

A nighttime cityscape with a glowing energy network overlay. The network consists of white arcs connecting various points, with some points highlighted by bright white lights. The city lights are visible in the background, and the sky is dark blue.

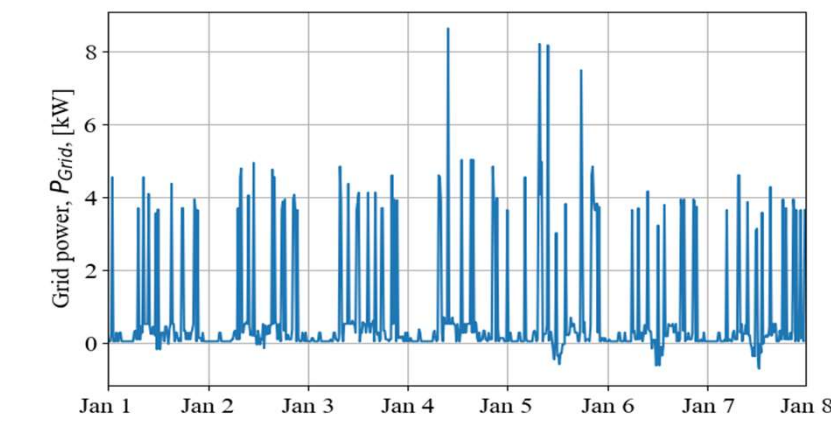
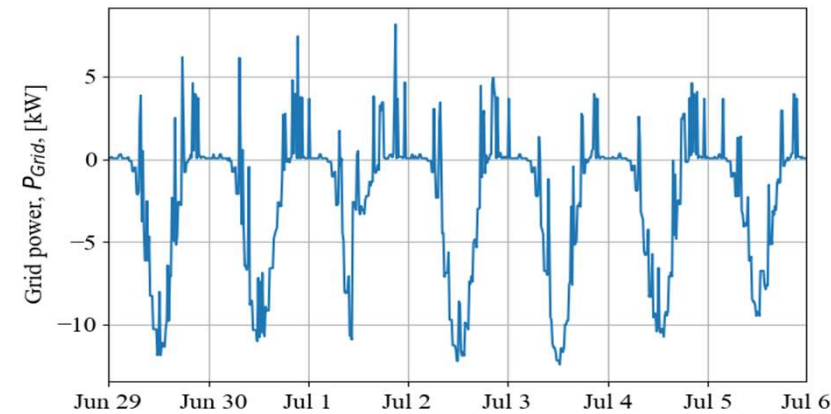
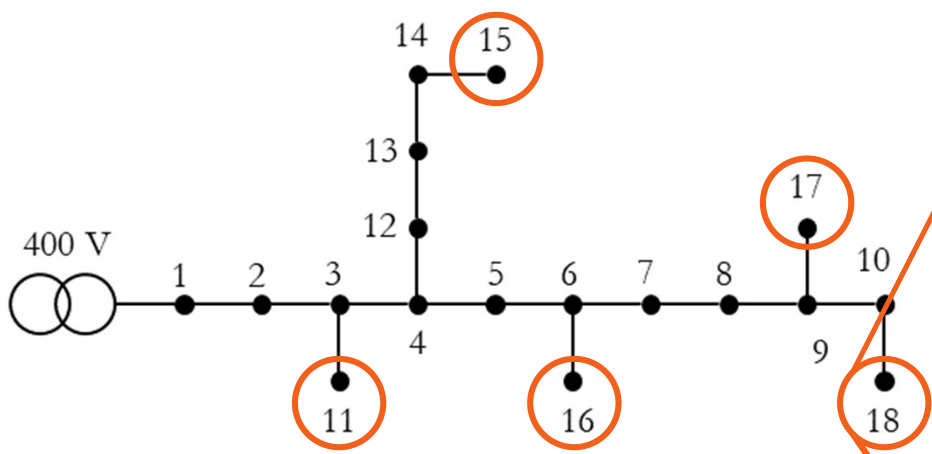
Energy market opportunities for residential prosumers participation

