


Modeling future heat pump integration in a power radial

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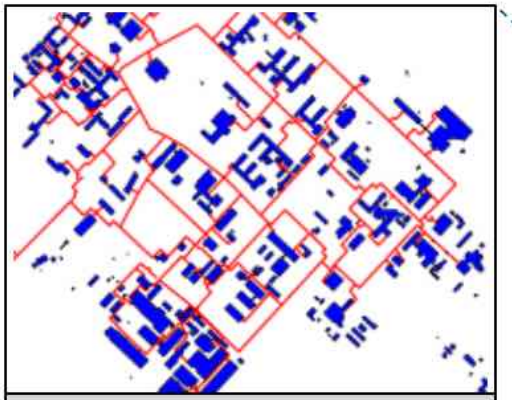
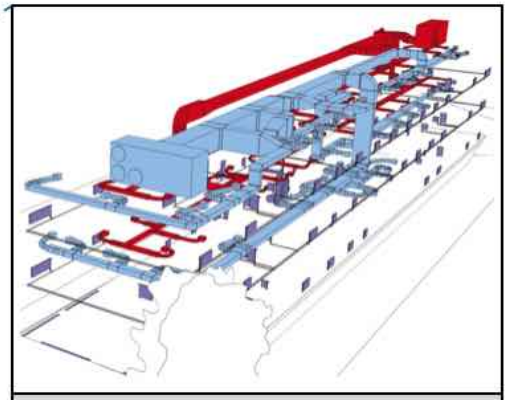
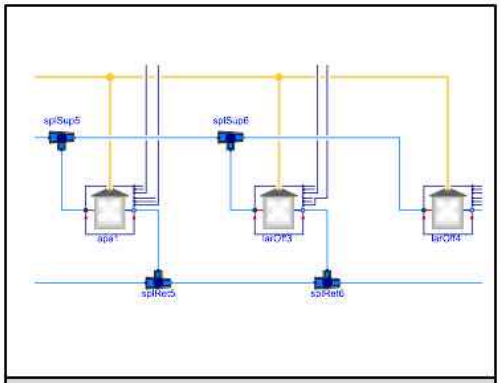
IBPSA Project 1



