FLEXe

Future Energy System

Multi-scale simulation results

- **Feasibility** of multi-level approach demonstrated
- **Ability** to assess technical feasibility of optimized running schedule **demonstrated**.

Basic model simulation results

- **Reliable model** which can simulate one year with 60s resolution in about 10h on a laptop. Logged data are exported at 1h resolution
- Results from **alternative heating grid pressure control algorithms** (focus on the worse case consumer pressure difference)
- Results on **predictive feedwater temperature control algorithm** based on short term weather forecasts (collaboration with FMI, scientific publication)

District heating network simulation and optimization

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Background

A case based prototype simulation analysis of district heating network performance was conducted with WILMAR, EnergyPRO and Apros tools.

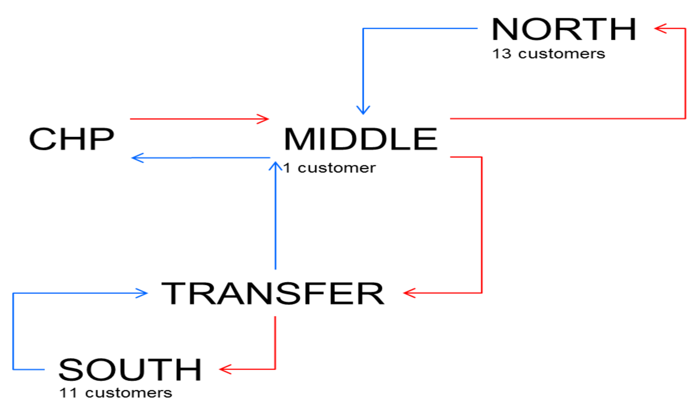

Figure 1. Schematic of the DH network.

Data of WP1 contributions from scenarios (VTT) and optimizations (Aalto) were integrated with the network model (VTT).

