



## Experience with Voltage Quality Monitoring in Norway

CEER-EURELECTRIC joint workshop on  
Voltage Quality Monitoring  
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## Outline

- Briefly about NVE
- Quality of supply regulation
- Voltage quality monitoring
  - Customer complaints
  - Customer enquiries
  - Continuous monitoring
  - Historical measurements
  - Accuracy etc...
- Audits
- Summary and conclusions



## Norwegian Water Resources and Energy Directorate (NVE)

- NVE is subordinated to the Ministry of Petroleum and Energy, and is responsible for the administration of Norway's water and energy resources.
- One of NVE's main functions is to promote an efficient energy market and cost-effective energy system.
  - The quality of supply in the transmission / distribution networks is an important issue for NVE.
  - NVE has set requirements for quality of supply for all parties connected to the power system including the TSO

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## Regulatory aims (Norway) for power quality

- Obtain a quality of supply that is beneficial for the society as a whole.
- Prevent an undesirable development in quality having focus only on reducing overall costs.
- Improve the knowledge of the actual quality supplied to the customers
- Provide a better basis for handling disputes and giving information.
- Improve the knowledge of the actual quality supplied to the customers.
- Clear responsibility. Improve the end-users rights

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# Regulation concerning Quality of Supply in the Norwegian Power System

In force 1st Jan 2005

Last edition 1st Jan 2007

Developed and supervised by av NVE

**Direct regulation regarding voltage quality, continuity of supply and liability and basis for the incentive based regulation on continuity of supply**

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## Quality of supply regulations – content

### Chap. 1 Introductory provisions

- *Purpose, scope and extent, departures (voluntary contracts), definitions*

### Chap. 2 General provisions

- *Liability for rectification, notification, procedures regarding dissatisfaction, disagreements etc*

### Chap. 2A Registration and reporting

- *Continuity of supply, licensee responsible and licensee affected, Which data to be registered and reported, Calculation of interrupted power, energy not supplied and other indices, etc. Basis for the financial incentive based scheme on continuity of supply given in another regulation. Continuous monitoring of voltage quality.*

### Chap. 3 Requirements regarding continuity of supply and voltage quality

- *Specific limits*

### Chap. 4 Information regarding reliability of supply and voltage quality

- *Specific information obliged to be provided by the network company, measurement methods, calibration, traceability, accuracy, documentation*

### Chap. 5 Other provisions

- *Supervision and inspection, orders and compulsory fines, violation fines, appeals, exemptions, entry into force*

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## Requirements about the duties to provide information about power quality

- Network companies are obliged to upon requests provide the following information to existing and future customers:
  - **Nominal voltage level, limits for each voltage quality parameter**
  - **Results from mandatory fault analysis**
  - **Results from mandatory registration of interruptions and voltage quality**
  - **Estimate the present and future number and duration of short and long interruptions (point of connection)**
  - **Estimate present and future voltage dips and swells (supply area)**
  - **Calculate min/max short circuit power in point of connections above 1 kV**
  - **Special circumstances that may influence the quality of supply**

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## Voltage Quality Monitoring - Customer complaints

- Rectification without undue delay:
  - Obvious causes
- Within one month:
  - Provide an evaluation and a schedule for rectification
- Within four months:
  - Network companies are obliged to carry out necessary measurements and assessments.
  - Minimum duration for measurements is 7 days, and shall as far as possible reflect the operative conditions relevant according to the case.
  - Find out who is responsible for any deviation from the regulation, and therefore responsible for rectification.
  - If someone else than the company is responsible, inform the party concerned about its responsibility.

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## Voltage Quality Monitoring - Customer complaints

- Measurements of all relevant parameters;
  - **Supply voltage variations**
  - Voltage dips
  - Voltage swells
  - **Rapid voltage changes**
  - **Flicker**
  - **Voltage unbalance**
  - **Harmonics**
- The limits in the regulation applies for the points of connection
- Costs related to measurements and assessments are covered by the network company

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## Voltage Quality Monitoring - Customer enquiries

- Obligated to provide measurements upon requests from customers regarding supply voltage variations, flicker, voltage unbalance and harmonics.
- The network company may require that the customer pay the costs related to such request.
- This is only when the request is not related to any dissatisfaction with the quality of supply.

