**Gutachten – Qualitätsregulierung**
Berücksichtigung und Verwertung von Netzzuverlässigkeit und Versorgungsqualität in Anreizregulierungsverfahren, mögliche methodische Ansätze, empirische Datenermittlung und Erfahrung in der internationalen Anwendung

**Präsentation vor dem Konsultationskreis**

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- Quality of the German Energy Industries
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1. Introduction and Scope of the Study

Background

- The New Energy Law provides that the Bundesnetzagentur (BNetzA) shall prepare a report on the cornerstones of an incentive regulation system by June 30th, 2006.

- The Energy Law provides with respect to quality regulation:
  - Efficiency targets must consider the quality of supply and respective quality targets
  - Quality targets must be based on reliability criteria, taking into account structural differences between the network operators
  - Violation of quality targets may lead to reduced network tariffs
  - The Ministry of Economics and Technology (former Ministry of Economics and Labour) may develop regulations with respect to
    - Setting minimum and maximum efficiency and quality targets, including the means to enforce these targets
    - Referential treatment of investments that serve the improvement of the security of supply
  - The Ministry of Economics and Technology shall monitor the security of supply with special consideration of the long-term adequacy of the system
Introduction and Scope of the Study

- Regulatory issues
  - How to define quality of supply?
  - How to monitor and regulate quality of supply?
  - How to get started in the absence of quality data and tested regulatory mechanisms?
Cornerstones of Quality Regulation System
Different Dimensions of Quality

- Quality of network operators are usually divided into four dimensions:
  - Safety: “The ability to avoid damage to property or persons”
  - Reliability: “The ability of a system to transport energy to and from its connected network customers”
  - Product Quality: “The technical quality of electricity and gas”
  - Service Quality: “The quality of the interactions between network operators and their clients”
Cornerstones of Quality Regulation System

- Are current quality standards adequate?
  - No apparent concerns that today’s safety standards and product quality are not sufficient (gas and electricity)
  - Average reliability in electricity seems to belong to the best in Europe
  - Reliability levels in gas are not well known, neither in Germany nor internationally
  - Service quality in Germany is unknown
The common regulatory structure

- Investment and Maintenance Decisions
- Execution of works
- Network (System)
- Network Operator
- Financial Incentives
- Provisions for a QMS
- Sanctions / Penalties
- Provisions for collection of data
- Costs
- Quality Criteria
Cornerstones of Quality Regulation System

- Common criteria for average reliability
  - Interruption > 3 minutes
  - SAIFI – System Average Interruption Frequency Index
    - Cumulated interruption frequency per connected customer
    \[
    SAIFI = \frac{\text{Summe aller Kundenunterbrechungen}}{\text{Summe aller angeschlossenen Kunden}}
    \]
  - CAIDI – Customer Average Interruption Duration Index
    - Average restoration time per interrupted customer
    \[
    CAIDI = \frac{\text{Kumulierte Dauer der Kundenunterbrechungen}}{\text{Summe aller Kundenunterbrechungen}}
    \]
  - SAIDI – System Average Interruption Duration Index
    - Cumulated interruption duration per connected customer
    \[
    SAIDI = \frac{\text{Kumulierte Dauer aller Kundenunterbrechungen}}{\text{Summe aller versorgten Kunden}}
    \]
  - ENS – Energy Not Supplied
    - Cumulated energy not supplied
Cornerstones of Quality Regulation System

- Scope of quality regulation
  - Identify any potential dissatisfaction of clients with current quality levels
  - Ensure a proper efficiency analysis, as common benchmark approaches do not consider quality of supply
  - Protect customers from over-extensive cost savings
    - Protect vulnerable customers from degrading quality
    - Provide incentives to achieve a socio-economically justified quality level
International Experience
Electricity - UK

- Detailed system developed since 1990 including
  - Technical regulation (Grid Code and Distribution Code)
  - Requirements for audited quality data
  - Publication of reported data
  - Protection of worst-served clients
  - Incentive for average quality performance

