Supplementary Information
Multiple time grids in operational optimisation of energy systems with short- and long-term thermal energy storage

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1 Tested time grid step sizes

Examples of the tested time grids are illustrated in Fig. 1 - 3.

2 Heating demand and weather data

The synthetic heating demand data can be found in the accompanying Microsoft Excel file (Heating_Demand_Data_20xx-20xx.csv). Both one year (2012-2013) and multi-years (2007-2013) heating demand are included. The weather data can be found in Weather_Data_20xx-20xx.csv.

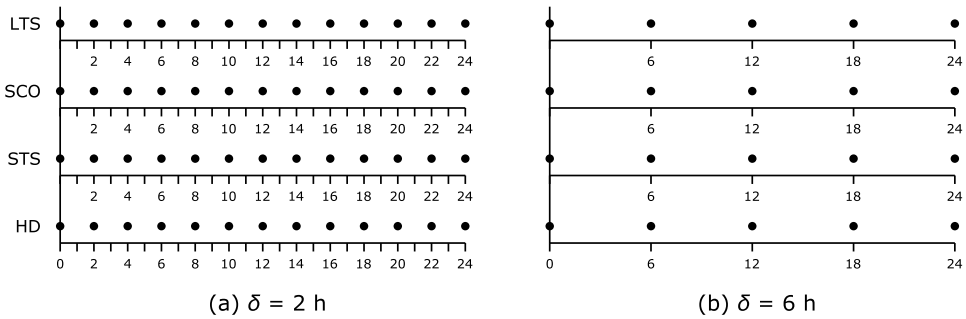


Figure 1: Examples of single uniform (SU) cases with (a) 2 h time step, and (b) 6 h time step.

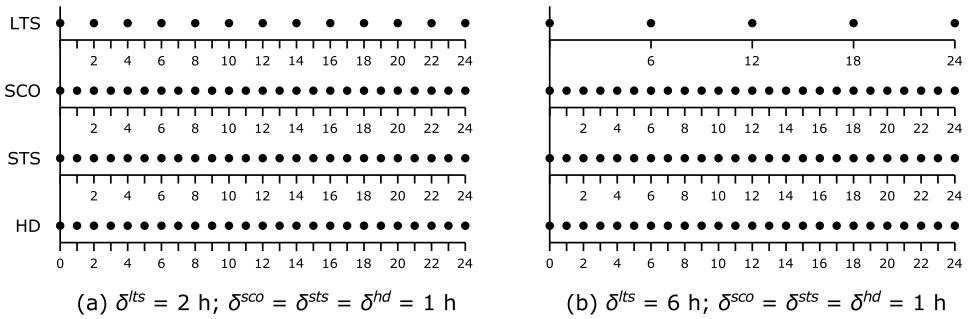


Figure 2: Examples of multiple uniform (MU) cases with different LTS time step size: (a) 2 h , and (b) 6 h.

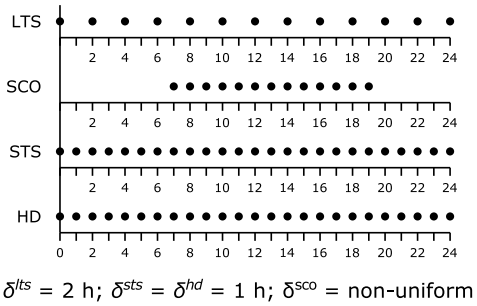


Figure 3: Example of the multiple non-uniform (MNU) case. Here only the solar collector (SCO) has non-uniform time grid, i.e. hourly during daytime.

3 Heuristic control parameter

Two main parameters in the heuristic control rule are the set-point temperature of the district heating (DLSP) and the required STS state-of-charge ($SOC^{sts}_{req,t}$). DLSP is a function of the ambient temperature and calculated according to Eq. 1 , which is based on Figure 2-4 in [1]. The values of $SOC^{sts}_{req,t}$ for three ranges of DLSP at different time of the day are given in Required_STS_SOC.csv. These values were gathered from Figure 2-5 in [1].

$$DLSP_t = \begin{cases} 55\ ^\circ\text{C} & \text{if } T_{amb} \leq -40\ ^\circ\text{C} \\ -0.48 \cdot T_{amb} + 35.8 & \text{if } -40\ ^\circ\text{C} < T_{amb} < -2.5\ ^\circ\text{C} \\ 37\ ^\circ\text{C} & \text{if } T_{amb} \geq -2.5\ ^\circ\text{C} \end{cases} \quad (1)$$

4 Short term storage operational profile

The resulting operational profiles of the short term storage (STS) for the reference case are illustrated in Fig. 4 and 5. The yearly operational profile in Fig. 4 shows that over the course of a year, the STS is rarely in fully-