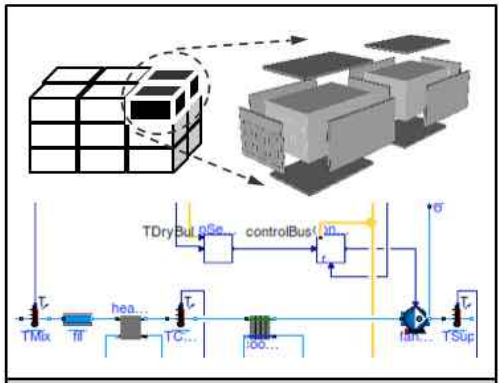
Geoinformation system



BIM



District energy system model



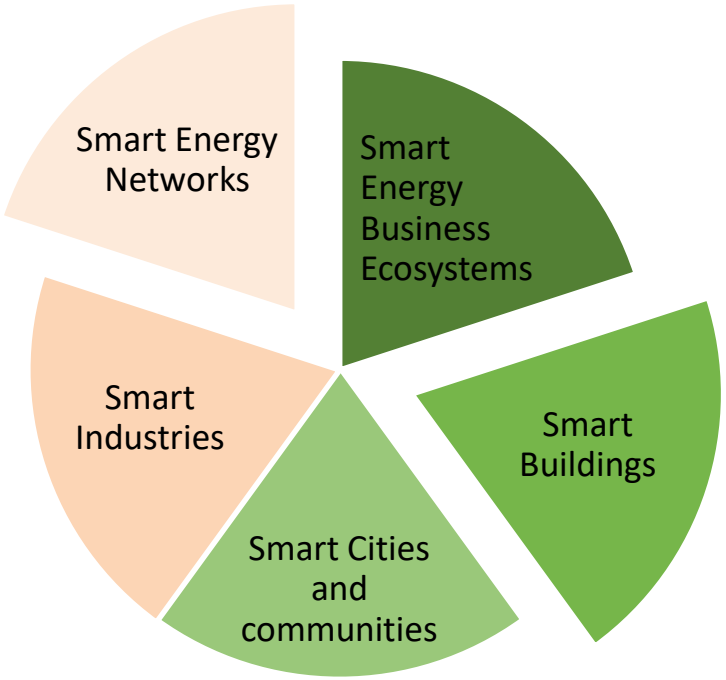
Building & HVAC model

Simulation, optimization and analysis

Simulation, optimization and analysis

https://ibpsa.github.io/project1/

Team: SDU Center for Energy Informatics



Danish Energy Agency

eUDP