- Incentive System
  - Based on Average reliability
    - Price of Quality, $\phi^{SAIDI} = 0,05 \rightarrow 0,5 \text{ €/min}, \phi^{SAIFI} = 4,5 \rightarrow 39 \text{ €/interruptions}$
    - Up to 3% of revenues at risk

- Guaranteed Standards for
  - Service Quality
  - Reliability (worst served customers)
    - Standards for normal and exceptional conditions

- Reporting and Auditing
  - Detailed reporting arrangements
  - Auditing performed annually
International Experience
Electricity - Netherlands

- Detailed regulation system comprising of
  - Technical regulation (Grid Code and Distribution Code)
  - Requirements for audited quality data
  - Publication of reported data
  - Protection of vulnerable clients
  - Incentive for average quality performance

- Incentive System
  - Average reliability
    - Price of Quality, \( \varphi^{\text{SAIDI}} = 0.20-0.25 \text{ €/min} \) (to be determined in 2006)
    - Up to 5% of revenues at risk

- Guaranteed Standards for Reliability (worst served customers)
  - Restoration time (more than 4 hours)
  - Household customers: € 35
  - Small commercial customers: € 910

- Reporting and Auditing
  - Detailed reporting arrangements
  - Auditing performed annually
International Experience
Electricity - Norway

- Incentive System
  - Energy Not Supplied (ENS)
  - 2001-06
    - Revenue cap increased or decreased depending on actual and expected cost of ENS
    - 2003-06 ENS cost €1,0-12,4/kWh
  - 2007-11 proposal
    - Incentive based revenue cap
    - Yearly efficiency calculations (DEA model)
    - Cost of short-term (<3min) outages included from 2008
    - Direct compensation for outages over 12hrs

- Reporting and Auditing
  - Detailed reporting arrangements to NVE
  - ENS differentiated between 27 customer groups
International Experience
Gas - UK

- Gas industry regulation driven by safety considerations
  - Separate safety regulator (HSE)
  - Principal concerns are
    - Gas escapes
    - Explosion
    - Fire
    - Carbon monoxide poisoning
- Regulation of quality of service is much less sophisticated than for electricity
- Limited data reporting
  - Number and duration of interruptions
  - Mains replacement performance
  - Environmental outputs
- Guaranteed and Overall Standards introduced recently
- No immediate prospect of linking quality to revenue through incentives
International Experience
Gas - Netherlands

- DTe considerations of gas quality regulation
  - Safety
  - Quality (security) of transportation
  - Gas quality
    - composition and pressure of the transported gas,
  - Service quality
  - Environmental quality

- Reporting requirements
  - Number of accidents
  - Average duration of the time needed to cancel the safety risk
  - Number of leakages

- Possible future use of incentive regulation with minimum performance standards

- Improvement to legal framework for gas network design, construction, operation and maintenance required
  - Regulatory responsibility for safety compliance unclear
International Experience - Summary

- **Electricity**
  - Several examples of sophisticated incentive regulation of quality
  - Average system performance drivers
    - SAIFI, CAIDI, ENS
  - Limited revenue exposure
    - Less than +/-5%
  - Often with extra protection for customers who get poor service
    - Penalty payments
  - Key requirement is good data
    - Detailed reporting protocols
    - Quality Management Systems and Auditing

- **Gas**
  - Safety is the over-riding consideration
  - Some monitoring introduced
  - Very few penalties and no financial quality incentive schemes
Status Quo of Quality Regulation in Germany

- The “Safety” and “Product Quality” of electricity and gas is ruled by special standards and rules. There is no immediate need to expand on these rules.

- General planning and operational standards exist only for 110kV-networks and above in form of an N-1 criteria. We do not see any reasons for modifying these planning rules.

- The “Reliability” of electricity is monitored since many years with the focus on components (since 2004 customer focussed). The existing data base from 2004 onward may serve as a basis to conduct initial trend analysis for medium and high voltage networks.

