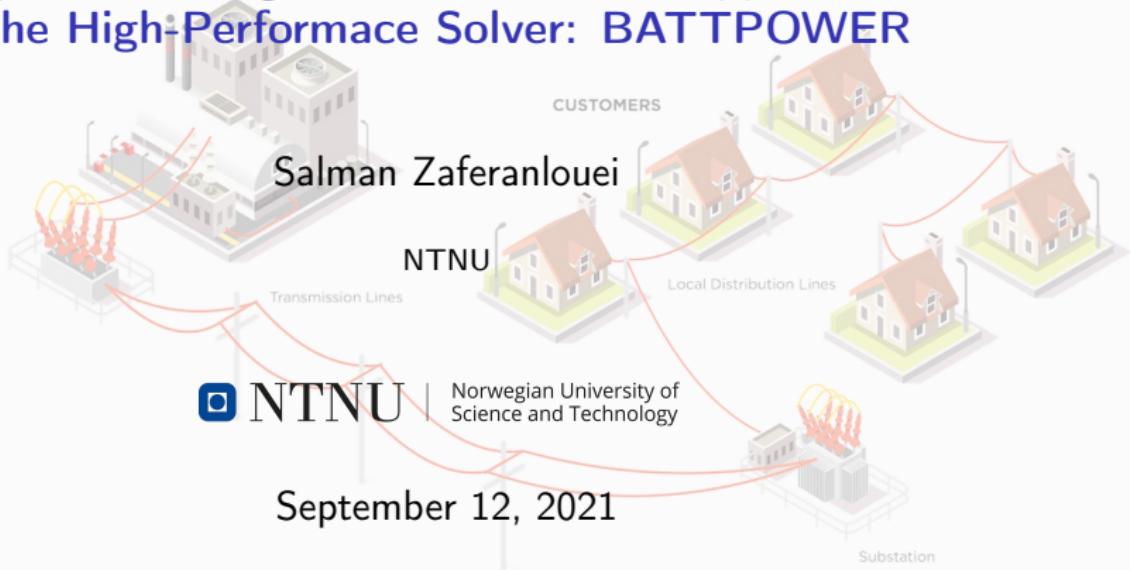


Large-Scale Integration of EVs, one Application of the High-Performance Solver: BATTPOWER



The presentation goal

- ▶ **Purpose:** To show what can be done with a high performance multi-period power flow solver. One example of the possible applications!
- ▶ **Phase I:** Background and Motivation
- ▶ **Phase II:** Case-Study
- ▶ **Phase III:** Results and Discussion

Project Name:	Battpower
Presentation Time:	20 min

Electricity Grid

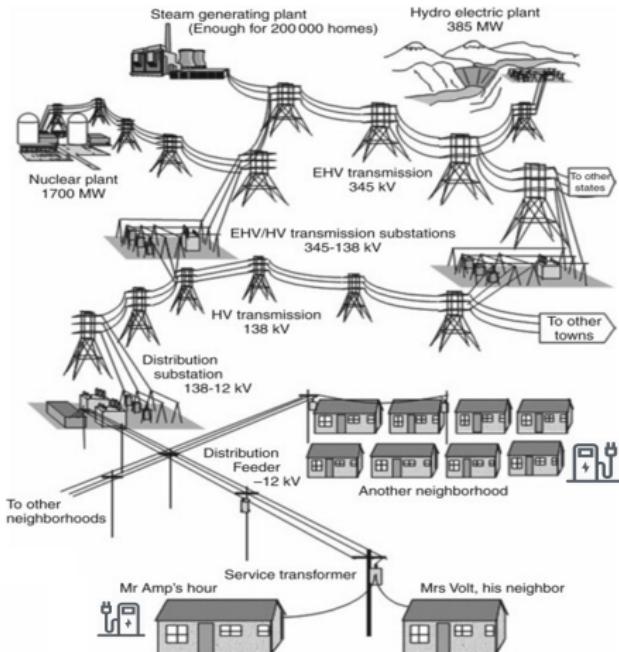


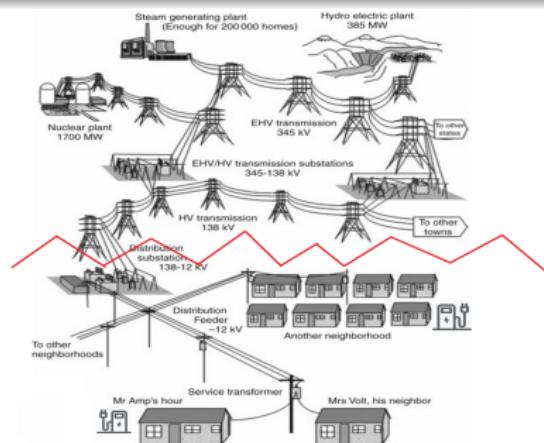
Figure 1: [www.sciencedirect.com/science/article/pii/B9781845697846500019]

Sustainability/Green shift/CO₂ reduction

For many reasons power electricity grid is facing decentralization

- ▶ Phasing out nuclear power plants
 - ▶ Increase penetration of solar and wind production
 - ▶ Many other points ...

