Analysis of solar-assisted heat pump using hybrid PV/T in Norwegian conditions

Graduate

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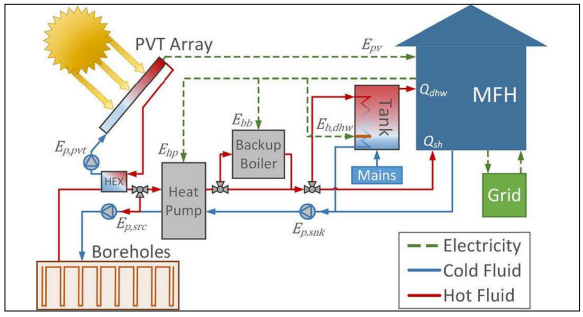
Initial Situation: Many buildings in Norway are heated with direct electric heaters. With Norway's high share of green electricity, this is not necessarily bad. But in a greener, less fossil fuel dependent future, electricity will be used in other sectors as well. Thus, a more efficient way to provide heat for residential buildings is required. A good solution are heat pumps preferably coupled with ground heat. In urban areas this could lead to a cooling of the ground, leading to a lower performance of the heating system. To overcome this, a regeneration of the ground with excess solar heat during summertime could be a possible solution.

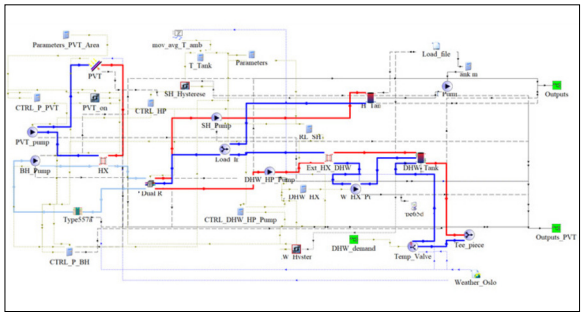
Approach: The method comprises the evaluation of an appropriate multi-family building from the Norwegian building stock, which is implemented into TRNSYS simulation software. Further on, a ground source heating system and a solar assisted ground source heating system using photovoltaic thermal (PV/T) collectors are modelled. Afterwards, system variants are simulated over an appropriate timeframe to rate and compare the performance of the different system variants.

Result: The essential results of the performed simulations show two main benefits from using a 150 m2 PV/T assisted ground-source heat pump (GSHP) system compared to a GSHP system. Despite a reduced spacing between the borehole heat exchanger from 20 m for the GSHP and just 10 m for the PV/T assisted ground-source heat pump system, the performance after 50 years is equal. It is possible to reduce the borehole depth for the PV/T assisted GSHP system by 10% and still meet the requirements for the borehole heat exchanger. An advantage can also be seen in the progression of the temperature of the borehole heat exchangers when using PV/T. The temperature drop is reduced and an equilibrium is reached sooner. Approximately 58% of the electricity provided by the PV/T collectors can be directly used for the space heating and domestic hot water demand. The other share could be used by the households or sold to the electricity provider.

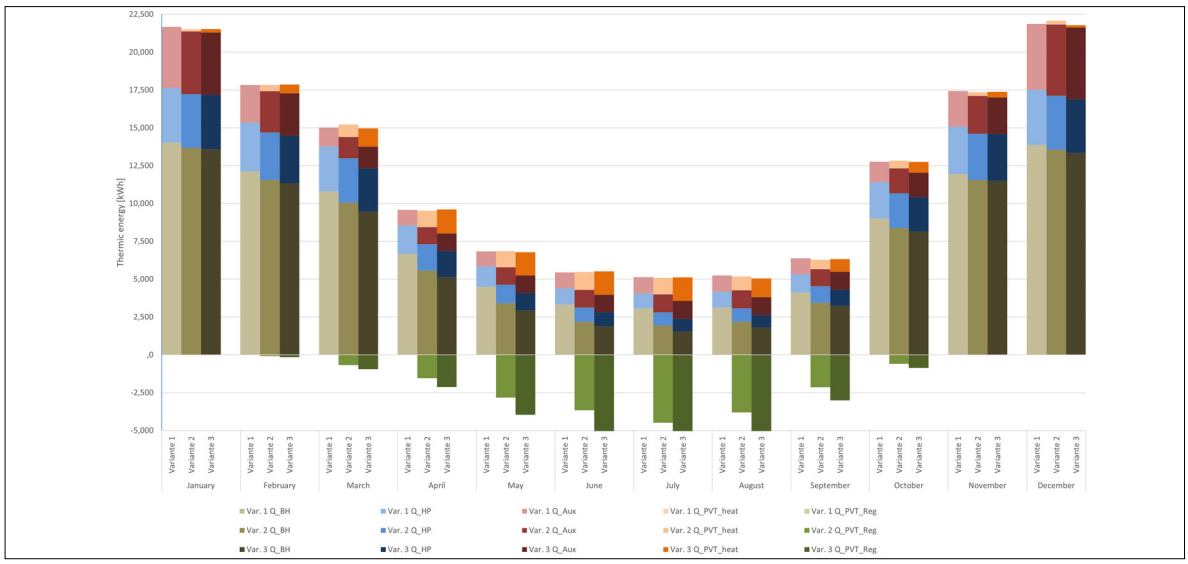
Scheme of the simulation model
Ground source heat pumps for Norwegian multi-family houses



Simulation model in TRNSYS
Own presentment



Thermal simulation results
Var 1: GSHP Var 2: GSHP with 100 m2 PV/T Var 3: GSHP with 150 m2 PV/T
Own presentment



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Subject Area
Building technology, Building physics, Heat pumps and geothermal energy, Electric solar technology, Solar thermal technology

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