Energi-, Forsynings- og Klimaministeriet

Adopt and apply Modelica tools for Danish district energy simulation

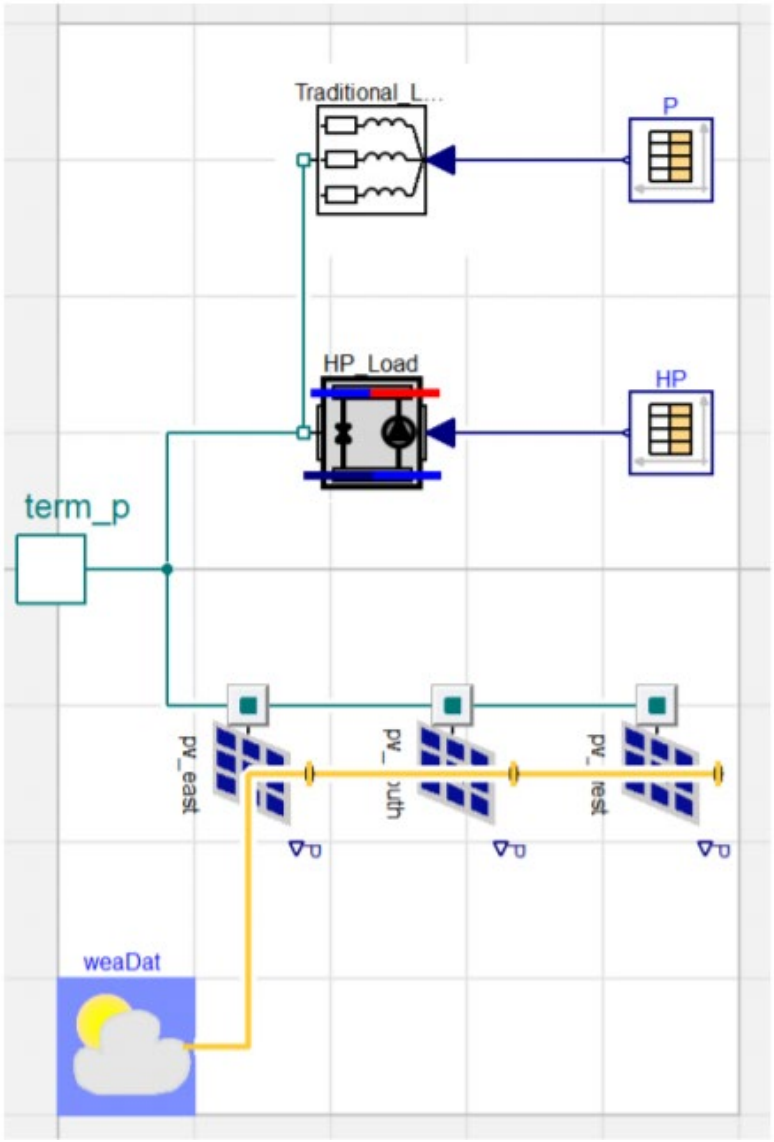
Team: EWII

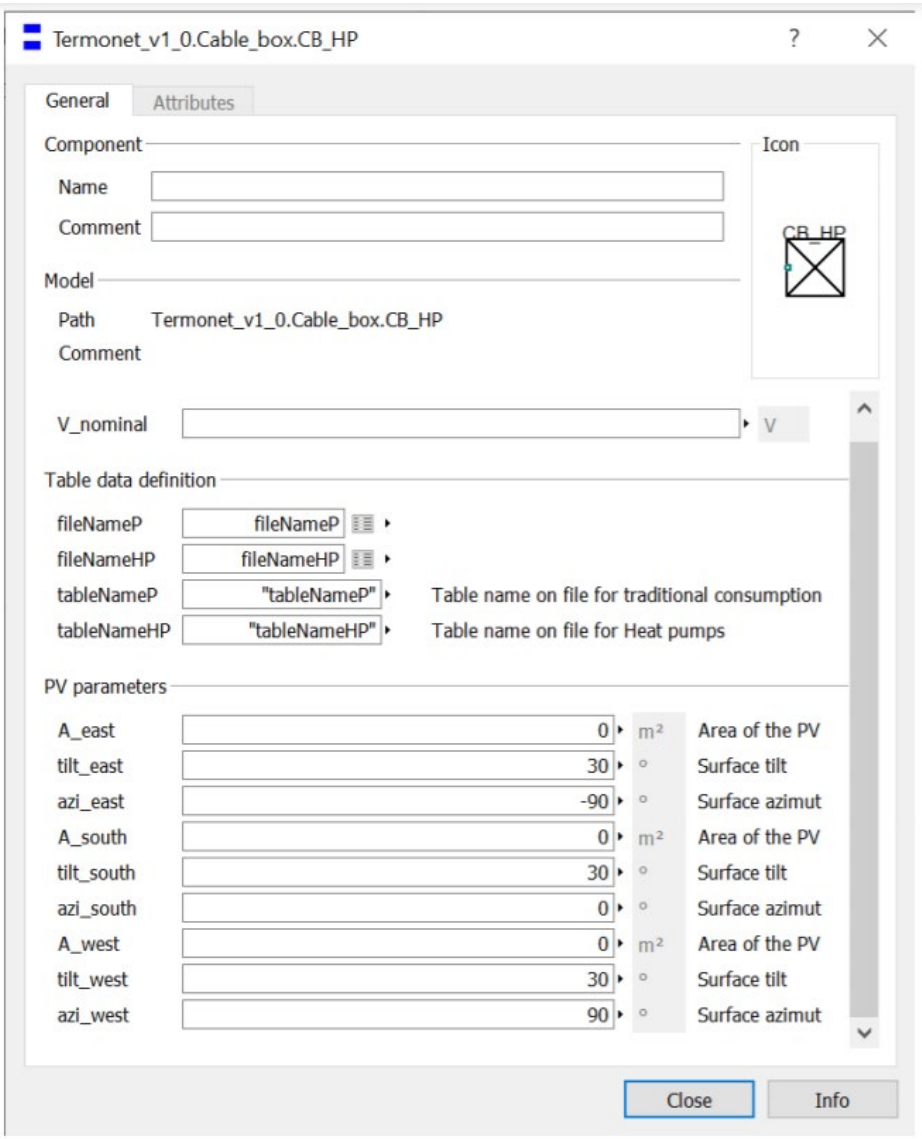
- Energy consultance, technology and optimization
- Renewable energy production, distribution and storage
- Internet, fibernet, electricity and district heating provider

