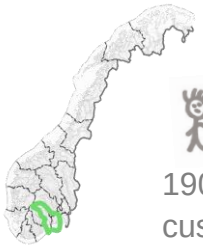
A DSO'S PERSPECTIVE ON NETWORK LOSSES



190 000 customers

15 557 km

1 390 km

NordREG. Workshop on incentives to reduce network losses in the Nordic countries

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Agenda

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  - Why are network losses important?
  - Green network investments
  - Network losses in our asset management – some examples
- 2. Incentives to reduce network losses
  - Factors to consider when designing incentives to reduce network losses
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  - Where do technical losses mainly occur?
  - Limited opportunity to influence factors affecting network losses
  - Movement of tasks and losses
  - Designing incentives is challenging - possible approaches in the context of the Norw. reg. model
  - Takeaway message!
  - *Actual vs. reference loss procurement price (optional)*

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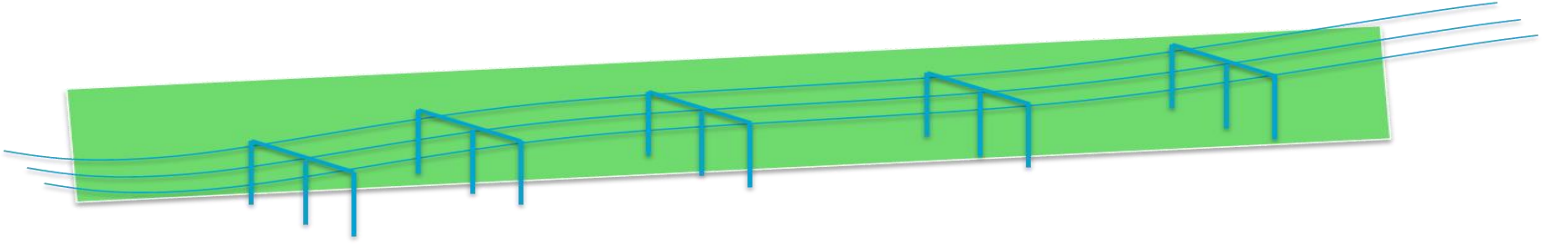
1. INTRODUCTION

Why are network losses important?

- Pillars of EU Energy Policy …. and also important outside the union!
  - Security of supply
  - Sustainability **– energy efficient power systems**
  - Competitiveness **– cost efficient power systems**



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Green network investments

- …are the DSOs and TSOs contribution to a more sustainable and efficient power system
- … are measures which reduces energy losses in the power system, e.g. voltage raising projects, network restructuring, etc.
- 1 MWh in reduced network loss = 1 MWh of "new" green energy

Total energy losses in the Norwegian regional and local distribution grids are 5-6 TWh/yr.

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Some examples

- Restructuring of the regional and transmission grid in the Tinn area of northern-Telemark in the mid 2000s.
  - System losses were reduced by ~45 GWh/yr (estimate)
  - Equivalent to the production of a small hydropower plant
- The recent restructuring of the regional and transmission grid in the Grenland area of southeastern-Telemark.
  - System losses were reduced by ~10,5 GWh/yr in 2016 and the benefit is expected to increase to 22,5 GWh/yr in 2030 (estimates)
- Possible voltage raising in mid-Telemark from 58/60 to 66 kV.
  - A possible reduction in system losses of ~3 GWh/yr

The sector, at least in Norway, has large investment plans because of aging assets and new connections. This makes it challenging to prioritize non-critical less profitable green investments.

Network losses in our asset management – some examples

- Investment analyses
  - The economic regulation and incentives with regard to network loss are not static. In the long run low costs are expected to be rewarded.
  - Most investment options are assessment according to the *minimum 4* principle – the net present value of four cost elements and a suitable period of analysis

    Investment costs

    Cost of energy not supplied

    Procurement of anticipated network losses

    Operational and maintenance costs
  - Larger investments and important choices are also assessed using a simulation based on the present economic regulation.
- We are positive to look at network restructuring projects e.g. moving transportation of energy to the transmission grid (first two of the green investments on p. 6)

