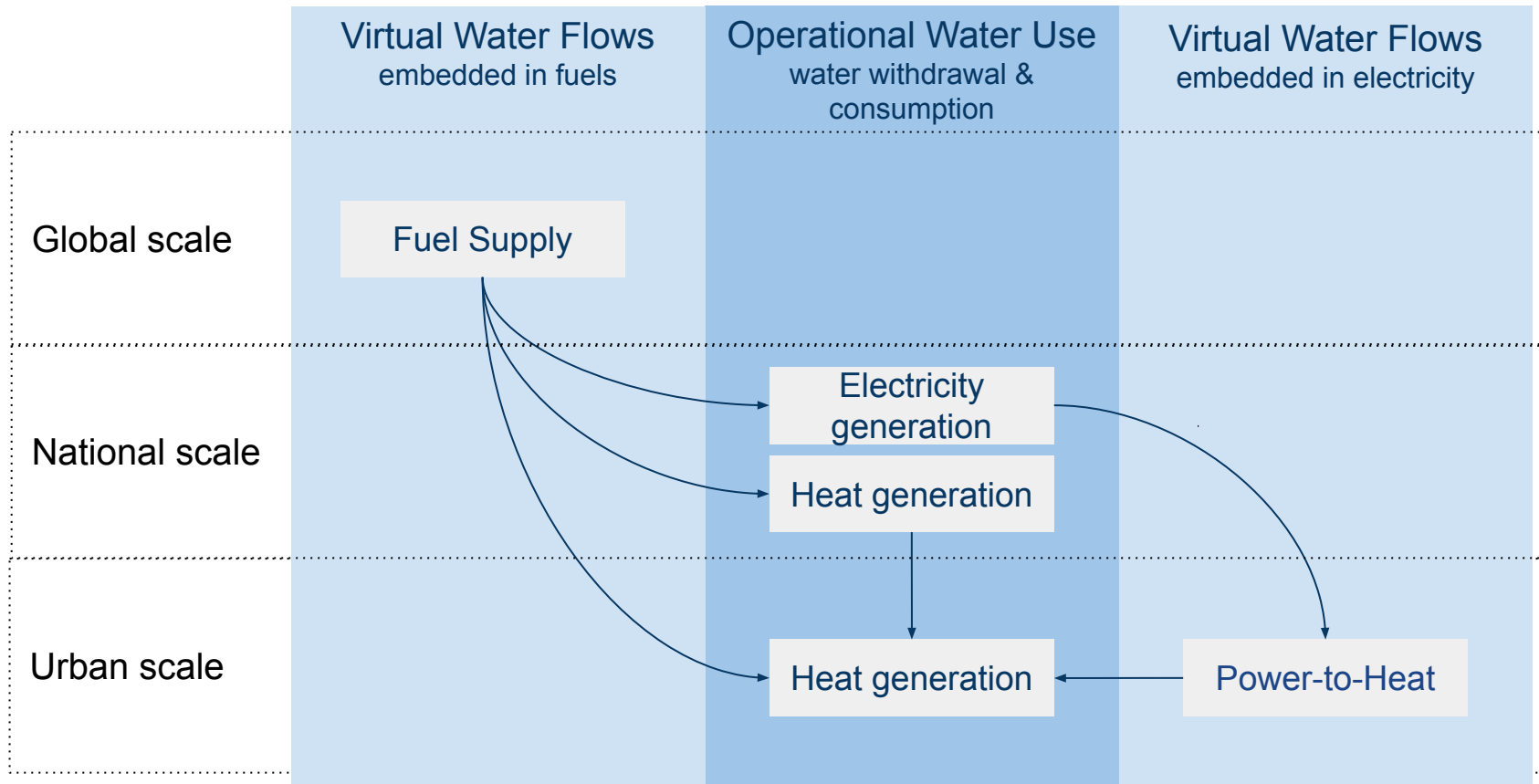
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The water use of heating pathways to 2050: analysis of national
and urban energy scenariosC Kaandorp^{*} , N van de Giesen and E AbrahamDelft University of Technology, Faculty of Civil Engineering and Geosciences, Department of Water Management, Stevinweg 1, 2628 CN
Delft, The Netherlands^{*} Author to whom any correspondence should be addressed.E-mail: c.kaandorp@tudelft.nl**Keywords:** low-carbon heating pathways, water-energy nexus, water withdrawal, water consumption, virtual water footprint,
power-to-heat, multi-scale energy and water use modelSupplementary material for this article is available [online](#)

