SMART GRID PROJECTS
ČEZ DISTRIBUTUCE, A.S.

Ing. Ondřej Tupý
4/2017
INTRODUCTION OF ČEZ DISTRIBUCE

MAIN FIGURES

Main tasks of ČEZd
- Distribution of electricity
- Operation of the grid in real time
- Asset management
- Asset development
- Connection of new customers

General figures
- FTEs: 2,846
- Distribution area: 52,697 km²
- Supply points: 3,608,324
- Distributed energy: 43 TWh/yr
- Peak load: 5,393 MW
- SAIDI: 2,3
- SAIFI: 261,7

Energy system of Czech Republic
- Production: ČEZ, producers
- TSOs: ČEPS, a.s.
- DSOs: ČEZ Distribuce, E.ON Distribuce, PRE Distribuce, LDS

Energy system of Czech Republic
**TRENDS**

**INCREASE OF POWER CONSUMPTION I/II**

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**Long term development of power consumption in ČR (1919 - 2013)**

<table>
<thead>
<tr>
<th>Time period</th>
<th>Energy consumption per capita</th>
<th>Population</th>
<th>World energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 tis. př. n.l.</td>
<td>2 kWh</td>
<td>15 000</td>
<td>30 MWh</td>
</tr>
<tr>
<td>1 n.l.</td>
<td>20 kWh</td>
<td>200 000 000</td>
<td>4 000 000 MWh</td>
</tr>
<tr>
<td>1800</td>
<td>5 500 kWh</td>
<td>1 000 000 000</td>
<td>5 500 000 000 MWh</td>
</tr>
<tr>
<td>2014</td>
<td>21 862 kWh</td>
<td>7 260 652 256</td>
<td>158 733 557 666 MWh</td>
</tr>
</tbody>
</table>

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**Zdroj:** ČEZ a.s., EGU Brno
TRENDS
INCREASE OF POWER CONSUMPTION II/II

![Graph showing trends in power consumption from 1995 to 2050.](image-url)
TRENDS
INCREASE OF DECE I/II

Vývoj výroby elektřiny brutto z OZE a její podíl na tůžemské brutto spotřebě (TWh)

<table>
<thead>
<tr>
<th>Year</th>
<th>Hydroelectric plants up to 10 MW</th>
<th>Hydroelectric plants over 10 MW</th>
<th>Wind power</th>
<th>Photovoltaics</th>
<th>Biogas + biogas</th>
<th>Biomass</th>
<th>BRKO</th>
<th>Share of OZE [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>4.50%</td>
<td>4.71%</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>2007</td>
<td>5.19%</td>
<td>6.81%</td>
<td></td>
<td></td>
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<tr>
<td>2008</td>
<td>7.73%</td>
<td>8.31%</td>
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<td></td>
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<tr>
<td>2009</td>
<td>9.67%</td>
<td>10.28%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2010</td>
<td>11.43%</td>
<td>13.17%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>13.27%</td>
<td>13.17%</td>
<td></td>
<td></td>
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<tr>
<td>2012</td>
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<td>2013</td>
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<td>2014</td>
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<tr>
<td>2015</td>
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<td></td>
</tr>
</tbody>
</table>

Table: Trend of energy production from OZE and its share in Czech gross consumption (TWh)

