MODELING OF ICE STORAGES FOR INTEGRATION IN SMART COMBINED HEAT, COLD AND POWER (CHCP) PLANTS

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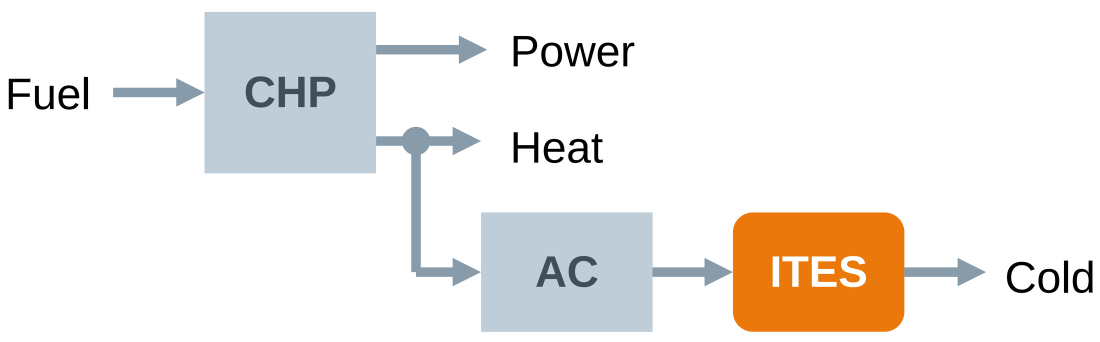
MOTIVATION

FLUCTUATING RENEWABLE ENERGIES

FLEXIBILITY REQUIREMENT IN THE POWER GRID

FLEXIBLE OPERATION OF CHCP

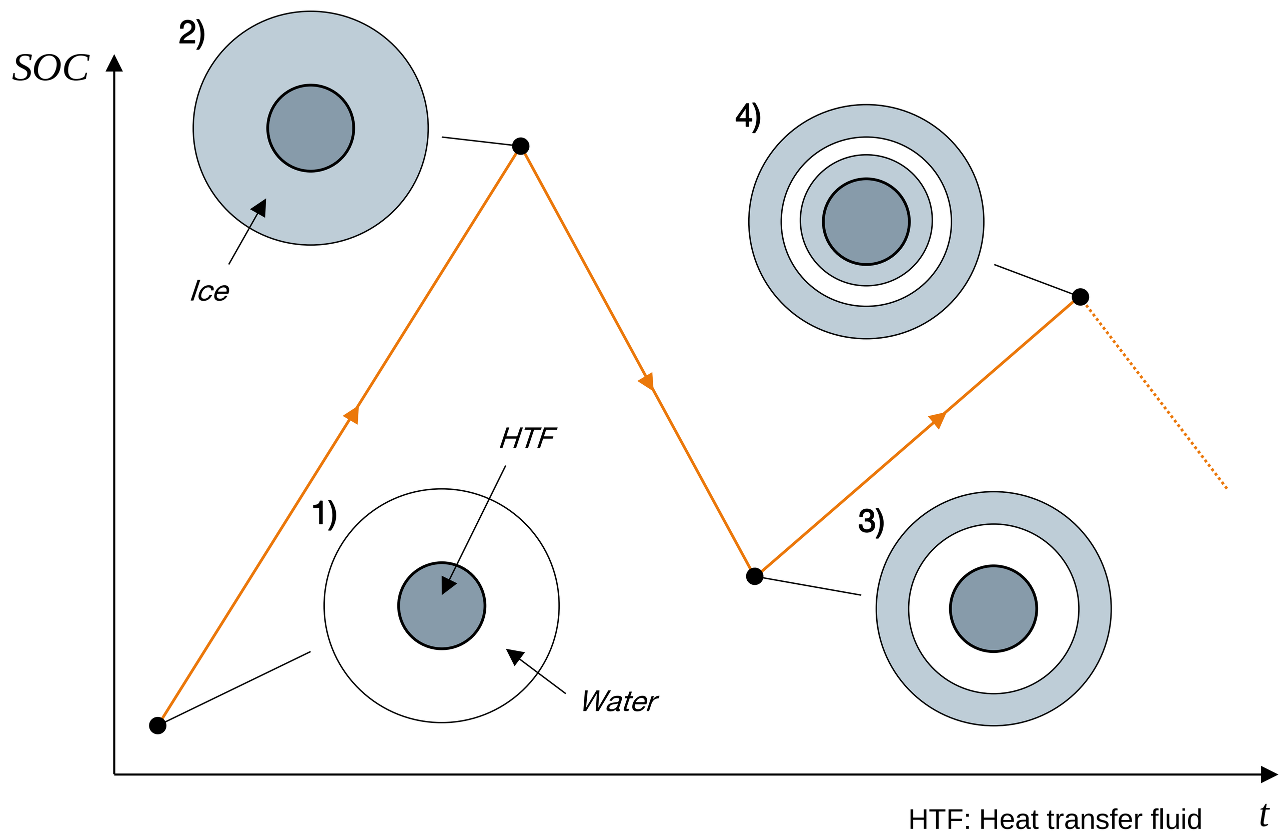


CHP: Combined Heat and Power; AC: Absorption chiller; ITES: Ice thermal energy storage