Objectives of the modeling

- Cable box model
- Validate simulations with measured transformer current
- Estimate current flow in year 2030

Modeling: Cablebox





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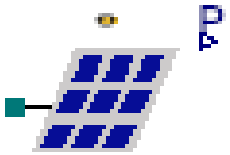
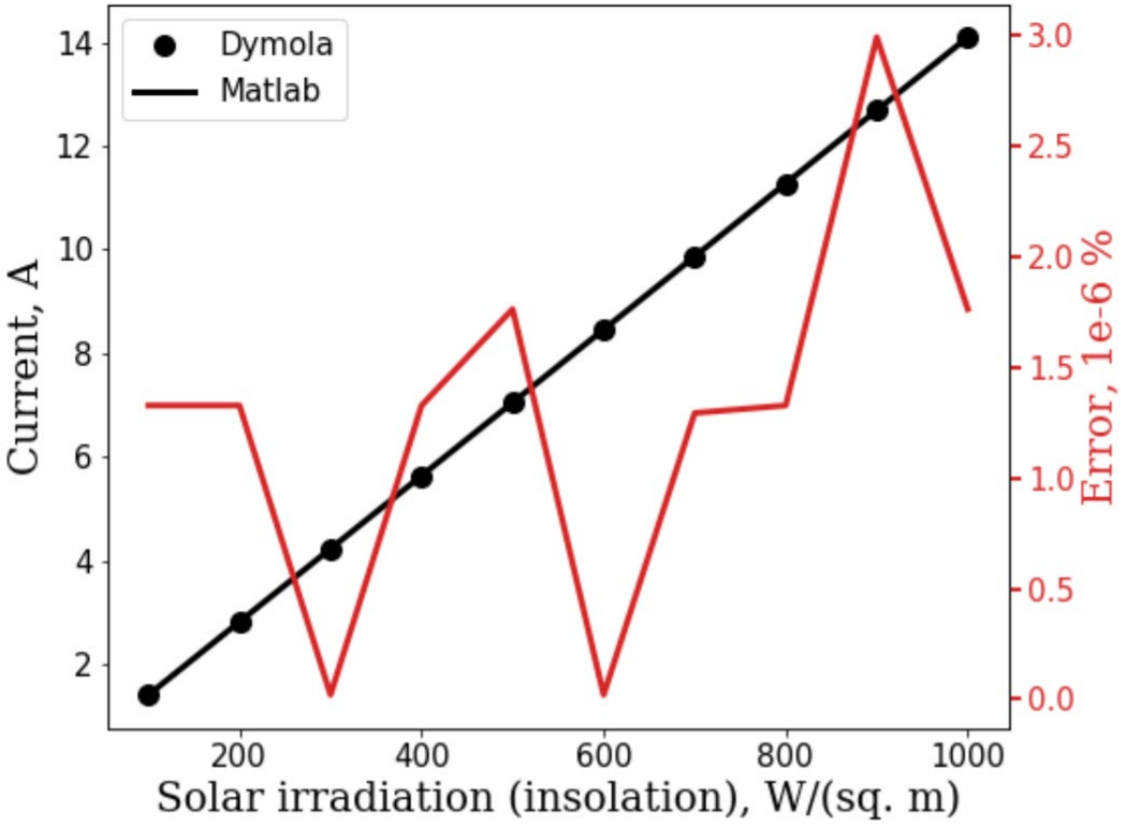
Modeling: Photovoltaics



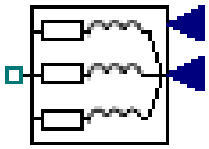
Buildings.Electrical.AC.ThreePhasesBalanced.Sources.PVSimple