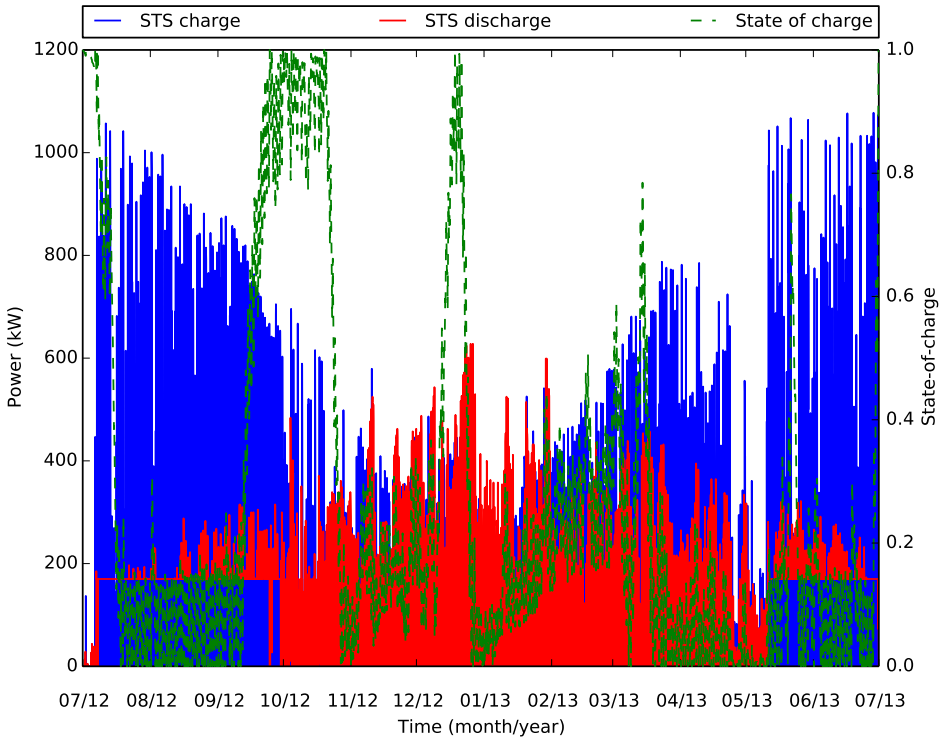
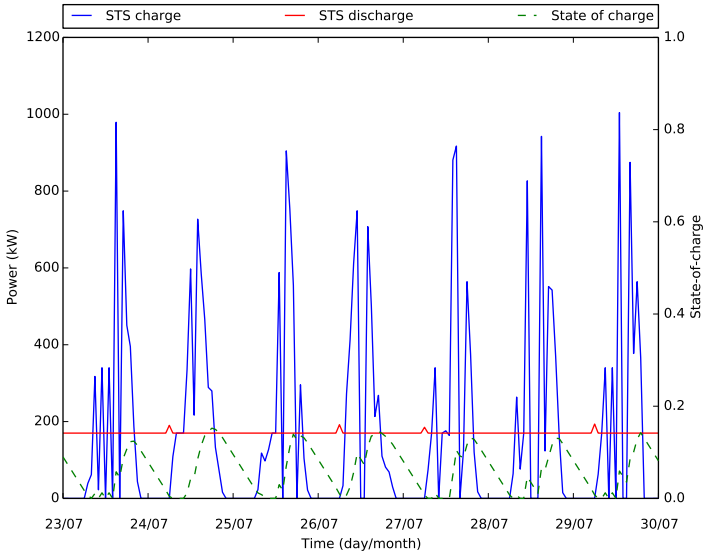


Figure 4: STS yearly operational profile for the reference case

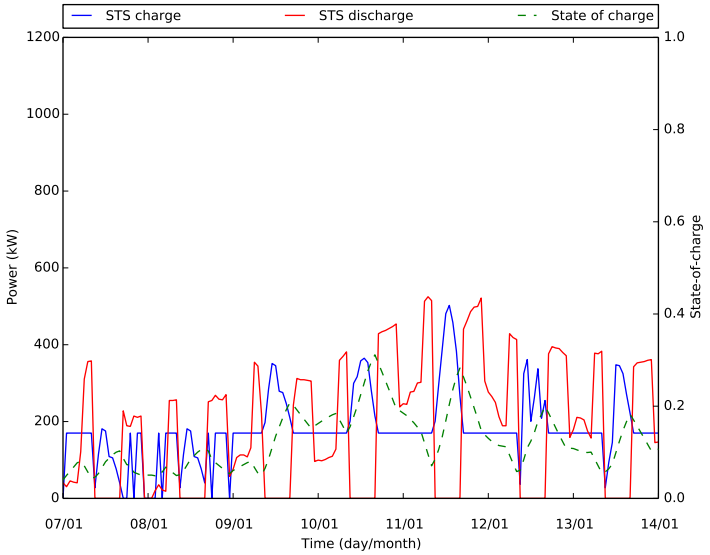
charged condition. This can be attributed to the deterministic nature of the optimisation process, which can produce less realistic charge-discharge profile. For example, it can be seen in Fig. 5a that even when the charging pattern is reasonable, i.e. matching the solar irradiation availability, the constant discharging to the LTS makes the state-of-charge remains relatively low. In the real control of DLSC, the discharging from STS to LTS in the summer happens during the night or whenever the STS is fully charged [1]. Despite this limitation, the STS model in this paper is sufficient to serve the main purpose of this work, which is to investigate the effect of different time series modelling on the computational cost and results accuracy of the optimisation. Furthermore, the resulting operational profile from the deterministic optimisation can be seen as the upper limit attainable by the system.

References

[1] H. Quintana, A Practical Approach to Model Predictive Control (MPC)for Solar Communities, Ph.D. thesis, École Polytechnique de



(a) Example of summer profile



(b) Example of winter profile

Figure 5: Example of STS weekly operational profile

Montréal (2013).
URL http://publications.polymtl.ca/1146/