J. Alpizar-Castillo

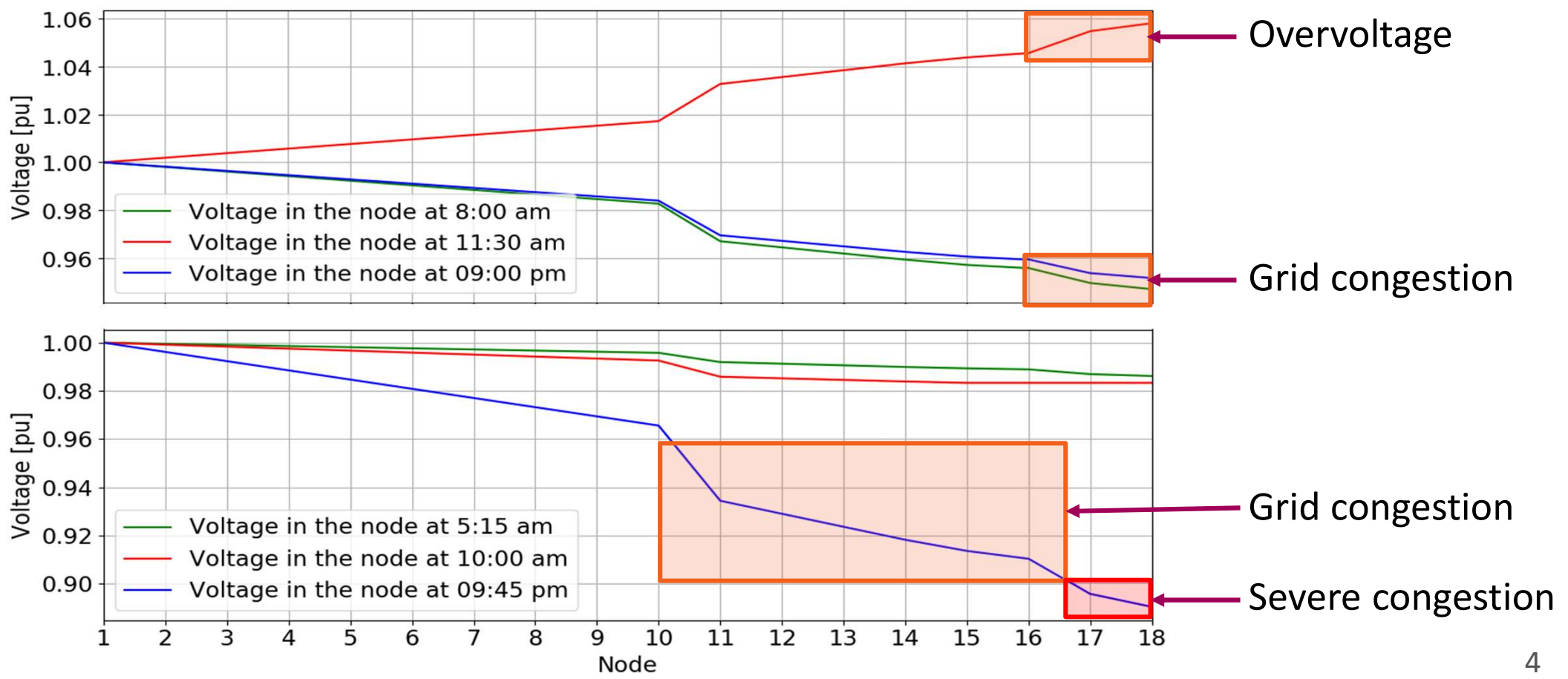
Introduction

- Challenges caused by the Energy Transition (heating and transport electrification).
- How to create opportunities from those challenges?
 - *Power curtailment*
 - *Peak-shaving*
- Business model canvas analysis.