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## Voltage Quality Monitoring - Continuous monitoring

- **Obligation:**
  - Network companies are obliged to continuously register voltage dips, voltage swells and rapid voltage changes within their own grid above 1 kV.
  - Costs related are covered by each company.
- **The number of instruments and choice of voltage levels:**
  - Balance the number of instruments and related costs
  - Trustworthy statistic
  - Characteristically networks

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## Voltage Quality Monitoring - Continuous monitoring

- **Why continuous monitoring?**
  - Voltage dips, swells and rapid voltage changes appear randomly in time, hence continuously monitoring is necessary in order to get a good picture of the situation
  - No solid requirements for voltage dips and swells exist yet, even though large costs for end-users and the society are involved
    - in Norway, between 170-330 MNOK (approx. 20-39 M€) annually for end-users.
  - Customers (end-users), in particular industrial ones, need realistic reference values to be able to perform sound cost-benefit analysis for possible countermeasures within their own installations

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## Voltage Quality Monitoring - Continuous monitoring

- Who should carry out continuous monitoring?
  - Network companies or the customers themselves?
  - The DSOs/TSOs are the best ones to
    - provide reasonable explanations for historical values
    - to predict future values based on historical values and knowledge about recent and future changes in the network structure and in the operation of the network.
  - DSOs/TSOs need good knowledge about the quality within their own grid in order to fulfil their duty for providing information to the customers.

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## Voltage Quality Monitoring - Continuous monitoring

- Measurement method, calibration and documentation of the accuracy
  - Relevant standards: IEC 61000-4-7, IEC 61000-4-15 and IEC 61000-4-30
  - Calibration based on the instrument vendor's specifications
  - Traceability for measurement parameters
  - Accuracy must be documented, for **both** measurement instruments **and** for measuring transformers.
  - The measured value, included the measuring uncertainty, must comply with the limits of the regulations

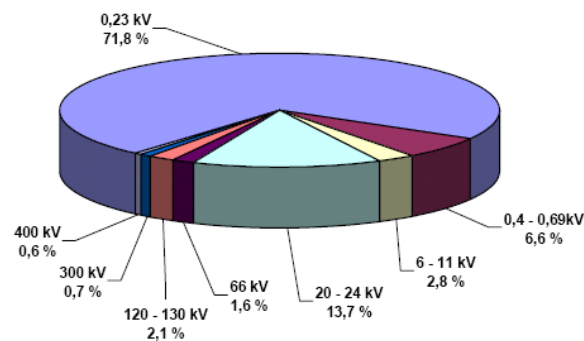
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## Voltage Quality Monitoring - Historical measurements

- Includes measurements from 1993 – 2003. Based on 671 supply terminal measuring points.
  - 39 of the 482 LV measurement sites are due to customer complaints



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## Audits within the area of continuous voltage quality monitoring

### Some remarks :

- Late installation of monitoring instruments
- Monitoring not yet started
- Not able to verify measurements of the required parameters
- Trouble with data-storage and data-communication
- Uncertainty about defining different characteristic areas of the network
- As a result of lack of historical voltage quality data, a network company fails their obligations within the information requirements.
- Lacking verification of instrument calibration and traceability
- Lacking documentation of the instruments accuracy.

**However, some companies are doing a great job!**

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## Voltage Quality Monitoring - ongoing research project

- Carried out by SINTEF Energy Research
- Evaluating the present state-of-the-art for continuous monitoring
- Consider possible reporting schemes including both results from continuous monitoring and from complaint cases
- Will be published in the near future

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## Summary and conclusions

- NVE has set minimum limits for quality of supply, including many VQ parameters in the Norwegian power system
- Voltage quality monitoring are carried out due to
  - customers' dissatisfaction with the quality
  - customers enquires
  - continuous monitoring
- Voltage quality monitoring provide important information for the customers
- Voltage quality monitoring are also important for the companies for maintenance, troubleshooting, etc.

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Thank you for your attention!

