Analysis of distribution grid tariffs in the Norwegian energy system

Lisa Kvalbein & Pernille Seljom
Renewables energy systems, IFE
Motivation

• Increased electrification can lead to the need for costly upgrades in the distribution grid

• The structure of grid tariffs can be used as an incentive to end-user to increase their flexibility and lower the peak demand

• Grid tariffs can be used to represent the distribution grid costs in TIMES-models
The cost of electricity in distribution grid

- The distribution grid is the low voltage grid delivering electricity to end users in each region.
- The cost at this level is then the electricity bill the end user needs to pay.
- The bill consists of three parts in Norway:
  1. The electricity price / marginal cost of electricity form high voltage grid
  2. Taxes
  3. Grid tariff
Payment structure of grid tariff

- Grid tariff (directly translated from Norwegian: Grid rental) is the cost of investments and maintenance in the distribution grid, in addition to grid losses.
- Different structure for end-use in residential building and in commercial buildings.
- The line is often set at yearly demand (lower/higher than 100,000 kWh) or at the size of the main fuse (lower/higher than 125 A)
IFE-TIMES-Norway

- Continuously developed with The Norwegian Water Resources and Energy Directorate (NVE)
- Modell strength
  - Covers the Norwegian energy system
  - Detailed description of end users (residential and commercial buildings, industry and transport)
- Modell specifications
  - 5 regions: Nord Pool spot price area NO1-5
  - Modell horizon: 2018 – 2050
  - 96 time-slices: 4 seasons x representative day of 24 hour
  - Deterministic and stochastic version

The model is documented here: IFE-E-2020/004 (3.599Mb) (unit.no)
Structure of grid tariff

• 3 structures will be investigated
  • Base
    • Flat charge per energy unit consumed for all electricity services
  • Tariff structure of today
    • Flat energy charge per unit consumed for residential
    • Energy charge with seasonal variations and demand charge for commercial
  • Tariff structure of tomorrow
    • Energy charge depending on time of use for residential
    • Energy charge with seasonal variations and demand charge for commercial

• All charges is calculated so that if there is no change in demand, i.e. no response to the incentives, the grid tariff income will be the same.

• Assumed the cost level of grid tariffs remains the same throughout the model period
Modeling the grid tariff

- New transformation processes is defined to represent the energy meter
  - One for residential sector
  - One for each season for the commercial sector
Modeling the grid tariff

- Only efficiency is set on the energy meter for residential
- Efficiency, lifetime and availability factor is set for the energy meters for commercial
The cost structure is set in scenario-files to be able to do scenario analysis.

For the energy charge, FLO_COST is used.

For demand charge, it is set as an investment cost with 1 year lifetime.

### Modeling the grid tariff

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Electricity Use in Commercial buildings in NO3

2020

Base

Today

Tomorrow

2050
Electricity Use in Residential buildings in NO1

- **2020**
  - **Base**
  - **Today**
  - **Tomorrow**

- **2050**
  - **EV charging**
  - **EL-specific**
  - **Heat**
### Power generation from PV in GWh

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<th>2050</th>
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<tr>
<td>Today</td>
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<tr>
<td>Tomorrow</td>
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<td>46</td>
<td>50</td>
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- For PV in commercial buildings, no clear grid tariff structure is of favor
- For PV in residential buildings, a grid tariff structure of time of use is favorable
Electric battery

- Battery is only favorable in commercial buildings in NO3 for scenarios including power demand charges in model periods 2035-2045
- 3.55 MWh - corresponds to 0.5 % of yearly peak demand in the region
- NO3 is a region with small difference in demand charges between the seasons.
Marginal electricity cost in transmission grid (ELC-HV)

2020

2050

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<th>NOK/MWh</th>
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<td>Summer</td>
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<tr>
<td>Fall</td>
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</table>
Marginal electricity cost in distribution grid (ELC-LV-*)

Residential

Commercial

2020

2050
Conclusion

- The modelling of three different grid tariff structures is demonstrated in IFE-TIMES-Norway

- The grid tariff structures
  - influences the investments in electric batteries and PV
  - influence peak demand marginally with current model assumptions

- Hypothesis: Grid tariff structure will have a greater impact with more end-use flexibility options (e.g. flexible EV charging), a stochastic modelling of short-term uncertainty and with an increase in grid tariff cost level

- What can we learn from your model team on modelling of the distribution grid and grid tariffs?
Thank you!


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lisa.kvalbein@ife.no

Master of Science