

Title: Sustainable Energy Autarky for New City Development

Decentralized renewable energy systems can fulfil local energy demands while decreasing the pressure that energy consumption puts on the environment. The largest challenge in implementing these systems is found in urban environments where the energy consumption is very concentrated. This challenge is addressed in a case study of the currently redeveloping Merwe-Vierhaven neighbourhood in Rotterdam. This research studies the possibilities of Merwe-Vierhaven to optimize its energy balance and become electricity self sufficient. To come to this optimization we study: 1) Energy consumption, 2) Energy production, 3) Load shifting in smart grids and 4) Usage of electric vehicles as energy storage devices.

The first part of the research calculates the energy production and consumption for different scenarios based on a timeframe of 1 year. Two different energy consumption scenarios are developed: the SMARTcity represents a society similar to the present for which a small growth in energy consumption is assumed until 2025. The GREENcity on the other hand describes a society in which energy conservation techniques are applied and the consumption is lowered up to 55%. The energy production is found to vary strongly with the available roof surface because of the large share of solar PV. With this it is found that when low rise buildings are constructed it is indeed possible to balance demand and supply in the area. The influence of electrifying the energy demand for heat and transport is also studied. It is found that the living potential of the neighbourhood can only keep that on an average city when a moderate shift (10% EV and/or heat pumps only for hot tap water, not for heating) towards electrification of the energy demand for heat and transport is made. Besides, applying these new technologies should be combined with energy conservation, as described in the GREENcity scenario to maximize the living capacity of the neighbourhood. In the second part of the research hourly production and consumption profiles are used as input for the EnergyPLAN model. The EnergyPLAN analysis reveals that the area is not self sufficient at all times. Moreover, even when a smart grid is implemented that can shift the load of flexible devices (household appliances and EVs), not more than 48% of the energy is directly consumed upon production. Storage through vehicle to grid, under the modelled conditions, does not make the energy balance more advantageous.