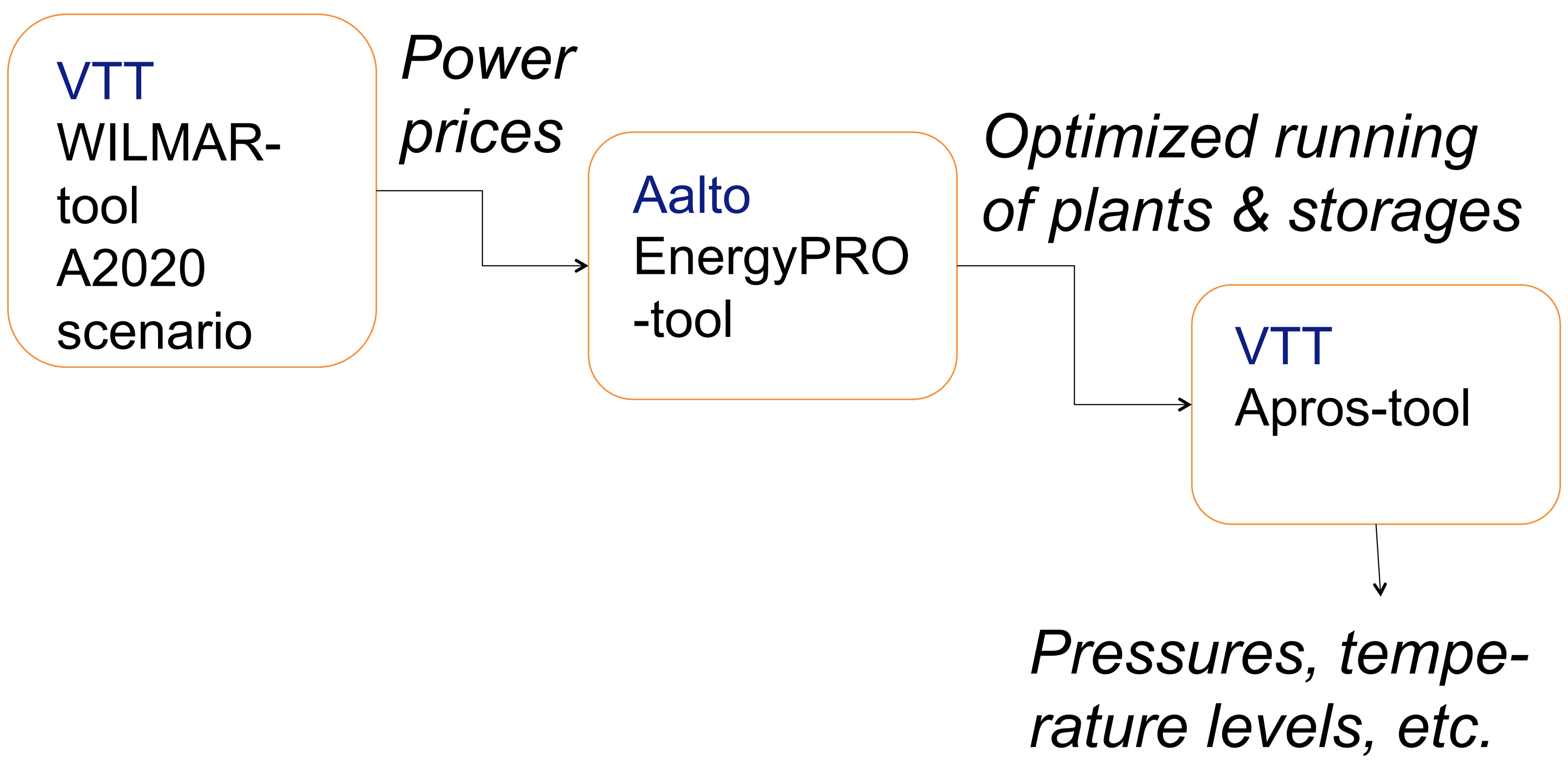

Figure 2. Data flow from one tool to another.

The WILMAR model

WILMAR was used to simulate the operation of the whole North European energy system with electricity and heat sectors.

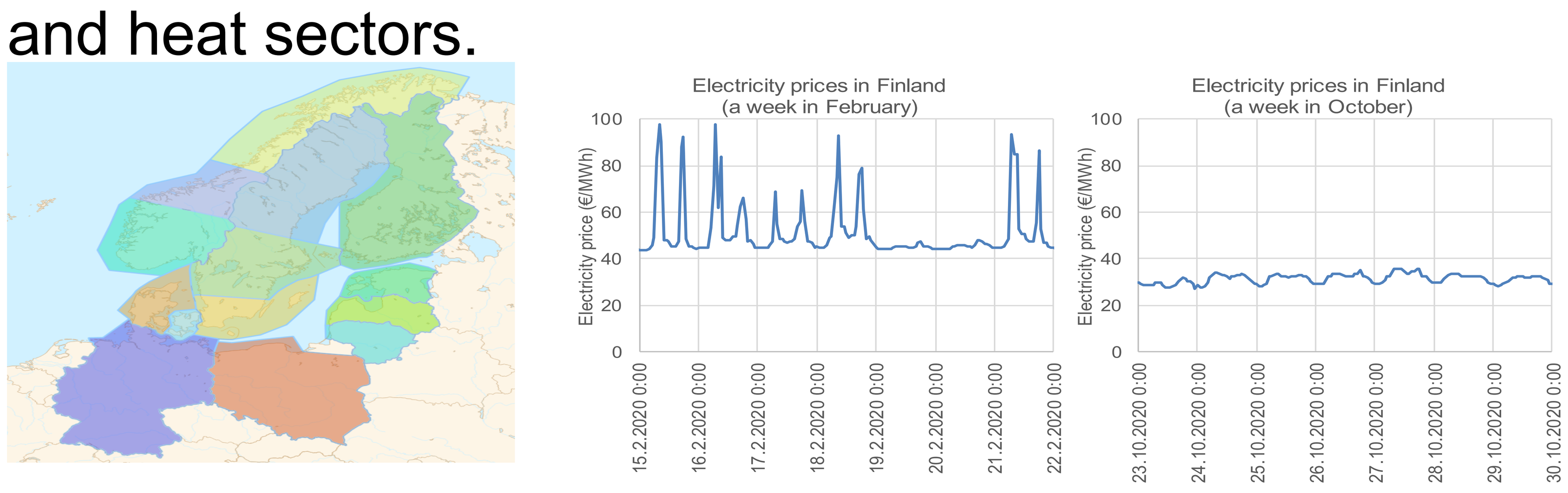

Figure 3. Left: The regions modelled in WILMAR. Each region can contain one or more district heating areas.
Right: Resulting electricity prices in Finland from example weeks.

The EnergyPRO model

Optimal hourly running patterns for a DH system with CHP production, heat pump and heat storages was studied in three future electricity price scenarios. The model solves the optimal operation strategy by minimizing the annual operating costs so that hourly heat demand is met. The minimized costs include fuel prices and taxes, revenues from electricity sales, subsidy for electricity produced with forest chips and start-up costs of the plants. It was found that in this case a larger than now usual heat storage (1% of the annual DH energy) reduces annual operating costs significantly. The relative profitability of CHP and heat pump depend on fuel and electricity prices etc. In general, it seems that it is good to have both in DH network to at least moderate extent.