$$P = I_s A \, f \, \eta \eta_c$$

$$I = \frac{P}{pf \, U}$$



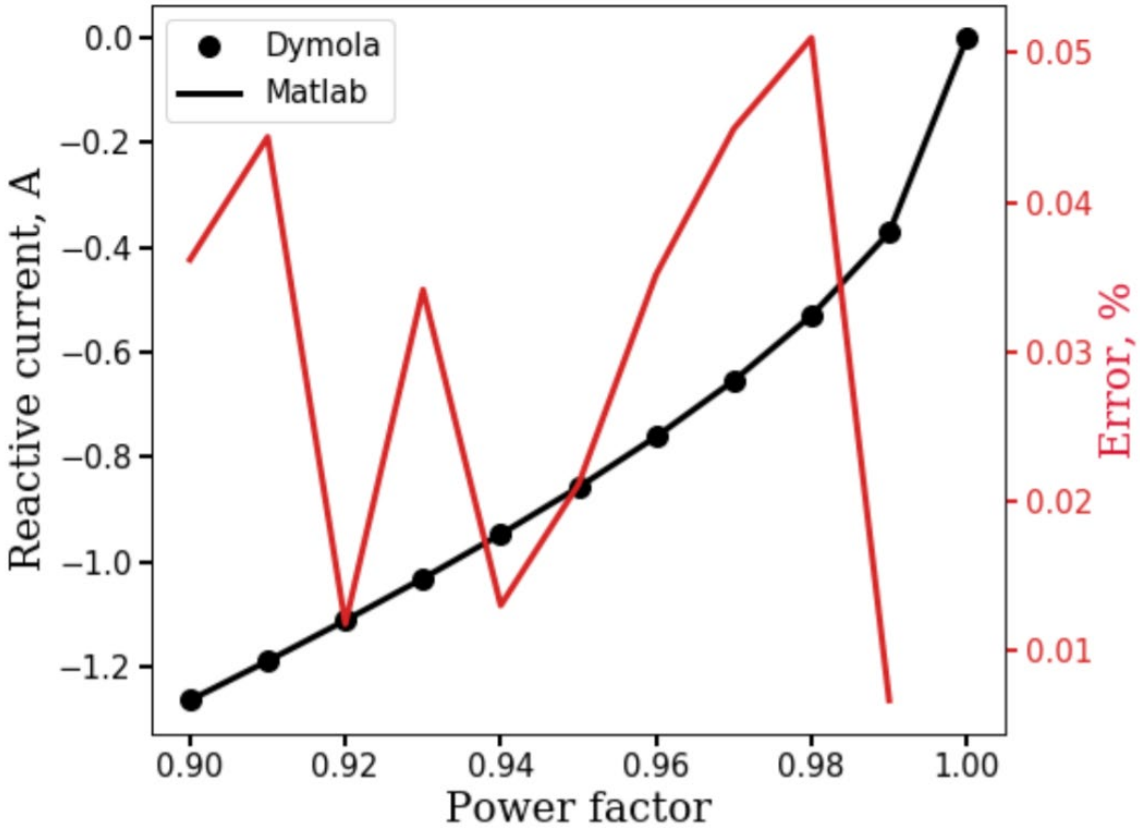
Modeling: Load



Buildings.Electrical.AC.ThreePhasesBalanced.Loads.Inductive

$$I = \frac{P}{pf\ U}$$

$$I_r = I \sin(\operatorname{acos}(pf))$$



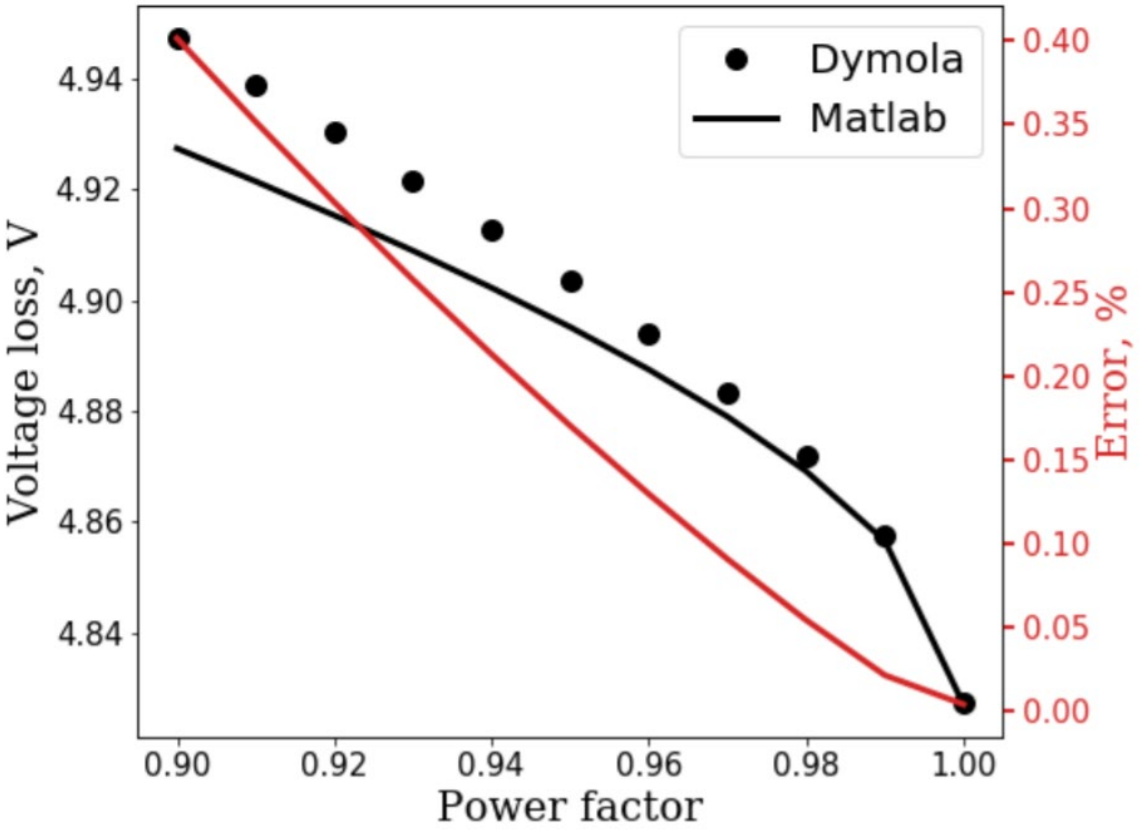
Modeling: Distribution cables