Challenges for Distribution System Operators (DSOs)

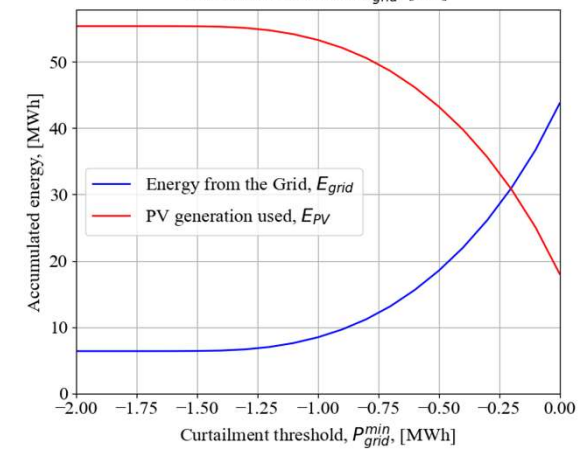
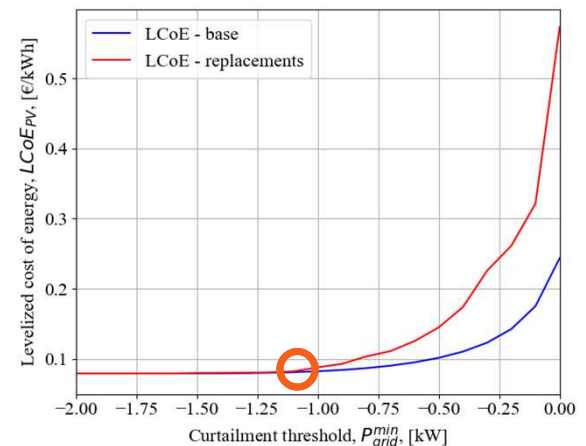
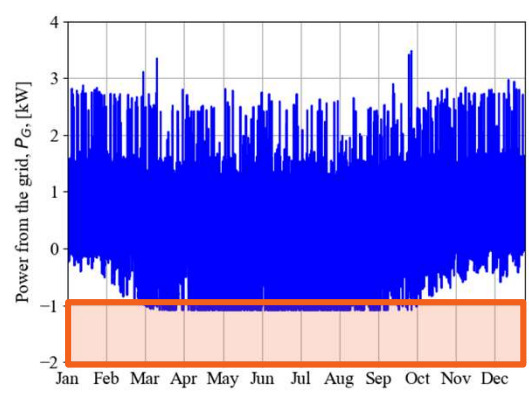
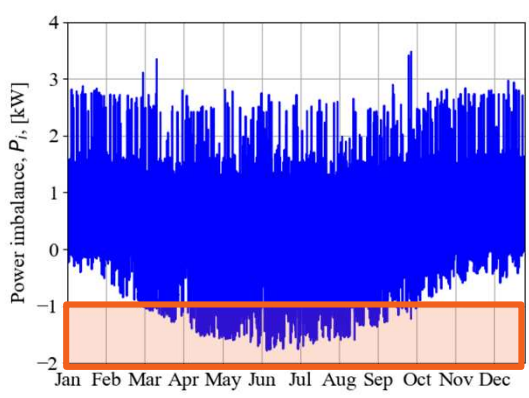
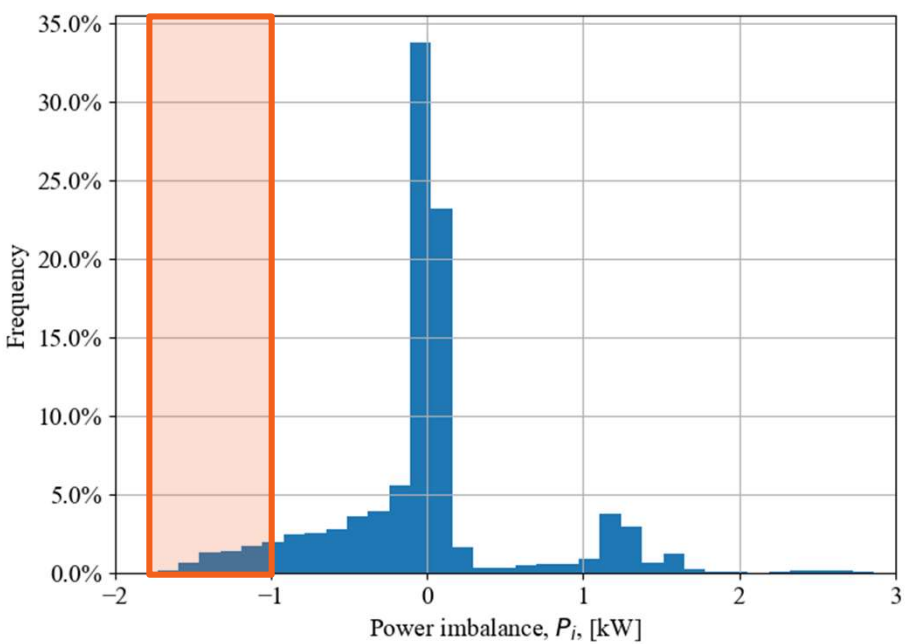