- The “Reliability” of the gas network is hardly monitored. Focus was always put on gas accidents. We suggest to expand the data base to include reliability data as well.

- The role of economic and safety regulators in approval of modification of these standards and rules should be further clarified and confirmed by respective regulations.
Recommendations
Reliability (Electricity)

- Overview

  - Two focus areas of quality regulation
    - Incentive to adapt average quality to socio-economic values
    - Protection of worst-served customers
# Recommendations
## Reliability (Electricity)

### Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>CPS</th>
<th>AQIS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Duration | *initially:* maximum duration per interruption  
*later:* several duration levels | CAIDI (average restoration time) |
| Frequency | *initially:* number of long interruptions per affected customer  
*later:* more complex frequency function | SAIFI (average interruption frequency per connected customer) |
| **Cause** |     |      |
| notified / not notified | no differentiation | differentiation |
| origin of interruption | Network operator of respective voltage level paid by network operator, who provides connection settled among network operators | Network operator of respective voltage level |
| **Structural Differences** |     |      |
| Customer Groups | *initially:* no separation or mutually accepted differentiation  
*later:* possible differentiation by size of customer based on willingness to pay | *initially:* no differentiation or mutually accepted differentiation  
*later:* possible differentiation by size of customer based on willingness to pay |
| Voltage level | no differentiation  
paid by network operator, who provides connection settled among network operators | differentiation |
| Geographical | *initially:* no  
*later:* possible differences to reflect local conditions | *initially:* no differentiation or mutually accepted differentiation  
*later:* as part of the efficiency assessment |
| **Special Events** |     |      |
| Force Majeur | included in data base, but explicitly described, excluded from calculation of criteria, no explicit definition | included in data base, but explicitly described, excluded from calculation of criteria, no explicit definition |
Recommendations
Reliability (Electricity)

- **Determination of Criteria**
  - Calculation of a company’s SAIFI and CAIDI
    
    \[
    SAIFI_i = SAIFI_{i}^{HV} + SAIFI_{i}^{MV} + SAIFI_{i}^{LV}
    \]
    
    \[
    CAIDI_i = \frac{CAIDI_{i}^{HV} \cdot SAIFI_{i}^{HV} + CAIDI_{i}^{MV} \cdot SAIFI_{i}^{MV} + CAIDI_{i}^{LV} \cdot SAIFI_{i}^{LV}}{SAIFI_{i}}
    \]

- **For small networks**
  - Averaging SAIFI – and probably CAIDI - over n years
    \[
    SAIFI_{t=0} = \frac{\sum_{t=-1}^{n} SAIFI_t}{n}
    \]

- Until averaging time is reached, a reduced financial weight might be considered (1/n)

- n needs to be determined based on a statistical analysis of the fluctuations of the number of interruptions
  - VDN-Störungsstatistik serves as a basis
Recommendations
Reliability (Electricity)

- Customer Protection System (CPS)
  - Evaluation of interruptions:
    - Socially and politically not acceptable quality level
    - Costs should be related to “price” of service
  - Criteria (proposed criteria and penalties)
    - Maximum duration of an interruption
      - 18 hours
      - €30 per interruption and interrupted customer
    - Multiple interruptions of a duration of 4 hours and more
      - 3 interruptions
      - €30 per interrupted customer
    - Tuning target levels and penalty payments for Phase II

- Settlement
  - Automatic payment by companies for exceeding maximum interruption time
  - Claims by customers for exceeding multiple interruption standard, burden of proof is with the network operators
  - Settlement procedure to be developed by network operators
  - Contracts to be modified accordingly
Recommendations Reliability (Electricity)

- Average Quality Incentive System (AQIS)

- Interactions with the cost efficiency analysis requires differentiation of
  - Optimal cost/quality ratio
  - Optimal quality level

![Graphs showing quality vs. costs and marginal costs of quality](image-url)
Recommendations
Reliability (Electricity)