MODELING [1]

PARTIAL CHARGE AND DISCHARGE

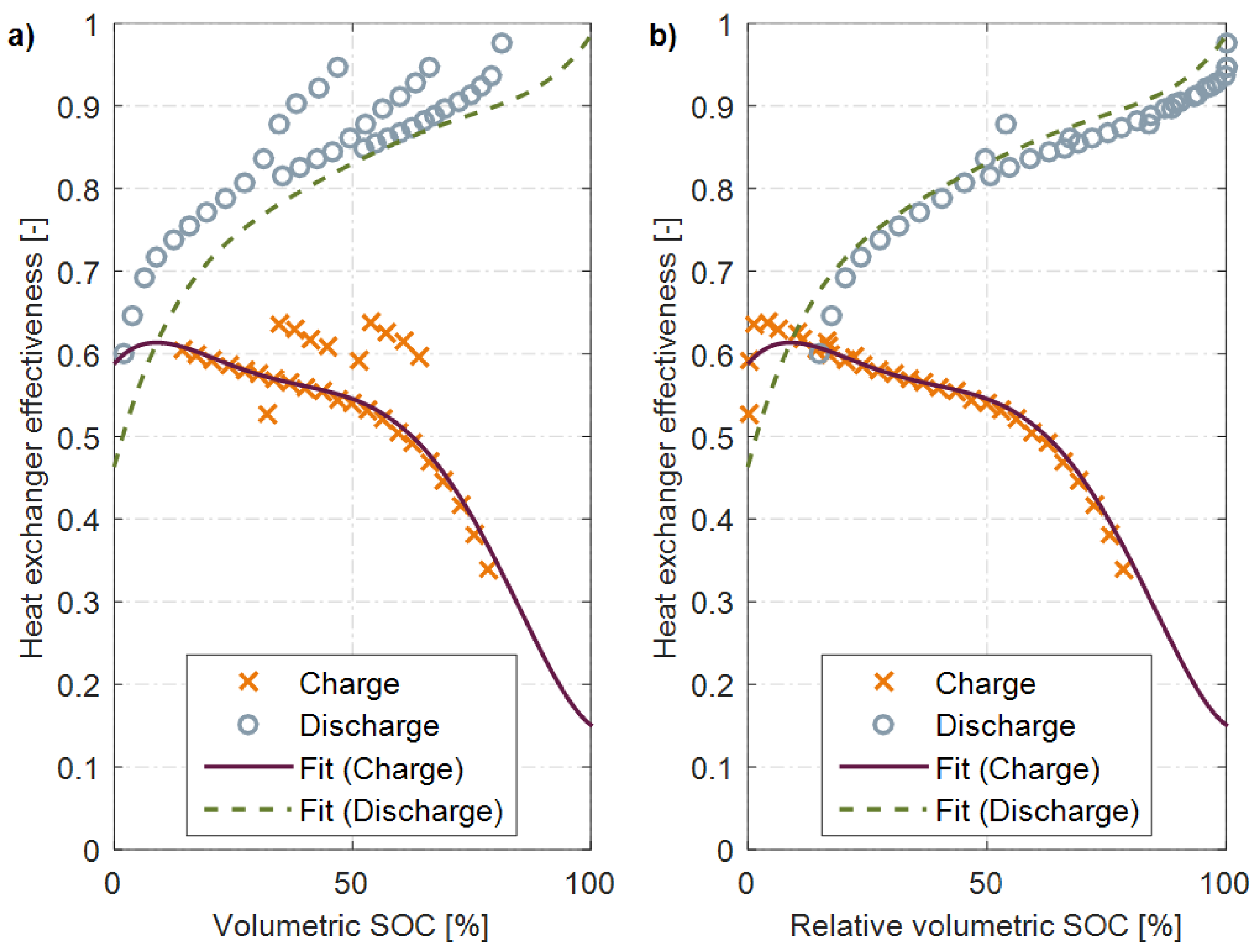
- Charge and discharge in a way that **multiple layers of ice and water** form adjacent to the heat exchanger tubes



