Master Thesis Assignment: Towards the Optimal Deployment of Residential Solar Photovoltaic Systems in the Netherlands

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1 Introduction

The supply of electrical energy to households in the Netherlands is undergoing drastic changes. The energy transition needs to account for the gradual phasing out of hydro-carbon fuels and the influx of large amount of renewable energy from solar and wind sources. An additional complexity is the electrification of transport and the large amounts of energy required for personal electrical vehicle charging. The change in energy landscape is expected to have a significant impact on infrastructure in cities and towns.

De Warmte Transitie Makelaars (DWTM, see warmtetransitiemakers.nl) is a small engineering and consultancy firm that aims at accelerating the transition away from an economy based on fossil fuels. The firm assists towns, housing corporations, neighbourhood initiatives, network operators and energy companies in projects geared towards replacing natural gas. To increase its portfolio of instruments, DWTM is eager to develop new mathematical modeling and numerical simulation tools for the deployment of photovoltaic systems for residential use. This assignment explores the development of such tools.

This assignment is split into two tasks that are described below.

2 First Task: Development of software tool to access the capacity of residential buildings to host photovoltaic-thermal collectors

First goal of this assignment is to develop a software tool that allows to optimize the size, amount and location of combined photovoltaic-thermal systems [1] to be installed. The tool will estimate the capacity of residential buildings to host these system. The tool will use as input data from opensource geographical information databases. Such databases include the Addresses and Buildings Key Register (BAG [2]), the Registratie Actueel Hoogtebestand Nederland (AHN3 [3]), information of the energy consumption of building [4], aerial photos and local weather predictions. The expected output is an enriched building database that provides optimal locations for photovoltaic-thermal collectors. This database should be easily accessible in software like QGIS [5] and/or Python. This database will help to analyse the power demand of residential areas. Simulations in which the demand varies on an hourly, daily and seasonal scale will be performed. Economic factors that allow to balance supply and demand will have to be taken into account.

3 Second Task: Development of software tool to access the amount of installed photovoltaic panels

Second goal of this assignment is to develop a software tool to assessment the amount of photovoltaic panels already installed in residential areas in the Netherlands. The tool will apply object recognition techniques [6] on large data sets of satellite images acquired using LIDAR [7] and possibly other techniques. A description of how similar ideas have been used to identify individual cars in a traffic stream is described in [8].

4 Final Scope

The previous two tasks will contribute to the coordination supply of solar energy to Dutch household and to the advice that DWTM will be able to give to its clients. In this coordination other energy source (geothermal, industrial heat, wind and storage), loads (electrical vehicle charging and domestic loads) and weather conditions will be taken into consideration.

5 References

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6. Object Recognition:`https://en.wikipedia.org/wiki/Outline_of_object_recognition`
7. LIDAR: `https://en.wikipedia.org/wiki/Lidar`
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