- Incentive system via AQIS
  - If the x-factor is determined without consideration of quality, the formula may be written as
    \[
    Rev_{t+1} = Rev_t^{\text{cost efficiency}} + Rev_t^{\text{Quality}} \pm Z
    \]
    \[
    Rev_t^{\text{Quality}} = \text{Revenue due to quality}
    \]

- Quality is weighted average from unplanned and planned interruption
  - Proposed weighting factor planned / unplanned: 66% / 33%
Recommendations
Reliability (Electricity)

- General description of incentive system

- Quality target
  - Depends on cost/quality curve of individual network operator and customer willingness to pay
  - May vary across the country
  - Dead Band reduces impact of small changes in quality
  - Upper and Lower Caps limit the impact of quality on revenues
  - Slopes mirrors the “willingness to pay” or the quality cost function of companies
Recommendations
Reliability (Electricity)

- Option I (average quality standard)
  - Quality Target is set by average of comparable companies (definition of clusters)
  - Slope is symmetric as no further information available and follows “common sense”
  - Reduced slopes for companies with strong stochastical fluctuations
  - Cap is symmetric at 2% of revenues
  - No dead band

- Evaluation
  - Consideration of quality levels to improve efficiency targets
  - Companies of one cluster only comparable, if slope is set right
  - Slope must be harmonized with x-factor
  - Incentives to reach socio-economically justified quality level only if slope equals willingness to pay (WTP)
Recommendations
Reliability (Electricity)

- Option II (minimum quality standard)
  - Penalties, if quality is below a minimum limit
  - Minimum limit set based on the quality frequency distribution in one cluster

- Evaluation
  - Strong incentive to increase quality above minimum level
  - Incentives to reduce quality to minimum level
Recommendations
Reliability (Electricity)

- Option III (individual quality standard)
  - As Option I, but individual quality standard are set based on the efficiency analysis

- Evaluation
  - Individual quality targets set off the shortcomings of the cost efficiency analysis
  - No clustering required
  - Incentives to reach socio-economically justified quality level only if slope equals to willingness to pay (WTP)
Recommendations
Reliability (Electricity)

- Implementation Scenarios (General Overview)

- Service Quality and Reliability: Reporting of Quality Data and Publication
- Service Quality: GS and Penalties
- Reliability: GS and Penalties
- Reliability: Modified GS and Penalties
- Reliability-AQIS: Select Option and choose financial consequences
- Reliability-AQIS: Integrated Cost and Quality Control
- Reliability: Simplified AQIS
Recommendations
Reliability (Gas)

- Measure Quality Criteria
  - SAIFI
  - CAIDI
  - Leakages?
- Same data as electricity, but explicit description of any safety-related interruption time
- Development of quality regulation management scheme requires time
  - CAIDI depends partly on strong safety requirements
- Proposed Guaranteed Standard for long supply interruptions
  - 18 hour target level, €30 penalty payment, with exceptions for safety-related time
Recommendations Service Quality

- Service Quality targets may be set based on international experience
- Targets should be set to protect worst served customers
- Targets are independent of structural differences
- Penalties should be paid automatically
- Service standards 1 to 5 are for gas and electricity, standards 6 and 7 are for electricity only
- Proposed Standards:

<table>
<thead>
<tr>
<th>Guaranteed Standard</th>
<th>Target Performance Level</th>
<th>Penalty Payment</th>
<th>Automatic Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Providing cost estimate for works</td>
<td>20 working days</td>
<td>€10</td>
<td>Yes</td>
</tr>
<tr>
<td>2 Execution of works</td>
<td>15 working days</td>
<td>€30</td>
<td>Yes</td>
</tr>
<tr>
<td>3 Connection of new supply</td>
<td>8 working days</td>
<td>€25</td>
<td>Yes</td>
</tr>
<tr>
<td>4 Reconnection following non-payment</td>
<td>1 working day</td>
<td>€40</td>
<td>Yes</td>
</tr>
<tr>
<td>5 Timed appointments</td>
<td>Morning or afternoon</td>
<td>€30</td>
<td>Yes</td>
</tr>
<tr>
<td>6 Responding to supplier's fuse failure</td>
<td>5 hours</td>
<td>€25</td>
<td>Yes</td>
</tr>
<tr>
<td>7 Resolving* metering or voltage problems</td>
<td>10 working days</td>
<td>€30</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*resolving = correction of problem or preparation of detailed action plan
Recommendations
Safety and Product Quality