Buildings.Electrical.AC.ThreePhasesBalanced.Lines.Line

$$I = \frac{P}{pf\ U}$$

$$\Delta U_f = I\ l_c\ (r\ pf\ +$$

$$x\ \sin(\arccos(pf)))$$

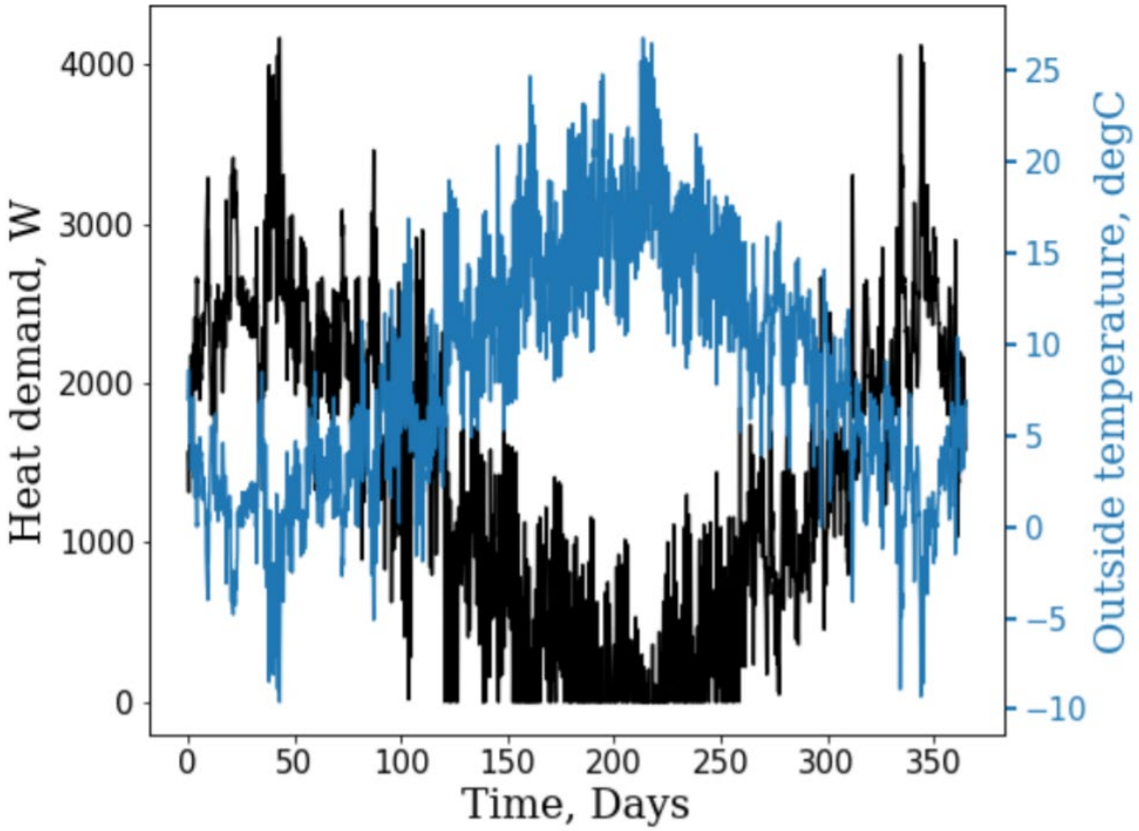


Modeling: Heat pump consumption

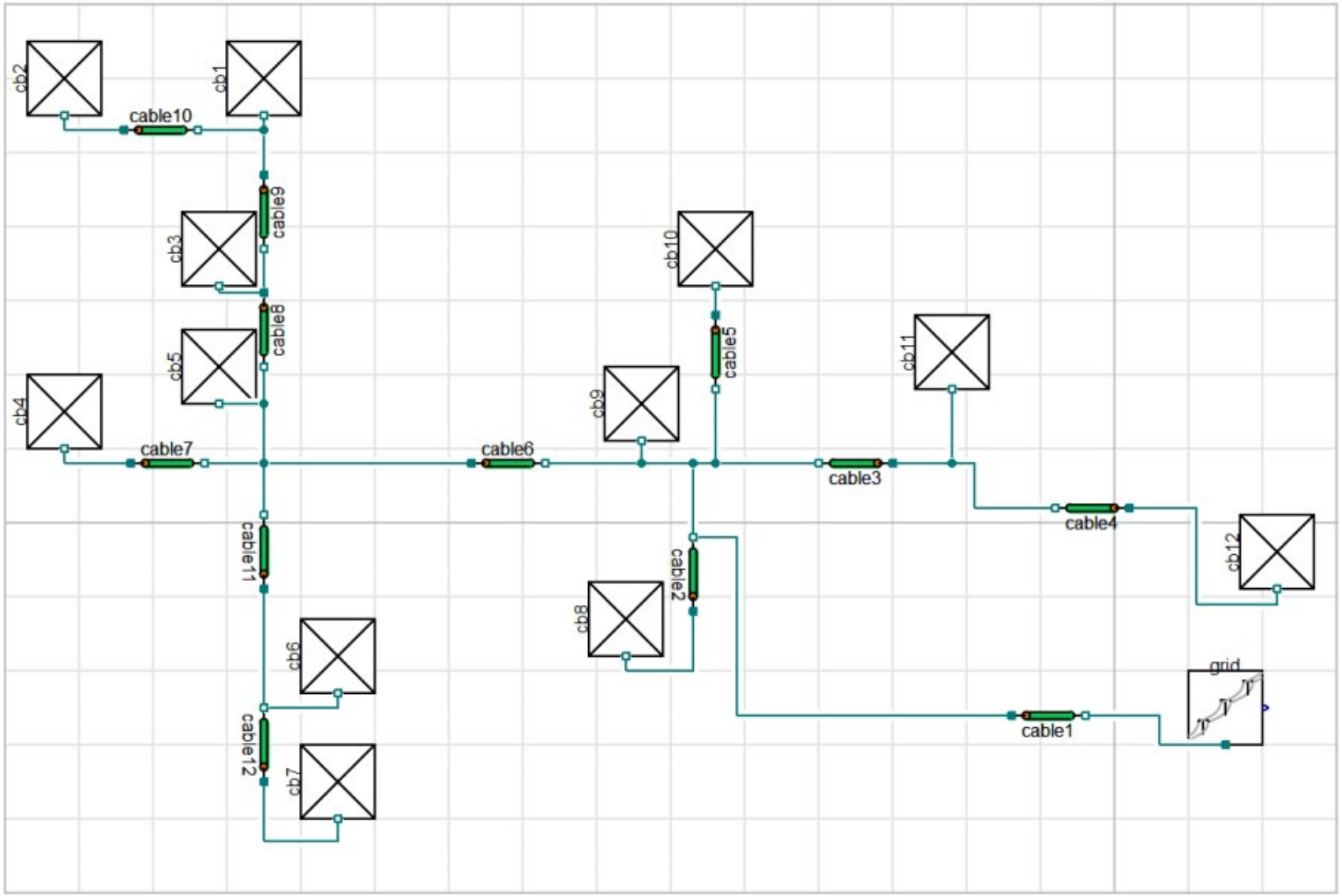
$$COP(T) = (-4.2E\text{-}5)T^3 + (4.9E\text{-}4)\,T^2 + (6.9E\text{-}2)T + 2.4$$