This chain between large power producers and consumers is weakened.



The Electricity System

Characteristics of power system

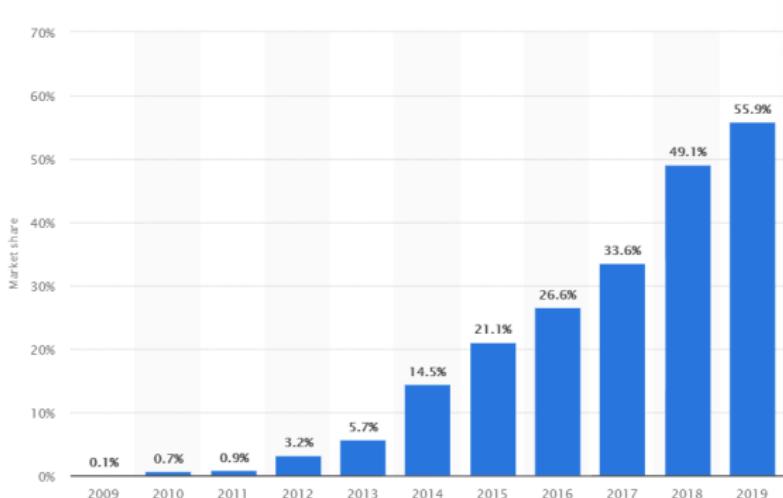
- ▶ power system with suppliers and consumers
 - ▶ power generated cannot be stored largely, so it must be consumed



Figure 2: A Typical Power System [Rochester Gas & Electricity]

Market Share

Market share of electric cars (BEV and PHEV) in Norway from 2009 to 2019



Penetration

Around 9% EV penetration in Norwegian transport sector. The Norwegian Parliament has decided on a national goal that all new cars sold by 2025 should be zero-emission (electric or hydrogen)^a.

^a<https://elbil.no/>

Motivation

1. Sustainability: Need tools for analysing operating conditions resulting from renewables, EV, storage and flexible demand.



¹ <https://www.nve.no/energy-market-and-regulation/retail-market/electricity-disclosure-2018/>

² <https://www.nordpoolgroup.com/Market-data1/Dayahead/Volumes/NO/Hourly/?view=table>

³ http://publikasjoner.nve.no/rapport/2018/rapport2018_74.pdf

⁴ Samdal, K., Kjolle, G. H., Singh, B., & Kvistad, O. (2006, June). Interruption costs and consumer valuation of reliability of service in a liberalised power market. In 2006 International Conference on Probabilistic Methods Applied to Power Systems (pp. 1-7). IEEE

Motivation

1. Sustainability: Need tools for analysing operating conditions resulting from renewables, EV, storage and flexible demand.
2. Economics: Norway electric industry revenues of 61.6 billion NOK in 2018¹. 1% savings worth 615 million NOK (estimated using ^{1 and 2})

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3. Reliability: Annual cost of power interruptions to Norway economy is 1600 MNOK/year (estimated using ^{3 and 4})

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Summary

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- ▶ Massive integration of renewable energy generations, decommissioning of thermal and nuclear power plants (with synchronous generators), more and more dependence on HVDC import/export, all are parts of the road map toward expected near future.

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- ▶ Massive integration of renewable energy generations, decommissioning of thermal and nuclear power plants (with synchronous generators), more and more dependence on HVDC import/export, all are parts of the road map toward expected near future.
- ▶ TSO have an important role in shaping new emerging markets, by opening dialogue with market players and introduce flexibility in a socio-economical manner.

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- ▶ Massive integration of renewable energy generations, decommissioning of thermal and nuclear power plants (with synchronous generators), more and more dependence on HVDC import/export, all are parts of the road map toward expected near future.
- ▶ TSO have an important role in shaping new emerging markets, by opening dialogue with market players and introduce flexibility in a socio-economical manner.
- ▶ Pilot Project 2018:
 - I FFR is a cost efficient measure for handling of low inertia challenges.
 - II Pilot project gave a profound understanding how FFR could be implemented and tested.
 - III Pilot project gave an overview of how flexibility could contribute to power system operational security.

Thank you for your attention!