Challenges for Distribution System Operators (DSOs)



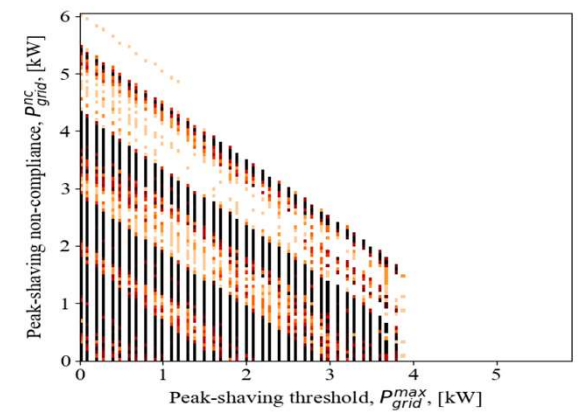
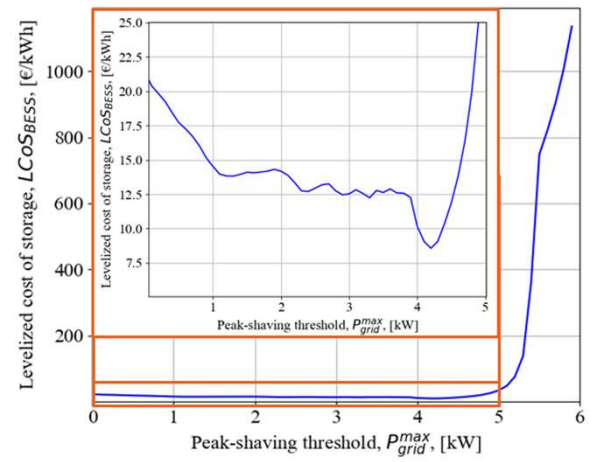
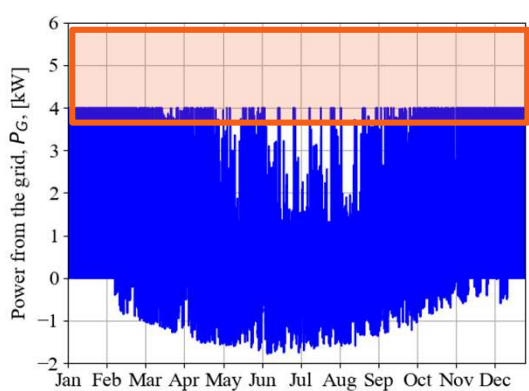
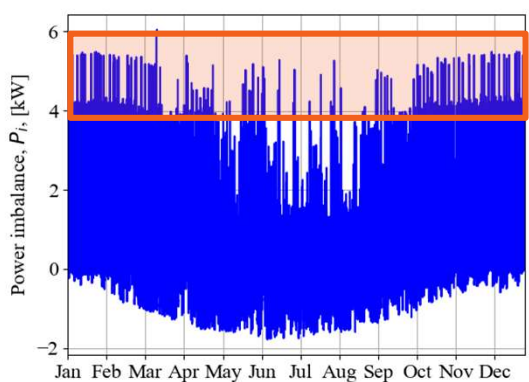
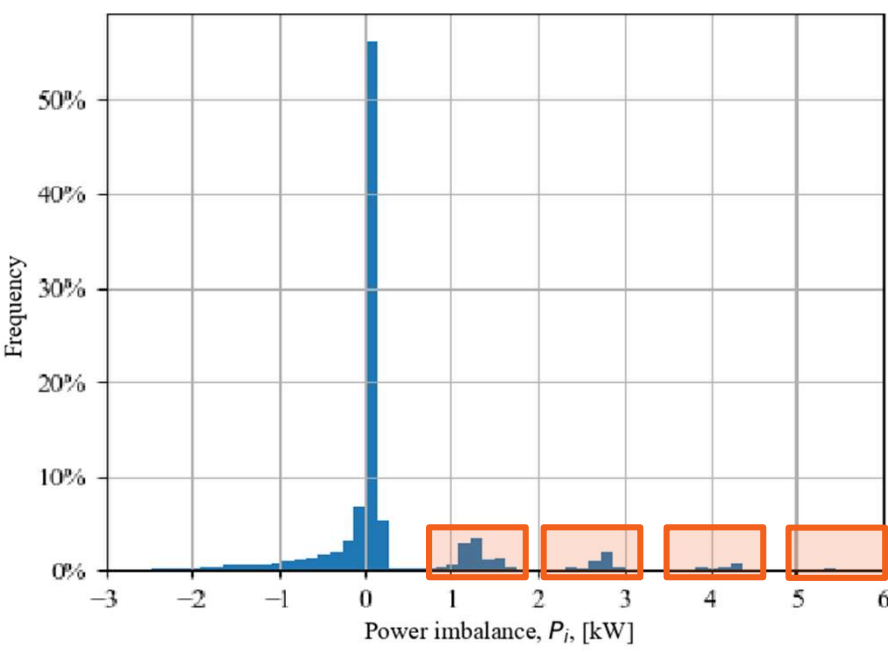
Turning challenges into opportunities: power curtailment