Network losses in our asset management – some examples

- Future-proof building standard
  - In order to prepare for and make future voltage raising more attainable, new network components are compatible with a nominal voltage of 400 V / 22 kV / 132 kV independent of todays operating voltage. This means that power lines, cables, etc. have a rated voltage of 145 kV, 24 kV, etc.
  - New LV-circuits are built as 400 V TN. When substantial new loads are connected to a secondary substation with an existing MV/230 V transformer, it is changed to a 3-winding MV/400/230 V transformer. The new loads are supplied at 400 V. Etc.
- Network operation
  - Voltage level is kept at the highest possible level given the limitations of network components and end users in order to minimise losses.
  - Many factors are considered when establishing the normal sectioning of radially operated networks (load sharing, accessibility, fault probability, etc.). We are probing the possibility of getting an optimization tool for network losses in our network information system.

Network losses in our asset management – some examples

- Tariffs for consumption of reactive power* and installation of capacitor banks to reduce the flow of reactive power in the grid and thereby lowering network losses
- Tariffs for regular generation incentivises locations beneficial for network losses.
- We are installing smart meters – 2019 is the mandatory Norwegian deadline
  - New meters and better balance control is expected to reduce losses
- Etc.

* If the customer has a powerbased tariff and cos phi < 0,9

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2. INCENTIVES TO REDUCE NETWORK LOSSES

Factors to consider when designing incentives to reduce network losses

Incentives

- Strengthens of incentives vs. current focus
- Design of incentives mechanism
- Addressing of collaborative projects where several grid owner are involved in order to achieve the best overall effect.
- …

Fairness / targeting

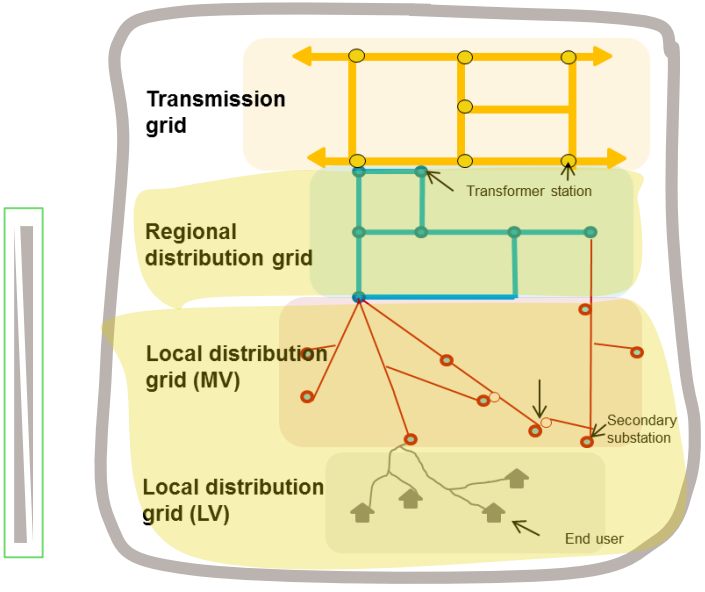
- Does the incentive mechanism target something DSOs can control or something they have less control over?
- Does it incentivise networks which transports energy efficiently or lightly loaded networks, networks with short average flow distances compared to network length, etc.?
- How does it target long-term investments making voltage raising attainable in the future?
- …

Horizon

- Is the method feasible today or is more data and research needed?
- …

The power grid

- Local distribution grid
  - Traditionally local distribution of electricity form regional stations to end-users. Bidirectional flows are coming!
- Regional distribution grid
  - Regional distribution form the more central transmission grid to regional stations, from generation plants to the transmission grid or other regional stations, etc.
  - Regional transportation. To what degree such is common depends on history, geography, consumption and generation pattern, the transmission grid, etc.
  - Some regional grids connects much varying generation, while others are more oriented towards stable consumption.
- Often fragmented ownership in the regional grid



Grids are diverse with regard to energy transport, especially regional grids. This has implications for the regulation of network loss.