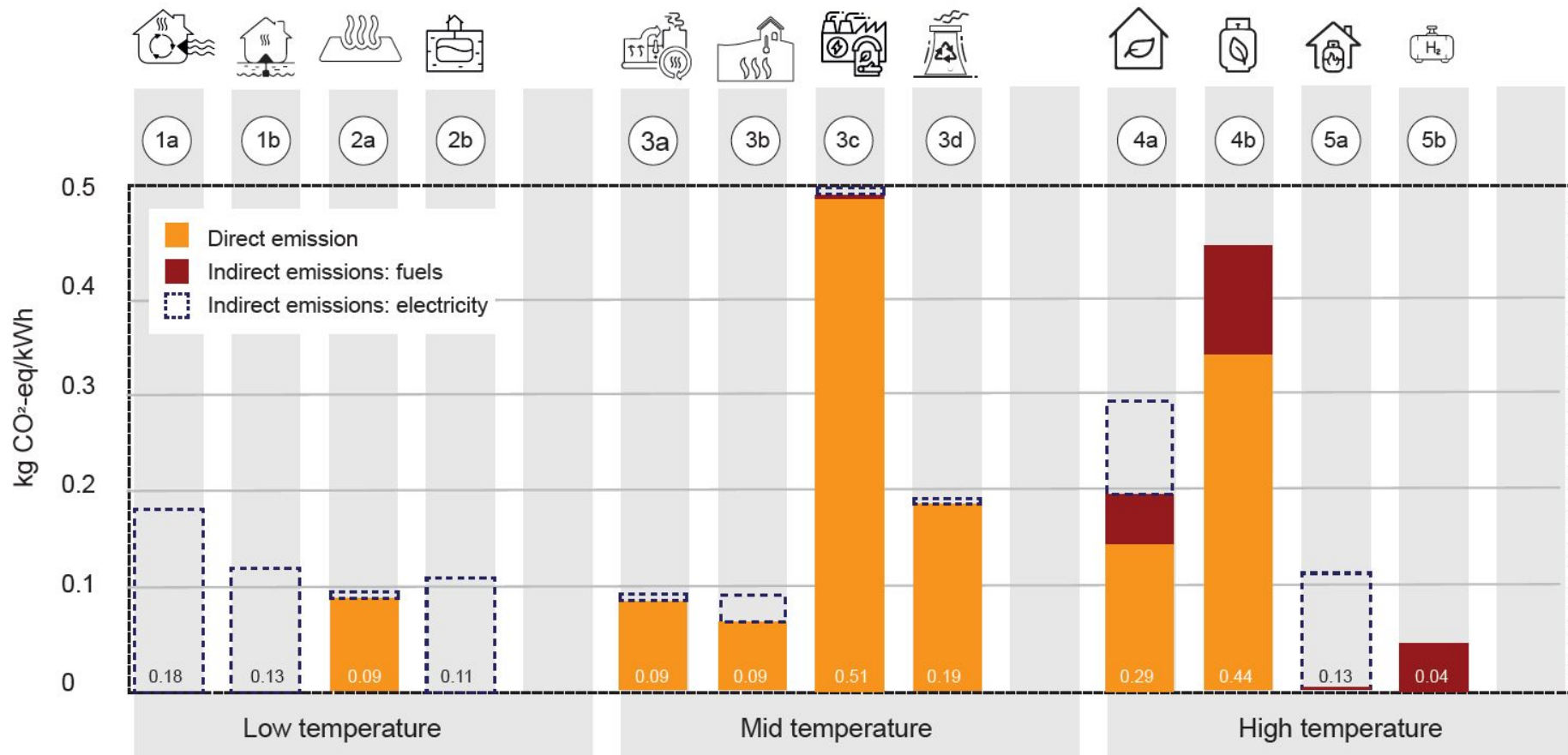
Abstract

Sustainable energy systems can only be achieved when reducing both carbon emissions and water use for energy generation. Although the water use for electricity generation has been well studied, integrated assessments of the water use by low-carbon heat systems are lacking. In this paper we present an analysis of the water use of scenarios for heat and electricity production for the year 2050 for the Netherlands and its capital, Amsterdam. The analysis shows that (i) the water withdrawal for heating can increase up to the same order of magnitude as the current water withdrawal of thermoelectric plants due to the use of aquifer thermal energy storage, (ii) the virtual water use for heating can become higher than the operational water consumption for heating, and (iii) the water use for electricity production becomes a relevant indicator for the virtual water use for heat generation because of the increase of power-to-heat applications.

