The regulation of electricity network tariffs in Sweden from 2016

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Outline

• Background

• Regulation of electricity network tariffs in Sweden

• Incentive schemes
  • Reliability of supply
  • Efficient utilization of the networks
  • Adjustment of the revenue cap as a result of the incentives

• Analyses and next steps
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• Analyses and next steps
The Swedish Energy Markets Inspectorate (Ei)

- Regulatory authority for electricity, natural gas and district heating
- Regulate monopoly operations in the electricity and natural gas markets, and monitor the competitive energy markets
- We contribute to realize the government's energy policy
Background

• Distribution of electricity is considered a natural monopoly

• The power system; three main levels (transmission, sub-transmission, distribution)

• Short history
  • 1996: network operations were separated from trade and production activities (unbundling)
  • 2003: the first performance based regulation of network tariffs was introduced
  • 2006: rules on mandatory customer compensation entered into force
  • 2012: the first version of current revenue cap regulation was introduced
  • 2016: improvements to the revenue cap regulation for the second regulatory period
A great challenge to develop a fair tariff regulation

- Distribution system operators (DSOs) operate under very different conditions
- Around 170 local and a few regional DSOs and one transmission system operator (TSO)
  - Significant different sizes
  - Different ownerships
  - Different geographic conditions, etc.
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A regulated revenue cap

- The revenue cap sets the upper limit on how much the DSO or TSO is allowed to charge their customers
- Reasonable coverage for their operational costs and reasonable return on the invested capital
- Ex-ante regulation: if forecast does not match the outcome → input to the next period (can save surplus one period)
Average:
Controllable ~23 %
Non-controllable ~33 %
Capital costs ~44 %

Controllable costs

Efficiency requirement

Non-controllable costs

Return

Asset base

Depreciation

Adjustments

Operational costs

Capital costs

Adjustment for over- or under charging in previous period

Revenue cap regarding a 4 year period
Overview of the tariff regulation

- **Operational costs:**
  - *Non-controllable costs* relate to costs that are considered difficult for the DSO to influence
  - *Controllable costs* all other operational costs
  - To simulate conditions on a non-monopoly market, an *efficiency requirement* 1.00-1.82 % is included in the model.

- **Capital costs:**
  - The regulatory *asset base* is the sum of all present purchase values
  - The asset base is input to calculation of capital costs and consists of *depreciation* and *return*
  - The return is *adjusted* based on reliability of supply and utilization
Calculations of the return and the depreciation

- Real **annuity** method 2012-2015
- Real **linear** method from 2016
- Depreciation time = 40/10 years + 10/2 additional years with limited compensation
- Transition rule: if the construction year is unknown or before 1978, it is set to 1978
- Equations + more details in the paper

**Capital costs per year from an investment as a function of its age**
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Incentive schemes (adjustments)

- Ei shall take into account the performance of the DSOs when calculating the revenue cap
- Reliability of supply incentive scheme
  - Introduced in 2012, but more detailed method from 2016
- Grid utilization (smart grid) incentive scheme
  - New from 2016 to meet targets based on a EU directive
The reliability incentive scheme

- Aims at promoting socioeconomically desirable levels of reliability of supply
- Reliability indicators: outcomes is compared with norm levels (baselines)
- Ei collects interruption data from the DSOs on a customer level since 2010
- The reliability scheme described here is applied on local DSOs and differ a bit from the scheme applied on regional DSOs and the TSO (see the paper)
How implemented changes meet incentive targets

- Avoid unmotivated differences **within** the same DSO
  - New indicator (CEMI₄) in addition to average reliability indicators

- Avoid unmotivated differences **between** DSOs
  - New norm level method for reliability indices based on customer density

- **Keep** current reliability for high performance DSOs
  - Over-performing DSOs will get their historical reliability level as their baseline
  - The costumer have already “paid” for the current network and the associated level of reliability
About the calculations

• >12 h outages are excluded to avoid “punishing” DSOs twice for same event

• CEMI\textsubscript{4} the share of customers that have 4 or more interruptions during a year and can only lower the reward or penalty and never affect more than 25 %

