Ensure A Stable Power Grid When Using Renewable Energy

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Resume

- Aleksander Kulseng
- Studying Master in Systems Engineering at University of South-Eastern Norway (USN) (2020 -)
- Studied Bachelor of Engineering (B.Eng.) Electronics and Information Technology at OsloMet – Oslo Metropolitan University (2013 – 2016)

Resume

- Professor Mo Mansouri
- Stevens Institute of Technology, USA
- University of South-Eastern Norway, Norway

- How can we ensure that we do not overload the power grid as we use more renewable energy sources, charging more electric vehicles and using more home electronics?

- What is the consequence of using more renewable energy and charging more electric vehicles ?

- How can smart home technology can make the grid more efficient, and reduce the need for infrastructure upgrades?

- The Nordic Transmission System Operators (TSOs) Svenska kraftnät, Statnett, Fingrid and Energinet.dk has identified the following challenges for the Nordic power system:
  - Climate change
  - Development of more Renewable Energy Sources (RES)
  - Technological development
  - Common European framework for markets, operation and planning

- Major types of renewable energy sources:
  - Biomass
    - Wood and wood waste
    - Municipal solid wate
    - Landfill gas and biomass
    - Ethanol
    - Biodiesel
  - Hydropower
  - Geothermal
  - Wind
  - Solar

- The power system needs to keep production at the same level as consumption at all times

- To be able to do this, flexibility is required. This can be used to change the input or output

- Flexibility can be achieved through utilizing transmission capacity more efficient, utilize information from Automatic Metering System (AMS) to further develop demand response and new technology

Current limitations in the power grid

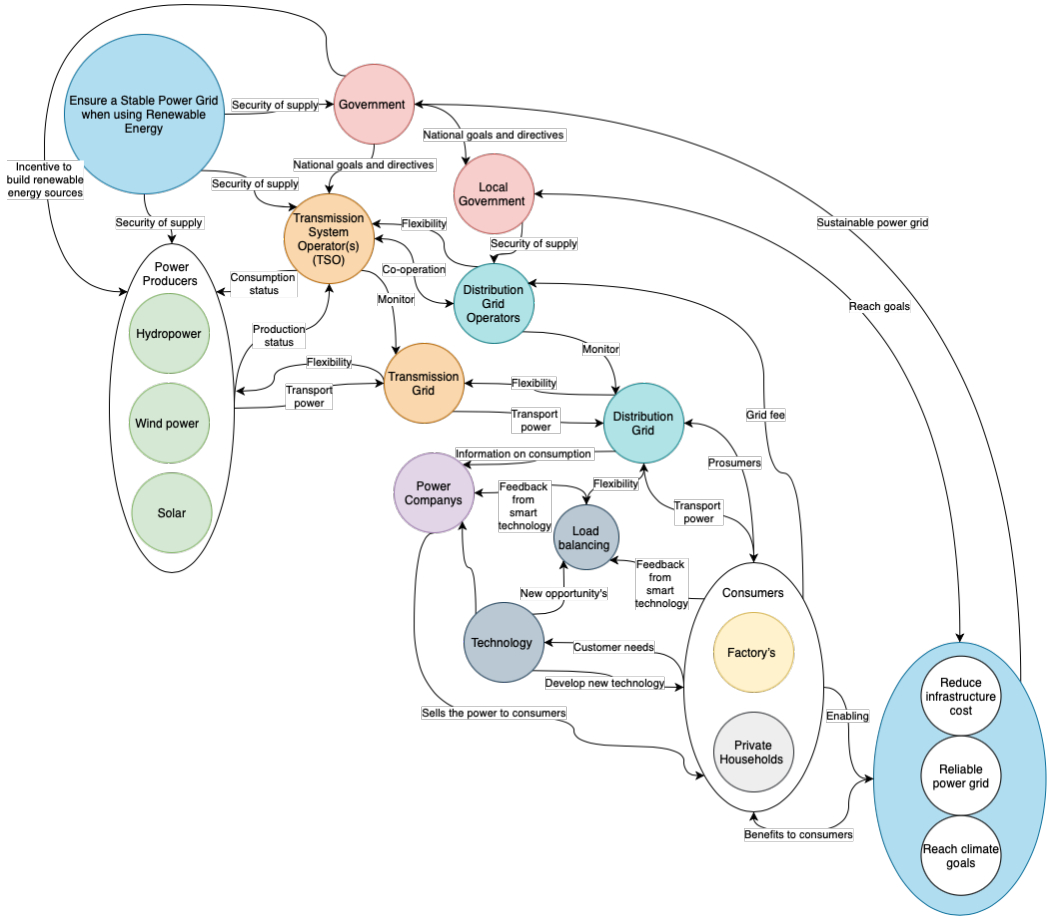
- Norwegian transmission grid is built from 1950 – 1980 and the last part of the transmission grid connecting northern Norway with southern Norway was finished in 1994
- The Norwegian government sees a need to modernize, restructure and expand the capacity in the transmission grid
- This is to increase the security of supply in some areas, more RES, higher consumption in industry and rural areas with population growth

Consequence of using renewable energy

- Renewable energy draw power from natural sources (solar, wind, ocean, hydroelectric and geothermal), that it is affected by environmental, seasonal and daily cycles. This means that production will vary during all hours of the day and be less predictable
- Because of this there is a need to store the energy, grid energy storage (dammed hydroelectricity, batteries, thermal energy storage and mechanical energy storage
- Storage of energy may give the TSOs and grid operators the flexibility and ability to maintain security of supply

Achieving a holistic view of the challenges

- From the Systemigram, we can see that there are many complex and complicated relationships and not individual problems
- The Systemigram contains many stories, and every story has an unique color, and the reading direction is appointed by the arrow
- The Systemigram gives a holistic view of the problem domain



Using smart technology for grid efficiency

- In recent years, there has been multiple research projects focusing on utilizing smart technology for grid efficiency. The focus has been to give TSOs and grid operators the flexibility needed to maintain security of supply and minimizing the impact on the customers
  - **NorFLex** - The goal of the project is to find the smart technological solutions for the power grid that smooths out the peak loads over the hole day
  - **Electric vehicles and buildings keep the power grid in balance** - This is a cooperation project between Tibber, Entelios and Statnett to use electric vehicles and large buildings to maintain balance between the production and consumption of electric power

Conclusion

- Norway, the Nordic countries and the EU are all shifting from large, centralized coal- and gas power plants to de-centralized wind- and sun power plants
- Smart technology, used right, gives the flexibility needed to help balance the power grid as more RES are integrated. Tibber is doing this in Sweden using only smart charges for electric vehicles, this can be expanded to utilize other smart technology to balance the power and to postpone the need for infrastructure updates