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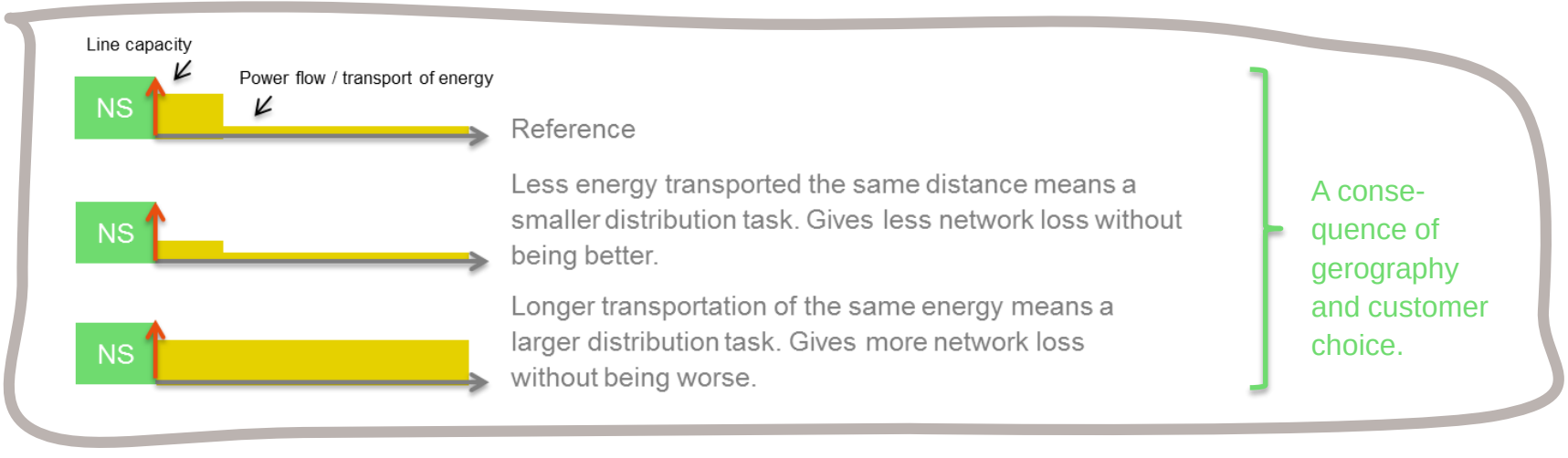
Where do technical losses mainly occur?

- In transformers when transforming energy
  - Beneficial with low losses relative to quantity of transformed energy
- In power lines and cables when transporting energy / power flow over distances
  - Beneficial with low losses relative to quantity of transported energy and distance of transportation. A long power line may have a short or long average power flow. It depends on load location.



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Limited opportunity to influence factors affecting network losses

- For facility specific concessions (not the less stringent area specific concessions), the regulator has the last words related to network structure and voltage level, i.e. significant factors for network losses
- The system operator - TSO in the Nordics - may in some cases decide the operation of regional distribution grids. Topology and network sectioning affects network losses.
- The voltage level in local distributions grids – e.g. 11 kV cable networks in cities - is a legacy of a distant past when the world was different than today. Digging up streets and changing to cables with a rated voltage of 24 kV have formidable costs.

Limited opportunity to influence factors affecting network losses

- A large share of generation often means significant yearly variations in network flow and losses
  - Regional distribution networks with a large share of generation may have high losses during warm and wet years. High production and a low local consumption gives much network transit. In colder and dryer years, both the network transit and losses diminishes.
- Regional networks with a large variability in network flow , e.g. because of penetration of generation, have higher losses that consumption oriented regional networks with a more stable flow.
  - Losses increases with the square of the current flow.

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Limited opportunity to influence factors affecting network losses

- A (regional) distribution gird may consist of assets owned by different actors with conflicting interest
  - Lets look at an example. The limiting component for raising a the operational voltage of a grid may be a power transformer. The owner of the transformer will however loose money if he reinvests his asset with a good technical condition prematurely (to a transformer with a different transformation ratio) in order to facilitate the reduction of technical losses in power lines owned by other DSO's. The owner of the transformer controls losses in the power lines, but he does not see the costs of these losses.
- Regional distribution grid often have a meshed topology and different DSOs may own different power lines.
  - A ring of several power lines supplied form two sides have a section with a reduced power flow, i.e. energy loss. This section is equally important as other sections. If different DSO's owns the power lines, its seems unfair if a regulations rewards the owner of the power line in the middle with the least power flow and energy loss.

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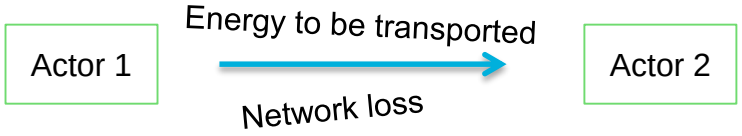
Movement of tasks and losses

- A project may reduce total network losses by moving the energy transportation task from one actor to another.



