About

Test objective name	MENB-TC01: Characterization of the effect of the voltage controller
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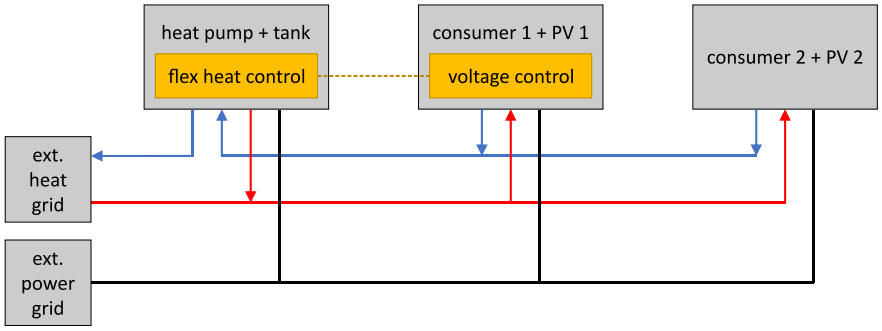
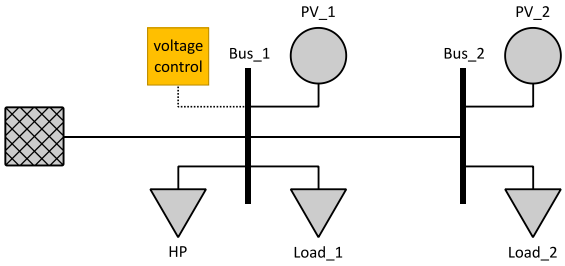
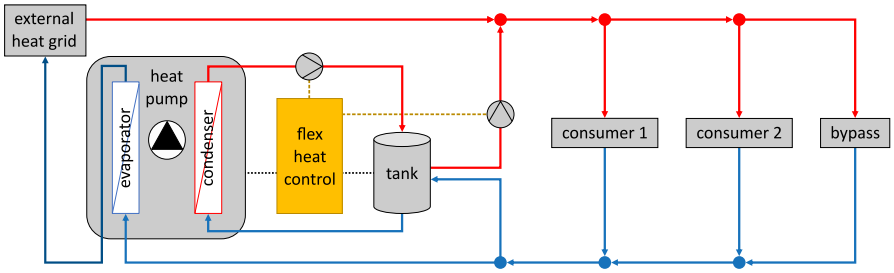
Short description	This test case addresses issues related to self-consumption in a local energy community (LEC) by characterizing the effects of a voltage controller within a multi-energy network setup. On the one hand, this includes the direct effects on the electrical domain, i.e., the reduction of voltage band violations and line overloadings in the power grid. On the other hand, the indirect effects on the thermal domain are characterized, i.e., the change in heat generation at the power-to-heat facility and heat supply of the district heating network.
Present use	Benchmark for (co-)simulation of multi-energy applications

Scope and goal

Test objective	☒ characterization ☐ validation ☐ verification ☐ optimization
Description incl. justification	In order for a LEC to be autonomous, the PV system has to be sized accordingly. However, a high power generation from the PV system without a corresponding high consumption on the consumer side can lead to a significant voltage rise in parts of the power grid. Therefore, synchronization of consumption with generation is necessary to ensure the power quality and avoid disruptions due to overvoltage limit violations. This is demonstrated with the help of a simple voltage control scheme for the example of the system configuration MENB-SC (see Figure 1 for an overview): • The voltage is monitored and the power consumption setpoint of the heat pump is adjusted (controllable/flexible load) to keep the voltage within acceptable limits. • The thermal sub-system uses a dedicated controller scheme – referred to as flex heat control – to operate the power-to-heat facility. It decides whether the heat supply is covered entirely through the external grid or whether the power-to-heat facility supports by discharging the tank. • If required, the heat pump is used to heat up the tank, always respecting the power consumption threshold from the voltage controller (i.e., the power consumption never exceeds the setpoint, but may be less).

	 Figure 1: Overview of the system configuration
System configuration	MENB-SC
Use case	MENB-UC01

Identification of test components

System Under Test	Due to the complex feedback between the thermal and the electrical sub-system, the voltage controller has an effect on the operation of both systems. Hence, this test case requires a joint assessment of the full multi-energy system for a complete characterization of the effects of the voltage controller. Figure 2 and Figure 3 show the details of the electrical and the thermal sub-systems, respectively.  Figure 2: Electrical sub-system including the voltage controller.  Figure 3: Thermal sub-system including the flex heat controller.
Object Under Investigation	The test case characterizes the effects of the voltage controller on the following components: • electrical busbars • electrical lines • heat pump • external heat grid
Function Under Investigation	• reduction of voltage band violations • reduction of line overloading • change in heat generation of the power-to-heat facility

Test criteria

Target Metrics	• $V_{bus,\,i}$ [p.u.]: voltage levels of electrical busbars (i = 1,2) • $\lambda_{line,\,i}$ [%]: line loadings of electrical lines (i = 1,2) • E_{hp} [MW_{th}]: total energy consumption of heat pump • Q_{ext} [MW_{th}]: total heat supplied by the external thermal grid
Acceptable test result	N/A