Power curtailment: limit the PV production, so less power is injected into the grid.

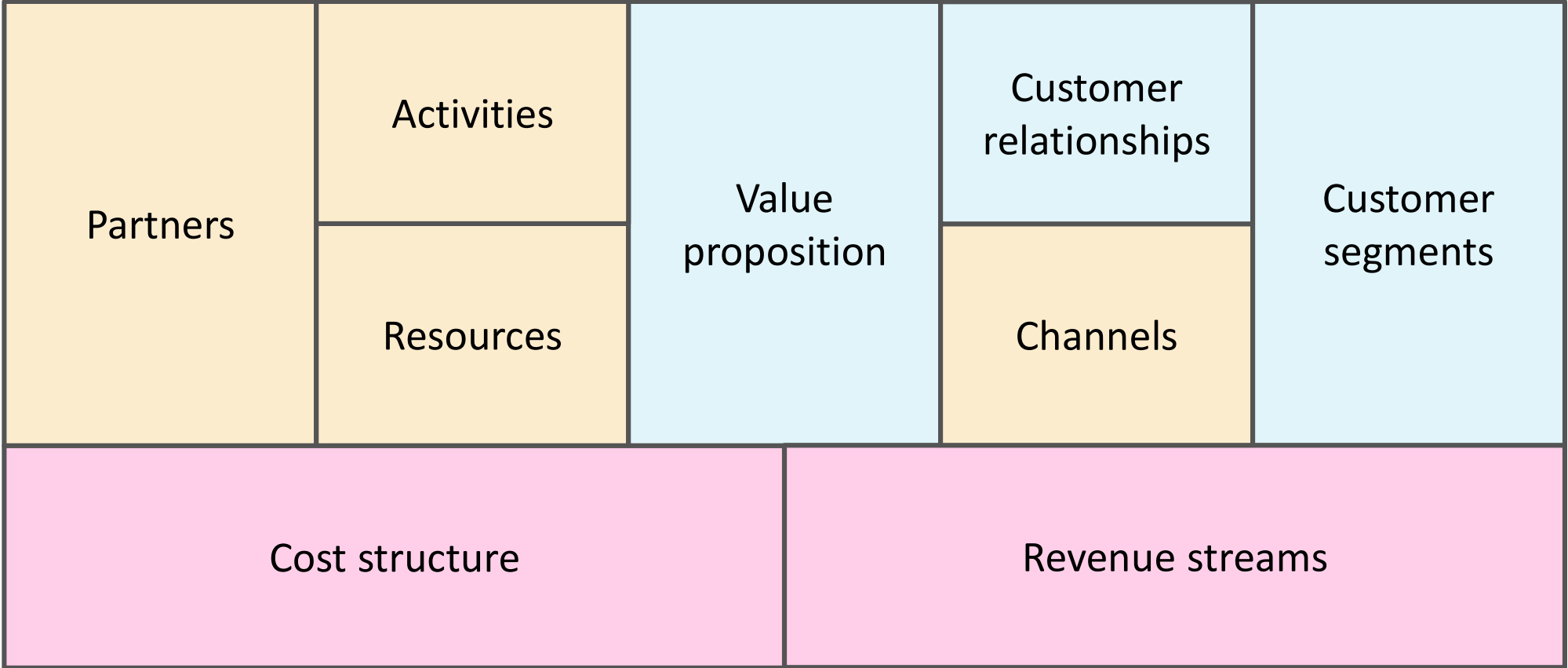


Turning challenges into opportunities: peak shaving