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Designing incentives is challenging - possible approaches in the context of the Norw. reg. model

Approach when deciding a cost norm	Incentives	Fairness/ targeting	Horizon	A few initial comments (no deep analysis)
A. Comparative total cost benchmarking between DSO's which includes				All comparative benchmarking approaches are affected by the factors DSO's have less influence over (pp. 14-16)
- Network distance, etc. as input and costs of network losses as output.	►	►	►	Gives an advantage to DSO's with less utilised networks and short transport distances within the total network (because of geography and localisation of loads).
- Delivered energy, network distance, etc. as input and costs of network losses as output.	►	►	►	Gives an advantage to DSO's with short transport distances within the total network (because of geography and localisation of loads)
- Transported energy / power flow (e.g. MW-mile type of approach), etc. as input and costs of losses as output.	►	►	►	Gives an advantage to DSO's with loss-efficient networks. Requires representative data about flow not currently available and research is needed.
B. Individual benchmarking of network losses, e.g. a method which compares the current year of the DSO against the average of the previous 5 years of the DSO.	► / ►	► / ►	►	The main benchmarking excludes costs related to network loss. The latter is handled through a separate benchmarking which ensures that the year to be benchmarked and its reference is more or less equally influenced by the factors which the DSO has less influence over and are more or less similar based on transportation distance / power flow given by geography and customer pattern. The method must be robust for load changes, etc., and many designs could be evaluated for suitability; losses / energy injected, losses / energy delivered, losses / MW-mile, etc.
C. Network losses as a pass-through cost without time lag.	►	►	►	The main benchmarking excludes costs related to network loss. The latter is a pass-through cost.
D. Network loss as a pass-through cost with time lag.	► / ►	►	►	The main benchmarking excludes costs related to network loss. The latter is a pass-through cost. The time-lag gives minor incentives to reduce loss.
E. Network loss ass pass-through cost in combination with an investment support arrangement for larger green investment packages.	► / ►	►	►	The main benchmarking excludes costs related to network loss. The latter is a pass-through cost with or without time lag. Benefits of cost cuts related to larger green investment packages are shared between society and DSO's. The approach makes it possible to incentivise measures which involves movement of losses from one actor to another or measures which require one DSO to invest so that others can reduce losses occurring in their assets.

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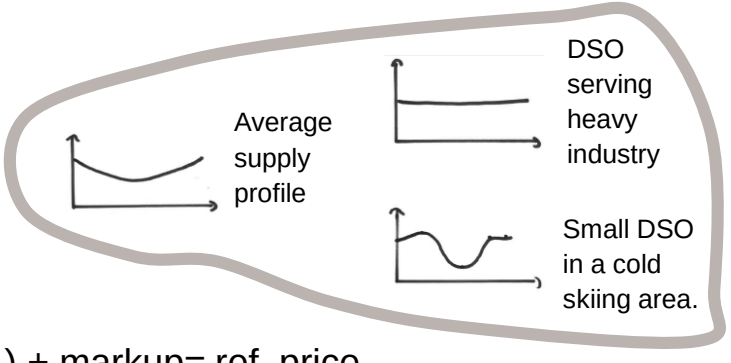
Actual vs. reference energy price

- Using actual costs in a regulation ensures cost coverage.
- "Reference price x volume" incentives efficient procurement.
- Challenges
  - Different price areas – a reference price per area.
  - Intra-annual variation in supply, network loss and energy price - weighting of monthly prices based on average monthly supply together with a markup, DSO specific monthly supply data with a smaller markup, etc.

Variations in connected loads influences monthly pattern

Geographical variation of climate and weather influences monthly pattern



- The Norwegian approach
  - (area price $_{\text{January}}$ x av. weight $_{\text{January}}$ + ... = weighted price) + markup= ref. price

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Takeaway message!

- Network losses are already taken into consideration
- Incentives to reduce network loss must be fair and targeted (right incentives)
  - Limits available approaches
- Weak incentives are far better than unfair or non-targeted incentives.
- Don’t forget important measures where net benefit depend on collaboration between assets owners.

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THANK YOU

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