- Current rules are adequate

- The role of the energy regulators should be clarified
  - Energy regulators should have a formal role in initiating and approving changes to the existing rules
  - Formal procedures required to ensure that safety issues are appropriately considered in the price control mechanism

- No need to set up guaranteed standards for voltage quality, regulated by customer complaints

- As a result of the customer survey, BNetzA may consider to require additional monitoring of voltage quality in electricity networks
Recommendations
Reporting and Quality Management System

- Quality criteria should be reported and published
  - Application of customer pressure through publication of information
  - Application of investor pressure through publication of data
  - Application of peer (competitive) pressure by publication of data and benchmarking

- Companies should be required or encouraged to set up a Quality Management System
  - Data
    - Unambiguous definition and format of quality indicators
    - Clear description of the data collection and registration process
  - Quality of Supply
    - Setting targets for the quality indicators
    - Procedure to estimate the future demand for network capacity and quality
    - Procedure for estimating the development of network quality
    - Contents and procedures for setting up investment and maintenance plans
    - Requirements for an emergency action plan
    - Responsibilities for maintaining an adequate asset register

- The role of regulatory authorities in defining the requirements for such a QMS needs to be determined
Summary

- Quality in electricity and gas is divided into
  - Safety
  - Reliability
  - Product quality
  - Service quality

- “Safety” and “Product Quality” are determined by technical design, planning and operating standards
  - There is no apparent need to modify or expand today’s planning and operating rules, neither in electricity nor in gas
  - There is no apparent need to expand today's standards for the gas quality and voltage quality
  - There is a value in formalizing the role of the state agencies and BNetzA in monitoring and enforcing compliance with the norm and standards defining the product quality
Summary

- Two-leg system to regulate “Reliability” of electricity
  - No general planning and operating standards in medium and low voltage levels
  - Reliability of transmission networks require specific consideration of network characteristics
  - General Quality Regulation Mechanism required for customers of medium and low voltage networks
  - Regulation System should be stable and clearly defined, as it must provide long-term incentives
  - Customer Protection System (CPS)
    - Maximum interruption duration and maximum interruption frequency
  - Average Quality Incentive System (AQIS)
    - Based in SAIDI and CAIFI
    - Socio-economically justified quality level requires to determine customer’s willingness to pay
    - Quality data can be used immediately, price depend on network size

- Deferred system to regulated “Reliability” of gas
  - BNetzA should start to measure reliability criteria for gas networks
  - Customer protection System (CPS)
    - Maximum interruption duration with special consideration of gas safety
  - Consider a AQIS only as more information about the reliability data emerges
Summary

- Introduce a guaranteed standards for “Service Quality”, even if an initial customer survey has not been undertaken
  - First recommendations for the GS and the respective penalty payments have been made and need to be discussed and modified according to the reactions of the network operators
- There is a value in requiring network companies to operate a Quality Management System, both for ensuring that data is delivered in adequate quality as well as in ensuring the quality is considered appropriately in the planning and operating decisions
  - Today’s TSM for gas and electricity need to be reviewed to check if they comply with these requirements
  - It is important to formalize the role of the regulatory agencies in initializing and approving changes to the current rules and in monitoring compliance
- There is a value in conducting regular customer survey’s in order to gain insight in the customer needs
  - Initial customer survey in order to understand the customer’s understanding of regulation, his rights and his needs for modifications
  - Regular survey’s to better understand his willingness to pay, particularly for quality
- All proposed data are subject to a careful review with today’s practice in Germany
Thank you for your attention!

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