$$SH = -0.16\,T + 2700$$

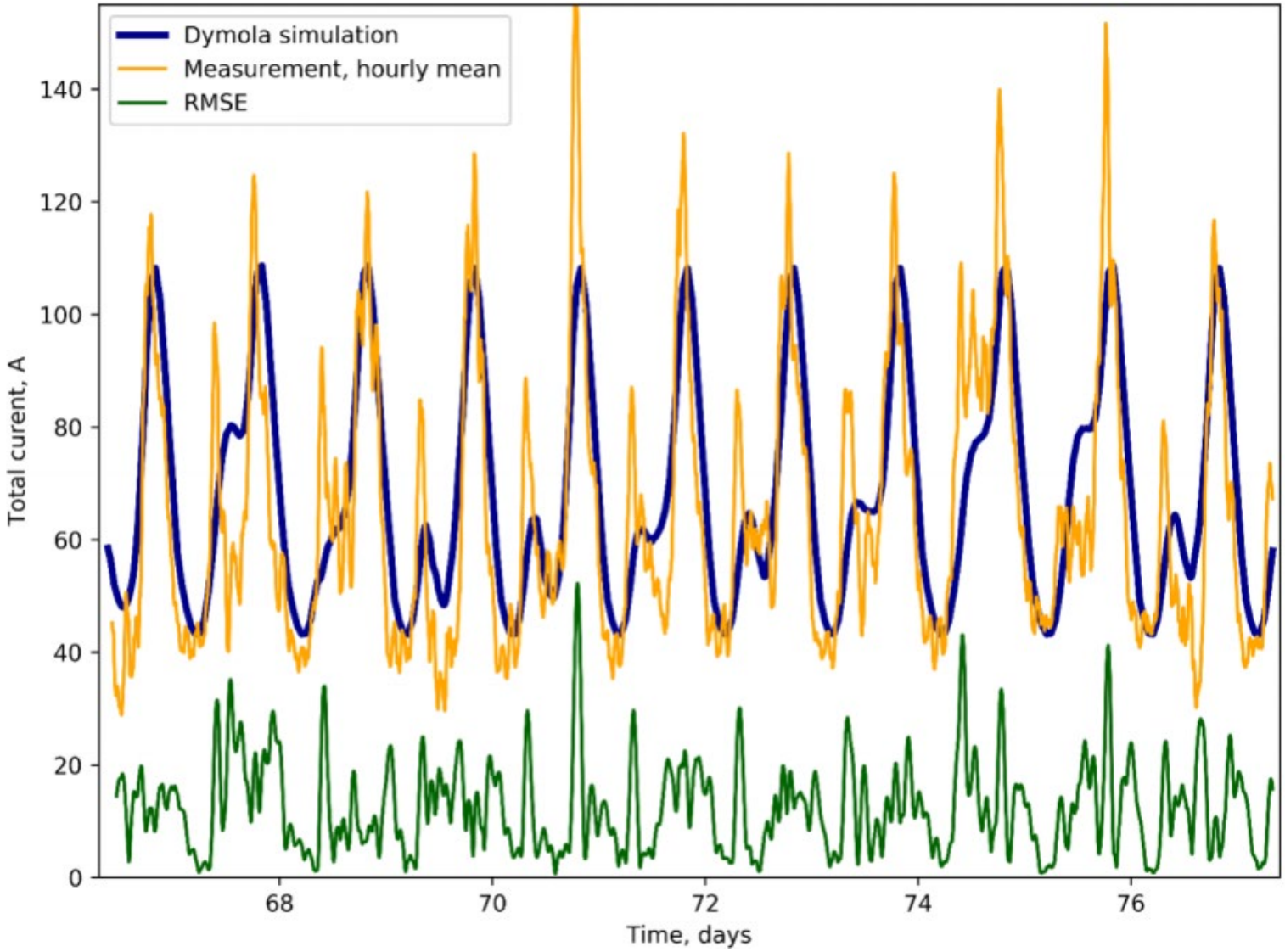
$$W = (DHW + SH)/COP$$



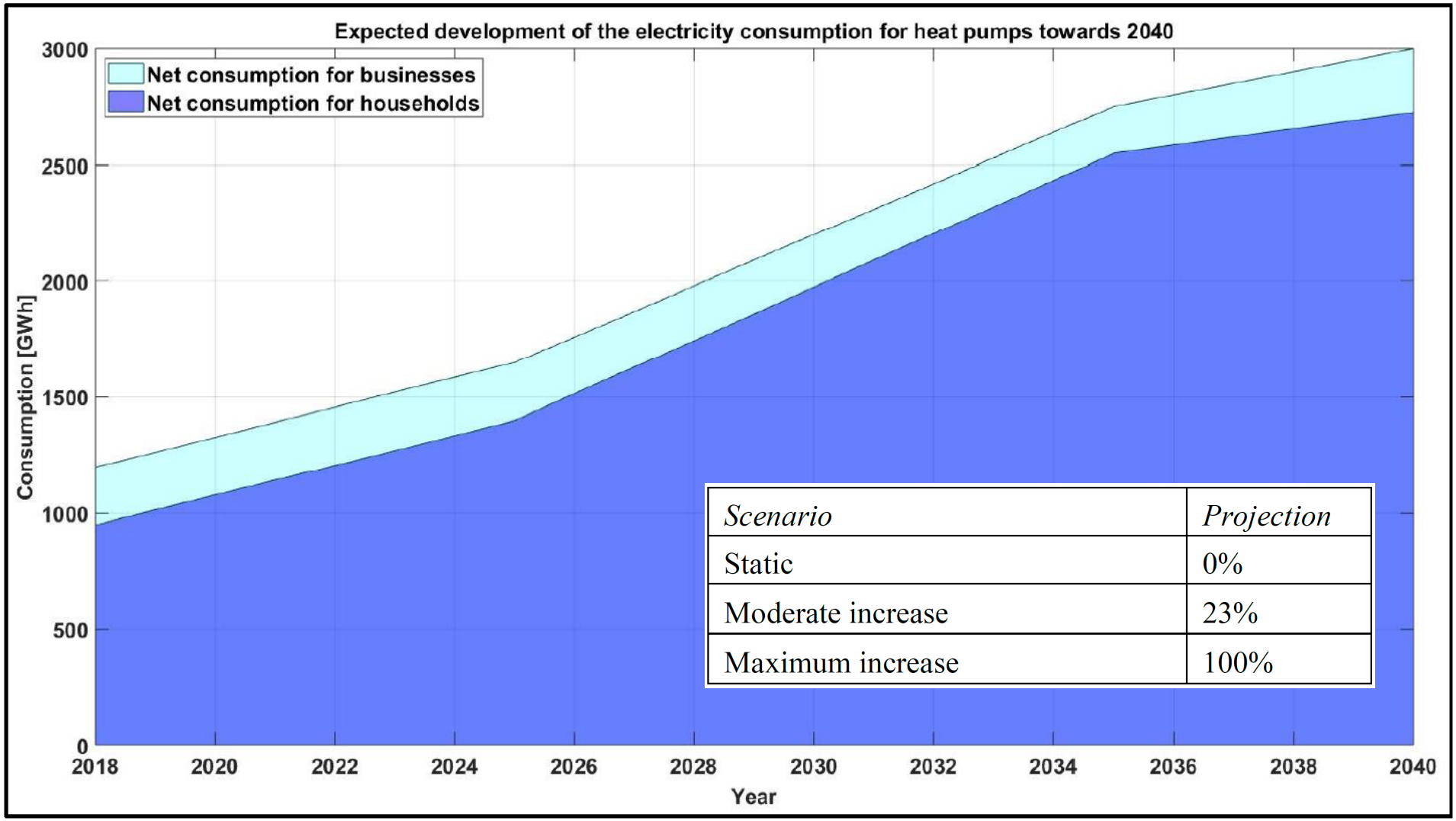
Radial branch model



Validation: March 2019

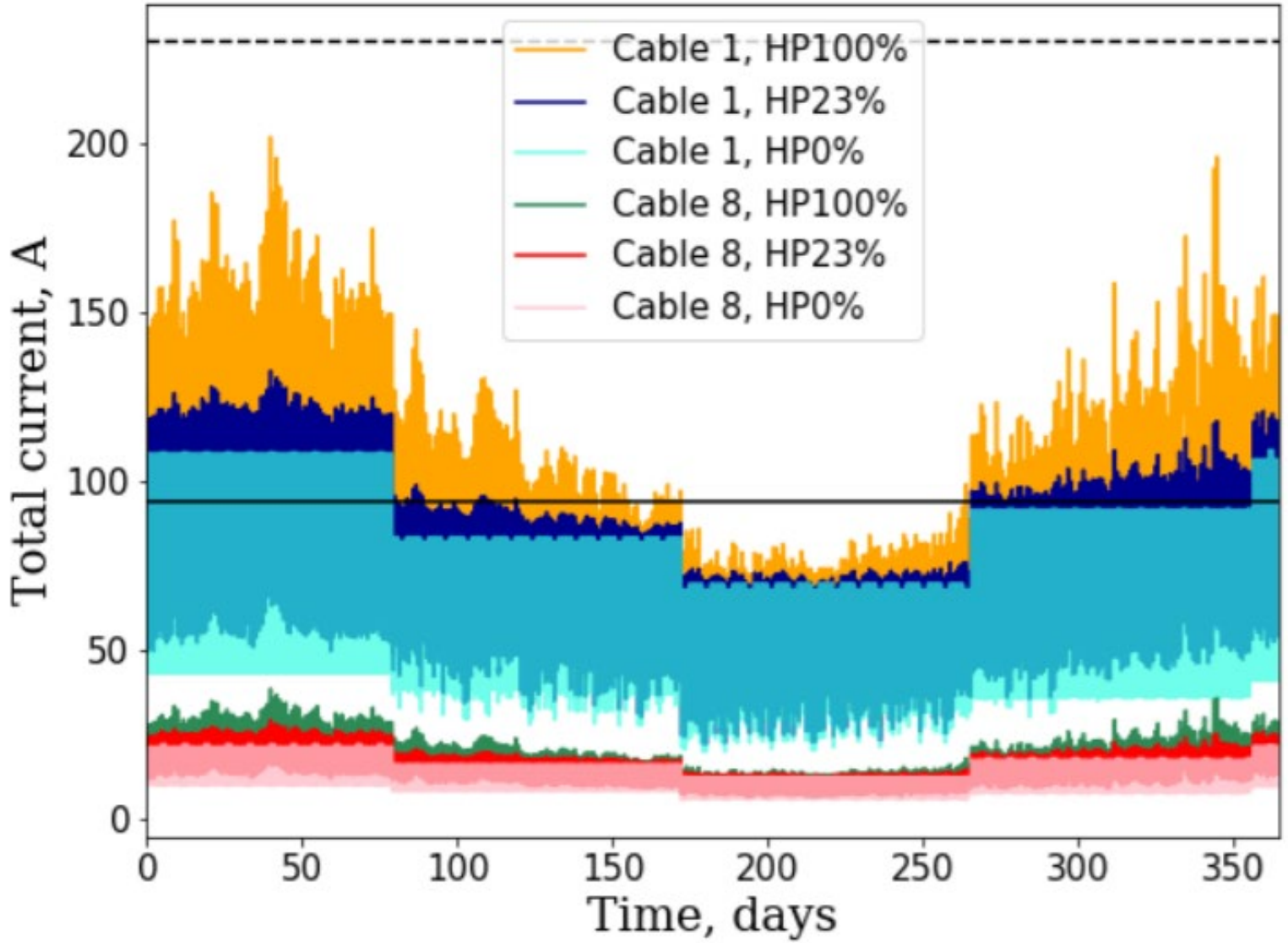


DEA-based HP scenarios for 2030

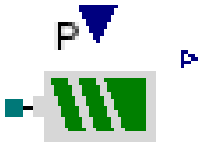


Scenario	*Projection*
Static	0%
Moderate increase	23%
Maximum increase	100%

E-net stays underloaded in 2030



Heat Pumps + Electric vehicles



Buildings.Electrical.AC.ThreePhasesBalanced.Storage.Battery

Scenario (HP/EV/PV)	Line capacity exceeded	i_max/i_capacity
23%/7.45%/0%	No	37%
100%/7.45%/0%	No	53%
23%/7.45%/50%	Short-term	44%
23%/24.7%/0% (2040)	No	42.8%
23%/65%/0% (2040)	Short-term	112%
100%/65%/0% (2040)	Long-term	140%

Mikkel Copeland & Klaus Jespersen, Master thesis, Syddansk Universitet, 2020

Conclusions

- The simulated transformer current with no heat pumps is close to the rolling average of the measured current
- No threat to cables in 2030 in all heat pump scenarios
- Long term stress in 2040 with 100% HPs and 65% EVs

Contact information

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