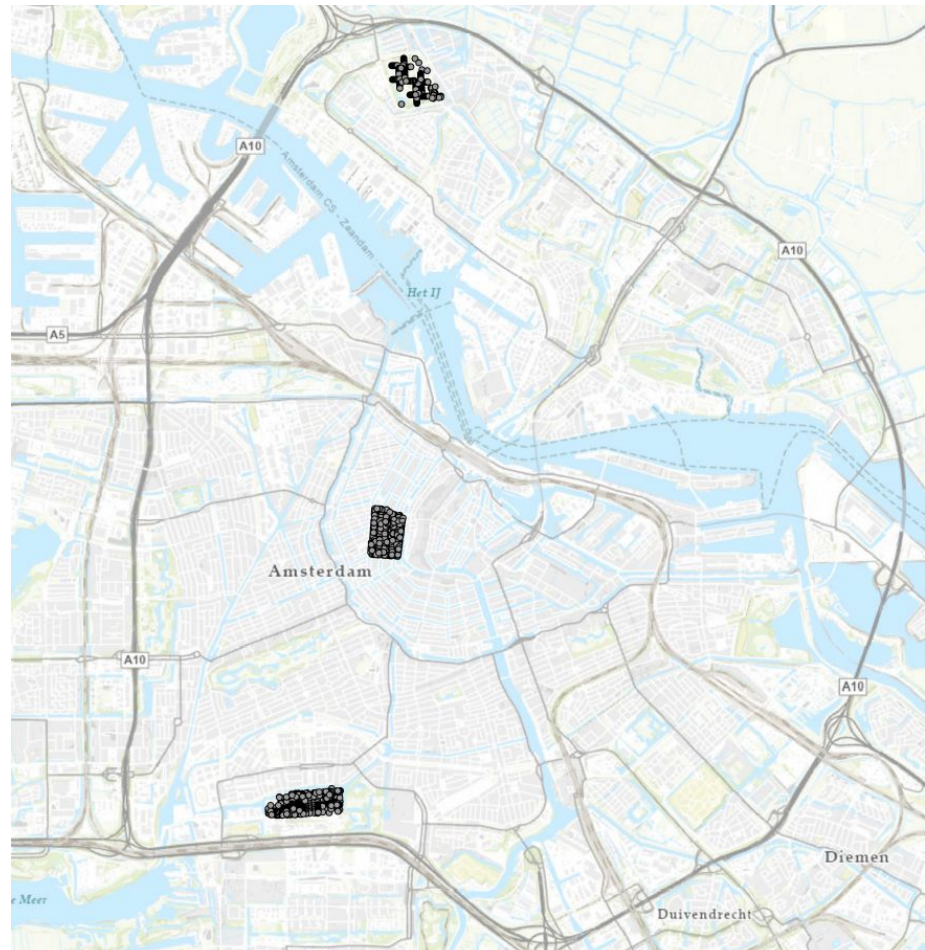
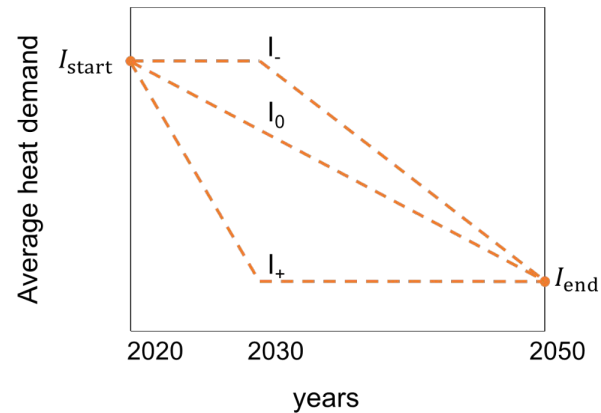
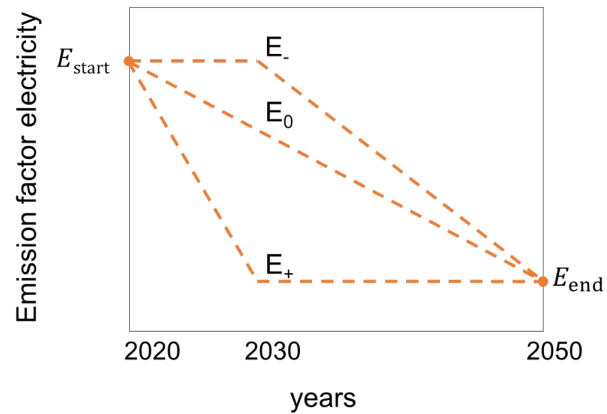
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Multi-scale Water-Energy use model



Emission factors per heating system



Optimization model for committed emissions



Energy justice and commoning practices

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Published paper on water use:

<https://iopscience.iop.org/article/10.1088/1748-9326/abede7/pdf>

Policy brief:

<https://www.verdus.nl/project/enlarge/>