Title: An integral approach for utility functions electricity, heat, hydrogen and water: the SPX project in the Netherlands.

Theo Fens
Els van der Roest
Niels Hartog

Abstract
The 2015 Paris Agreement is the foundation for the energy transition in the Netherlands. By 2050 all fossil based energy sources need to be replaced by renewable sources. The Dutch SPX project (System design Power to X) is a realisation of the energy transition in an urban environment and encompasses a novel integral approach for utility services. The system is based on an integration of production, conversion and storage of renewable energy on a neighbourhood level, with heat and hydrogen as the most important energy carriers. Simulations with a for this purpose developed model that is able to analyse the system on an hourly basis, showed that this, in a first order approximation, is technically and economically feasible. These simulations provide the basis for the SPX project with the objective to practically prove that such an integrated utility service system can be realised.

Novel in the SPX project is the use of a high temperature (60 ˚C) heat storage in a subsurface aquifer to allow the use of efficient power to heat conversion in connection to a district heating network. A large MW size heat pump is employed to allow extracting of heat from surface water and groundwater (for cooling) in summer with renewable PV and wind based electricity. In winter, the stored heat will be recovered to meet the heat requirements of residential housing. As such a four season round renewable heat/cooling coverage can be achieved.

Another novelty in the SPX project is the abundant use of DC technology (Direct Current). The present electricity system is traditionally based on AC (Alternating Current). New developments in power electronics enable more and more applications based on DC. For example PV panels, electric vehicles, heat pumps etc. Also in high voltage transmission systems DC is increasingly applied (HVDC). In addition, appliances that we use on a daily basis are in majority running on DC: PCs, laptops, smart phones, TVs, tooth brushes, induction cooking and led lighting. For all these appliances to function, AC is converted to DC, and vice versa for PV panels. These conversions suffer from disadvantages such as losses, which can be omitted by (re)designing systems such that they can function on DC directly. In the SPX project the objective is that the systems and the distribution network are designed and implemented such that they can function on DC directly.