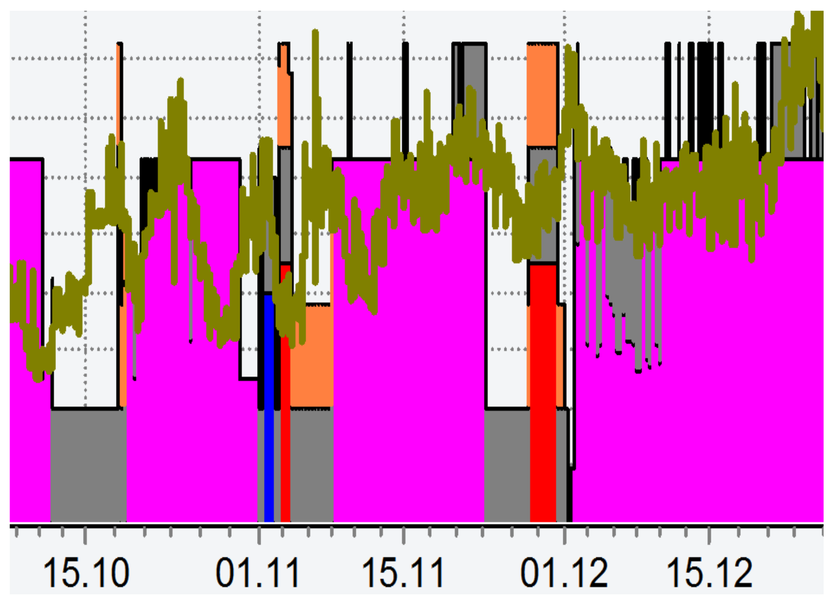

Figure 4. An example of a simulation result. Heat productions during some months for CHP (magenta), heat pump (grey) and heat-only- boilers (red, orange). Heat demand is the green line. Large heat storages allow the plants to run in full power when the production cost is low.

The Apros model

A realistically dimensioned first principles model of the case system was built (1 power source, 1 heat storage, 25 consumers of 4 types distributed in 3 areas), based on work of the EFEU program. Model was used to evaluate technical feasibility, e.g. obtained customer

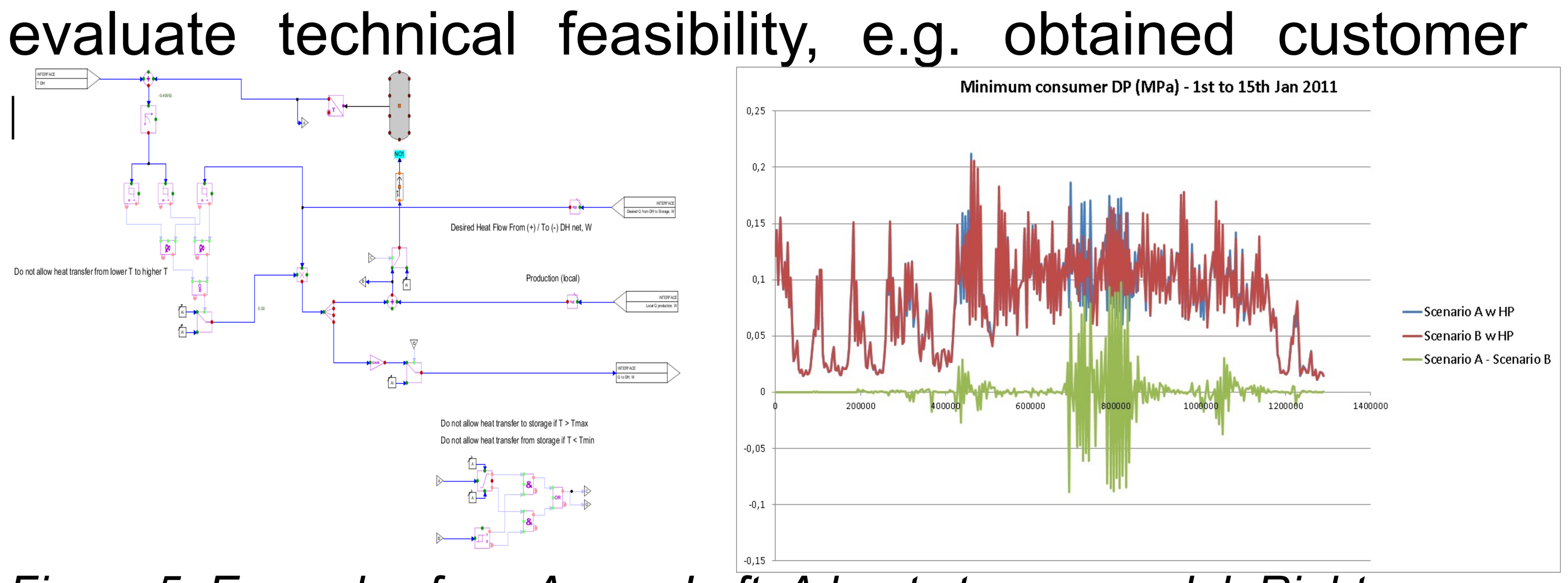

Figure 5. Examples from Apros. Left: A heat storage model. Right: Example simulation result for two weeks, with different electricity prices.