CINELDI

Centre for intelligent electricity distribution
- to empower the future Smart Grid

PhD: Optimal coordination of distributed flexible resources

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Challenge and objectives

- New peak loads and distributed generation are pushing the operational limits of the distribution grid.
- Dispatchable generation is replaced by VRE, and some areas may rely on electric energy storage (EES) and other flexible resources to secure the supply.
- Remote areas are transferring into microgrids capable of operating off-grid as an alternative to upgrading existing grid connection.
- Higher utilizing of distributed flexible resources providing local solutions on local problems.
- Distributed flexibility can provide services on aggregated level.

Research tasks

- Develop optimization tools for flexible resources, such as batteries, electric vehicles, household loads and distributed generation.
- Integrate grid modelling into optimization model.
- Account for uncertainties such as demand and generation forecast error.
- Study the value of flexibility.

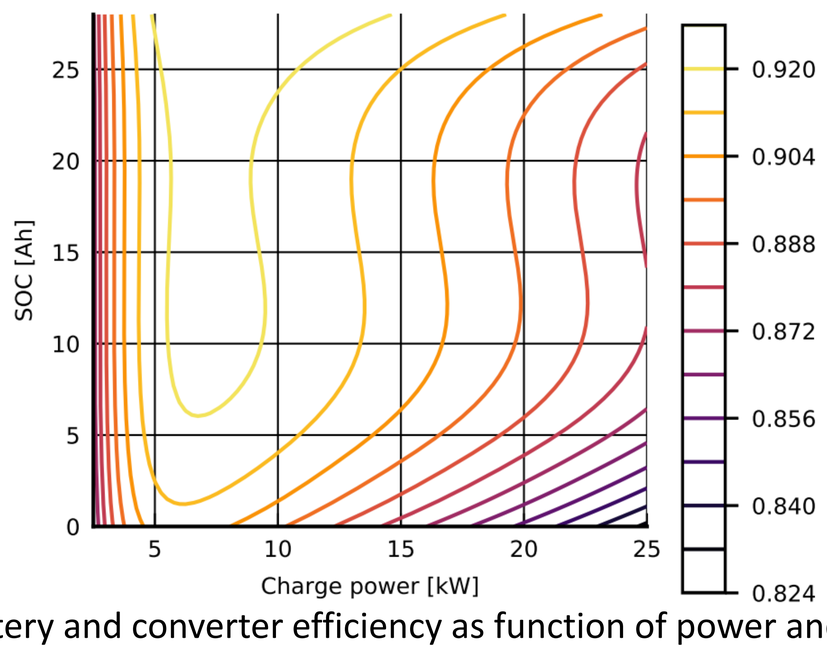
Approach

- Utilize open source software tools to build optimization models for flexible resources and grid accounting for uncertainty with Stochastic Dynamic Programming (SDP) or Stochastic Dual Dynamic Programming (SDDP).

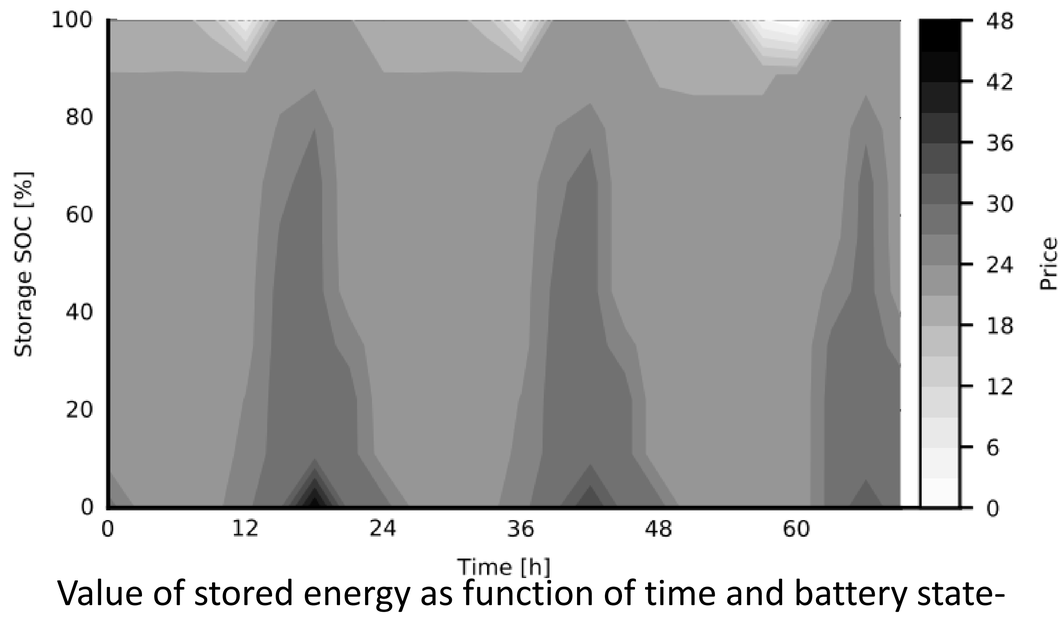
Significant results

- Multi-stage stochastic optimization model of batteries considering cyclic degradation of batteries.
- Detailed battery optimization model representing batteries with charge, current and voltage variables to enable more accurate operation closer to physical limits.
- Pricing of electricity and stored energy in systems dominated by VRE and EES under uncertainty.

Illustrations



Battery and converter efficiency as function of power and state-of-charge



Value of stored energy as function of time and battery state-of-charge

This work is funded by the Research Council of Norway (grant number 272398) and associated with CINELDI - Centre for intelligent electricity distribution, an 8 year Research Centre under the FME-scheme (Centre for Environment-friendly Energy Research, 257626/E20). The authors gratefully acknowledge the financial support from the Research Council of Norway.