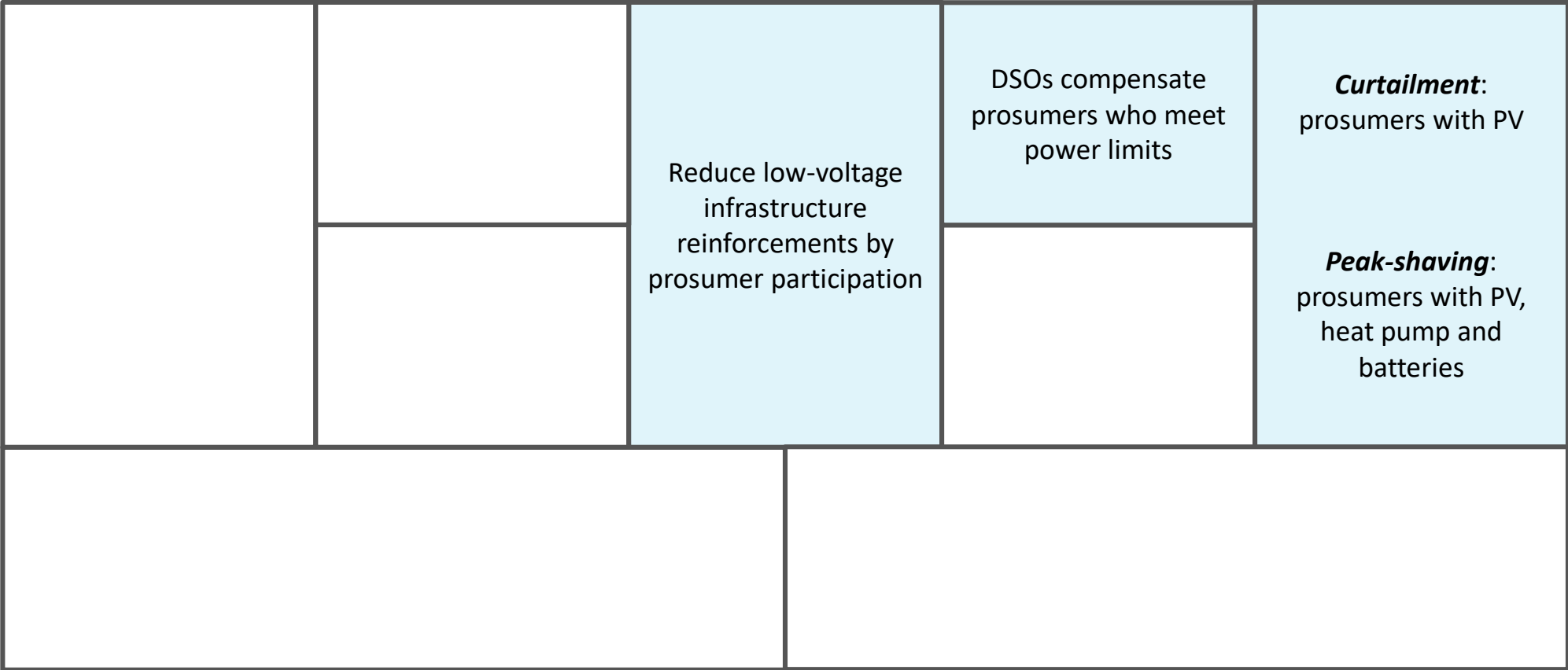
Peak-shaving: use energy storage (e.g., batteries) to limit the power demanded from the grid