• Customer groups:
  1. Household
  2. Industry
  3. Agriculture
  4. Commercial
  5. Public service
Parameters that are input to the calculations

• For all five customer groups:
  • Average number of interruptions (SAIFI) and average interruption time (SAIDI)
  • Advertised and non-advertised interruptions

• This gives $5 \times 2 \times 2 = 20$ reliability indices where all has its own cost parameter

• All 20 equations are summarized and in some cases adjusted by CEMI$_4$

• Detailed equations and definitions are provided in the paper
Choosing the norm level (baseline)

• Two different norm levels, use the lowest of:
  1. A costumer density based level (black; 60 minutes in the example)
  2. Own outcome: average 2013-2015

• A DSO with lower reliability
  • The norm (yellow) is then gradually approaching the costumer density norm from the own norm value (100 minutes in the example)

• A DSO with higher reliability uses own norm (blue; 40 minutes in the example)
Sensitivity analysis of the reliability incentive

- The adjustment as a function of equal changes in all reliability indices
- Without any and with max impact from CEMI₄
- Example:
  - If all reliability indices are 200 % of the norms, then the adjustment is -2.44 % without any impact of CEMI₄ and -1.83 % if CEMI₄ is improved with 0.25 “points” or more (i.e. decreased share)
Incentive scheme for efficient grid utilization

• EU Energy Efficiency Directive → requirement to incentivize DSOs to operate their networks efficiently

• Ei shall take into account to what extent the grid is utilized efficiently when calculating the revenue cap

• Indicators used for measuring to what extent the grid is utilized efficiently: (a) network losses and (b) load factor combined with the cost of feeding grid

• Losses and cost of feeding grid are categorized as non-controllable costs
  • However not 100 % non-controllable: With new techniques and solutions the possibilities to improve potentially increases with time
Network losses

• Examples of how to decrease energy losses:
  • Increase the voltage level (often not an option)
  • New equipment (material, feeder area etc.) and more even utilization (e.g. smart grid solutions)

• Incentive scheme: The adjustment is proportional to $0.5 \times \text{[changed cost for losses between the own norm period and the outcome]}$

• $0.5 \rightarrow$ The DSO and the customers equally share both savings and cost increases
Load factor and cost of feeding grid

• The daily load factor is the average daily load divided by the highest load that day. This value is between 0 and 1; the higher the better

• Adjustment:
  = 0 if unchanged or increased cost (i.e. never a reduction)
  = [decrease of feeding grid fee]*[the average of all daily load factors] else

• The overall idea: more even load gives less capacity requirements which can give reduced fee – the higher load factors, the higher share of the savings to the DSO
Integrating adjustments in the revenue cap

• All outcomes from reliability and utilization calculations are summarized → potential addition or reduction on the return

• Changes in on how to set the upper and lower limit of the adjustment:
  • The limits in percentage of the revenue cap has increased from ±3 % to ±5 %
  • Limits regarding all four years instead of calculated limits each year
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Sensitivity analysis

- Ongoing sensitivity analysis of the entire regulation – a few examples to the right
- Several hundred parameters (input data) that can be changed, mostly in relation to the reliability incentive
- More results are planned to be presented, e.g. at CIRED 2017
Average profit/year with different re-investment periods

• Assumptions:
  • LCCA: From the first investment, over the re-investment + a new identical period
  • Replaced with an identical component
  • Age related changes that can affect incentive schemes are not included

• Optimum to replace after 50 years, but a stable outcome between ~35 and ~55 years
Future development work

• The second regulatory period (2016-2019) is ongoing and the consequences of the implemented incentive schemes are yet to be seen

• Ei aims to investigate the possibilities to further develop the regulatory model – focus will be on improving incentives for grid utilization (smart grids) – hope to publish some brief ideas during CIRED 2017

• Reference groups: both own and external projects

• A new customer interruption cost investigation

• Important to develop incentives to meet future challenges and opportunities, but at the same have a predicable regulation useful in long-term investment planning
Time for questions...

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