HTF: Heat transfer fluid

EMPIRICAL MODELING APPROACH

- Introduce a **new relative state of charge** that includes information on the **preceding charge and discharge operation** of the storage
- **Fits for full charge and discharge** can be used (see below)



MODELS

- **ε model**: **Empirical** model based on the **heat exchanger effectiveness** [2]

$$\varepsilon = \frac{T_{\mathrm{ITES,in}} - T_{\mathrm{ITES,out}}}{T_{\mathrm{ITES,in}} - T_{\mathrm{PCM}}}$$

- **kA model**: **Empirical** model based on the **heat transfer coefficient** [3]

$$kA = -\dot{m}_{\mathrm{HTF}} c_{p,\mathrm{HTF}} \ln[1-\varepsilon]$$

- **Neto model**: **Physical** model describing the **thermal resistances** [4]
- **Koller model**: **Physical** model based on a **differential equation** of the **adjacent water or ice layer** [5]

PCM: Phase change material

RESULTS & DISCUSSION [1]

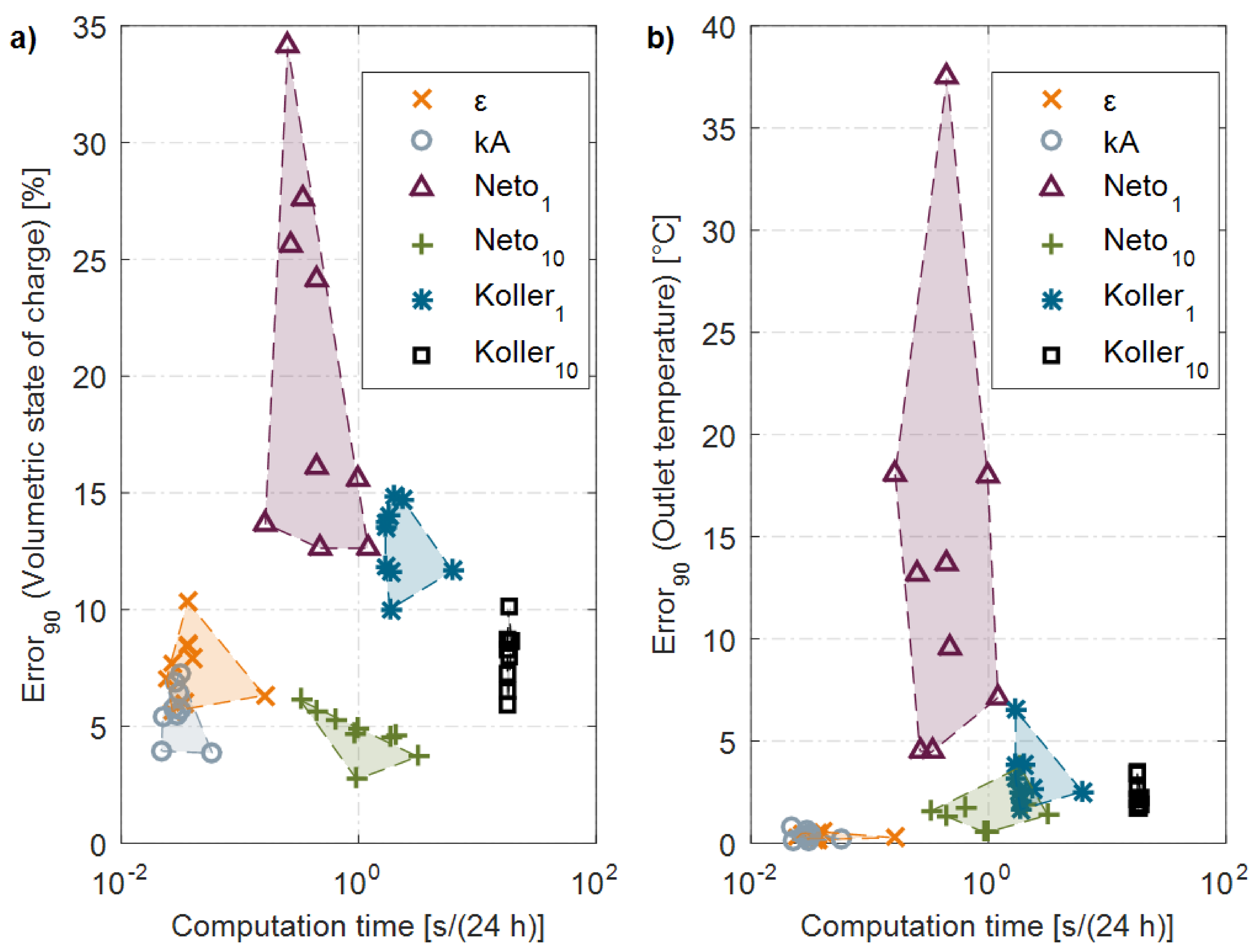
DISCUSSION

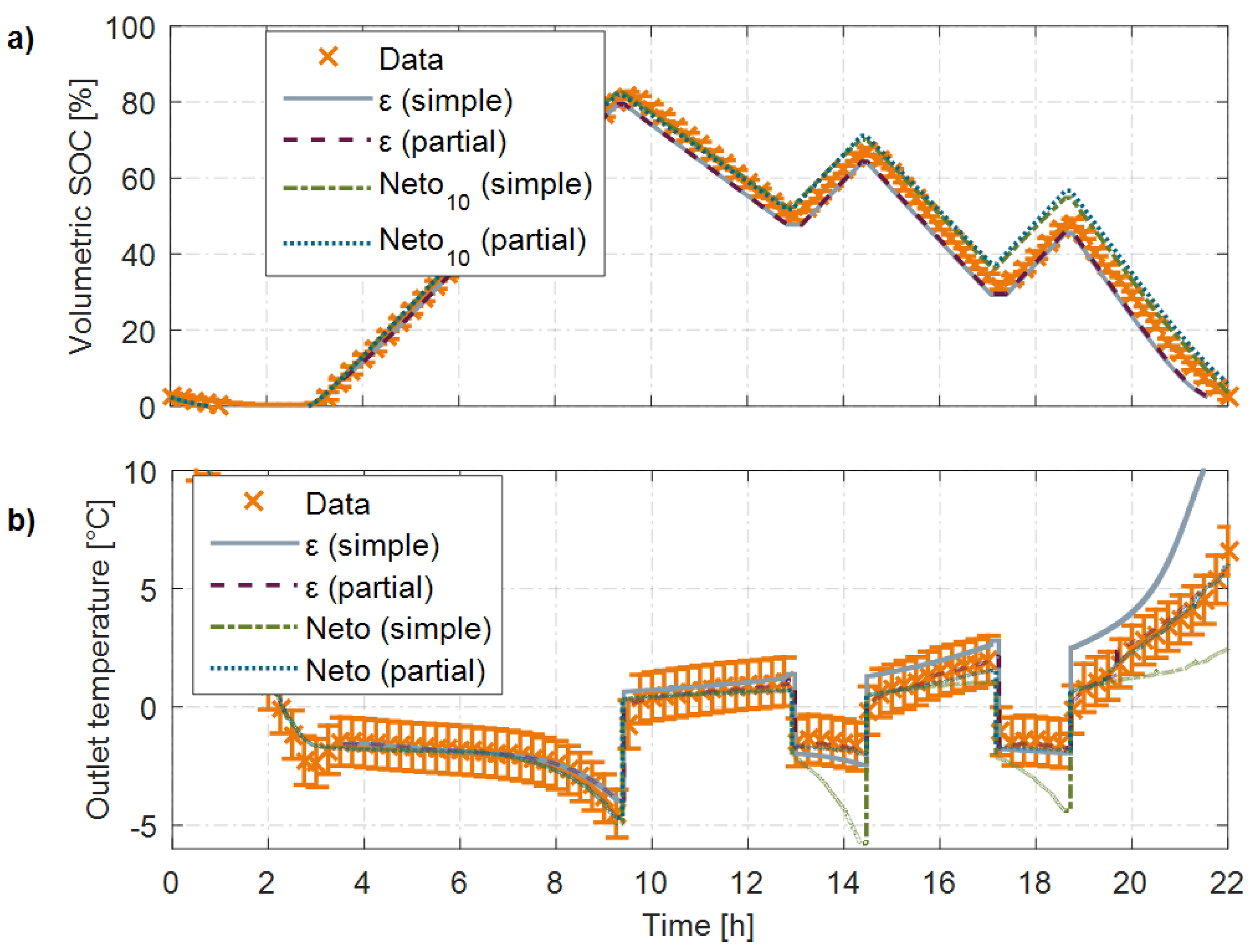
- **Physical models** only suitable with **> 10 segments** (see subscript)
- **Empirical models faster** than **physical models** and **smaller deviations** from measured data

CONCLUSION

- **Challenges** for implementing ε model (partial) in model-predictive controller due to **nonlinearity** and **required information on preceding storage operation**

→ **Forward Dynamic Programming**





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