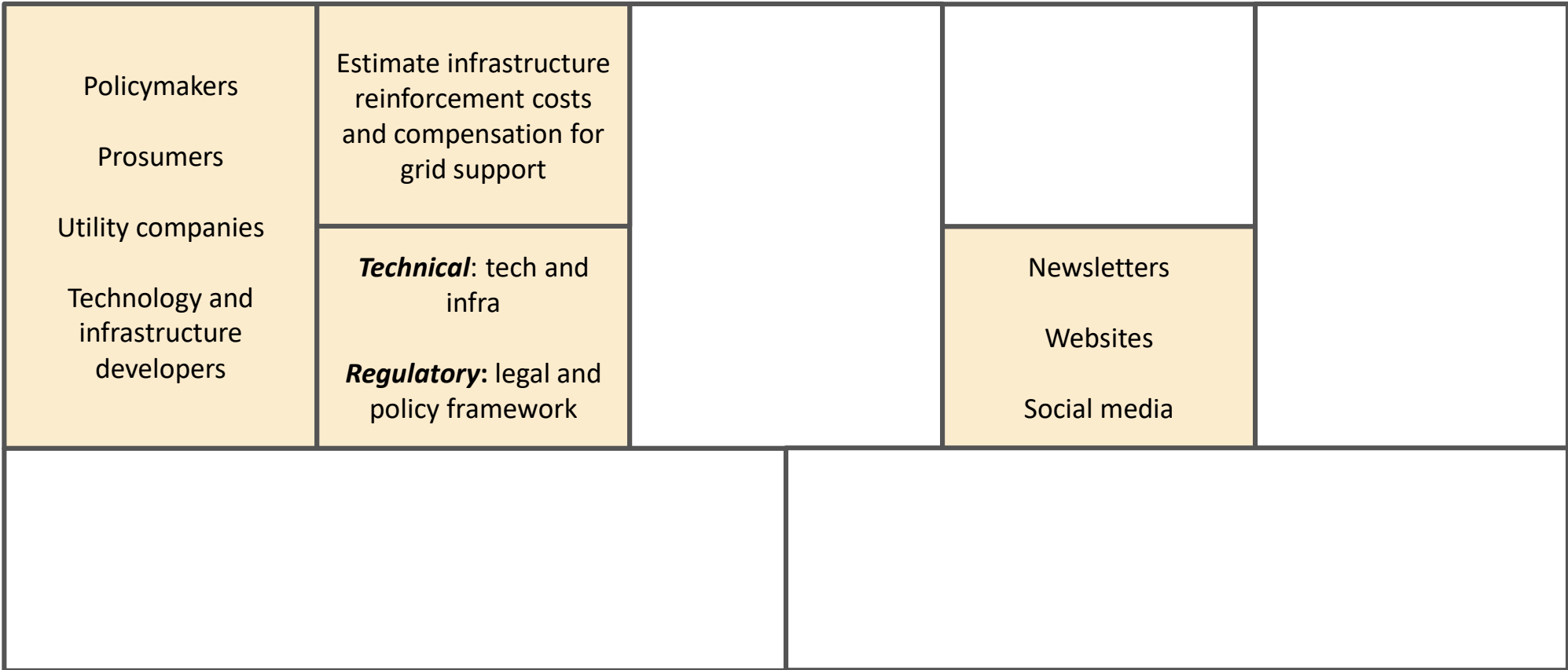
Business model



Business model: Value proposition



Business model: Value creation and delivery



Business model: Value capture

<i>Prosumers:</i> device purchase (CAPEX)	<i>DSOs and utility companies:</i> communication infrastructure (CAPEX, OPEX) and compensations (OPEX)		<i>Prosumers:</i> compensation above the feed-in tariff	<i>DSOs and utility companies:</i> difference between network reinforcement and compensations

Conclusions

- Energy transitions can cause stability issues, grid congestion, and overvoltages on the distribution networks.
- Prosumer participation through ancillary services can help the DSOs to address the issues.
- The framework to implement power curtailment and peak-shaving is almost ready for their deployment in low-voltage distribution networks.

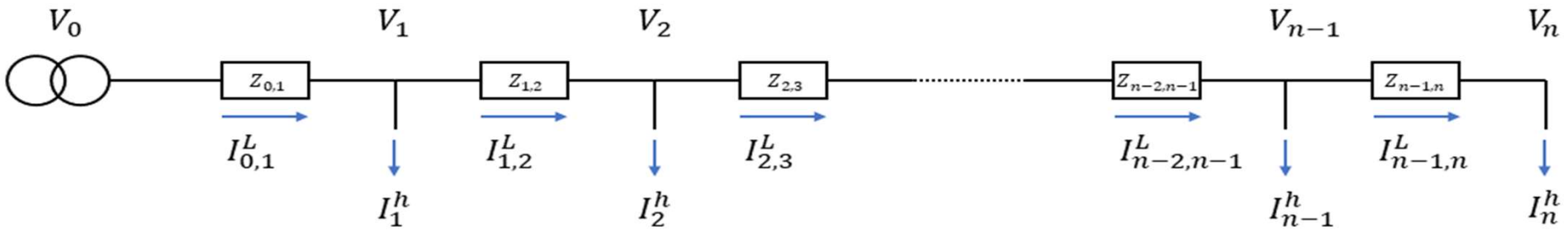
Thanks

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Discussion and contact



Generic network model for voltage analysis



$$\left. \begin{aligned}
 V_1 &= V_0 - I_{0,1}^L Z_{0,1} \\
 V_2 &= V_1 - I_{1,2}^L Z_{1,2} \\
 &\vdots \\
 I_{n-1,n}^L &= I_n^h \\
 I_{n-2,n-1}^L &= I_{n-1,n}^L - I_{n-1}^h
 \end{aligned} \right\} \begin{aligned}
 &V_j = V_0 - \sum_{i=1}^j I_{i-1,i}^L Z_{i-1,i} \\
 &I_{j-1,j}^L = \sum_{i=j}^n I_i^h
 \end{aligned} \right\} V_j = V_0 - \sum_{i=1}^j \left(Z_{i-1,i} \sum_{k=1}^n I_k^h \right)$$

Conclusions and future work

- Adding only PV increases the voltage in summer
- Replacing gas-based boilers for heat pumps as sole heat sources in most buildings can cause the voltage to drop outside the limit allowed by the technical standard EN50160
- Combining heat pumps with solar collector reduces the usage of the heat pump, but the voltage still remains near the allowed limit.
- Adding thermal storage showed the best voltage behavior in the distribution network.
- Further work is recommended in aggregating the individual MCES systems to enhance the flexibility of the network, consider aging of the batteries and including EV chargers.