<table>
<thead>
<tr>
<th>Year</th>
<th>OZE [MWh]</th>
<th>Hydroelectric plants up to 10 MW</th>
<th>Hydroelectric plants over 10 MW</th>
<th>Wind power</th>
<th>Photovoltaics</th>
<th>Biogas + biogas</th>
<th>Biomass</th>
<th>BRKO</th>
<th>Share of OZE [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>3,512,850</td>
<td>1,001,845</td>
<td>1,082,683</td>
<td>1,288,819</td>
<td>1,017,878</td>
<td>1,026,254</td>
<td>1,285,978</td>
<td>1,011,674</td>
<td>1,001,797</td>
</tr>
<tr>
<td>2007</td>
<td>3,393,509</td>
<td>1,077,493</td>
<td>1,157,451</td>
<td>1,348,937</td>
<td>1,150,685</td>
<td>1,102,912</td>
<td>1,457,762</td>
<td>1,104,187</td>
<td>1,104,742</td>
</tr>
<tr>
<td>2008</td>
<td>3,730,659</td>
<td>1,206,611</td>
<td>1,257,401</td>
<td>1,412,907</td>
<td>1,196,796</td>
<td>1,097,732</td>
<td>1,499,947</td>
<td>1,151,865</td>
<td>1,151,674</td>
</tr>
<tr>
<td>2009</td>
<td>4,686,514</td>
<td>1,688,815</td>
<td>1,887,810</td>
<td>1,948,276</td>
<td>1,343,068</td>
<td>1,302,640</td>
<td>1,640,290</td>
<td>1,347,938</td>
<td>1,347,938</td>
</tr>
<tr>
<td>2010</td>
<td>5,886,915</td>
<td>2,247,504</td>
<td>2,278,810</td>
<td>2,048,978</td>
<td>1,537,254</td>
<td>1,402,912</td>
<td>1,719,537</td>
<td>1,539,742</td>
<td>1,539,742</td>
</tr>
<tr>
<td>2011</td>
<td>7,847,904</td>
<td>2,935,382</td>
<td>2,978,020</td>
<td>2,818,978</td>
<td>1,912,912</td>
<td>1,752,640</td>
<td>2,090,290</td>
<td>1,916,742</td>
<td>1,916,742</td>
</tr>
</tbody>
</table>

Source: ERU
The results of simulations of typical network show that without additional investment in strengthening distribution networks and implementation of selected projects, smart grid distribution network will not be able to integrate DECE according to the Reference scenario.

Implementation of Smart Grid solutions can reduce the cost of integration, strengthening the network standard is still necessary.
STRATEGY
ČEZD ADAPTS EUROPEAN BEST PRACTICE

KAPI
- Evaluation of asset condition, risk assessment
- Optimization of TOTEXes, risk assessment

Spatial survey
- Monitoring of vegetation, simulations of growth
- Accurate planning, optimization of the process

SW for coordination of grid shutdowns
- Analytical tool for optimizing the activities of the CEZd
- Optimization work and costs, reducing the impact on SAIDI / SAIFI

WF management
- Planning and execution process improvements
- M&O support
NEW PROJECT TECHNOLOGY

DISTRIBUTION CONCEPT DEFINES THE DEVELOPMENT FRAMEWORK OF NT (NEW TECHNOLOGY)

<table>
<thead>
<tr>
<th><strong>New technology concept</strong></th>
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<tbody>
<tr>
<td>▪ Interflex</td>
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<tr>
<td>▪ Voltage stabilization in distribution network</td>
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<tr>
<td>▪ Šumperk – mesh network analysis</td>
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<td>▪ Voltage control at high-voltage level U/Q regulation (Roll out)</td>
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<tr>
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<tr>
<td><strong>OZE (Renewable energy sources) integration, EE quality</strong></td>
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<tbody>
<tr>
<td><strong>SAIFI, SAIDI reliability</strong></td>
</tr>
<tr>
<td>▪ Vrchlabi Smart Region</td>
</tr>
<tr>
<td>▪ High-voltage insulated cable fault detector</td>
</tr>
<tr>
<td>▪ Kralovice compensation</td>
</tr>
<tr>
<td>▪ Drone use analysis</td>
</tr>
<tr>
<td>▪ Prague’s critical infrastructure supply system</td>
</tr>
<tr>
<td>▪ Installation of DOP (Roll out)</td>
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<table>
<thead>
<tr>
<th><strong>DISTRIBUTION CONCEPT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Smart measuring, communication</strong></td>
</tr>
<tr>
<td>▪ SGRP</td>
</tr>
<tr>
<td>▪ LODIS</td>
</tr>
<tr>
<td>▪ Icing measurement</td>
</tr>
<tr>
<td>▪ Verification of optical attachment during reconstruction of DS</td>
</tr>
<tr>
<td>▪ Installation of DTS (Roll out)</td>
</tr>
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</table>
NEW TECHNOLOGY PROJECTS
NT PROJECTS IN ČEZD SHARE NATURAL LIFE CYCLES

Analysis, collection of inputs

Operation, collection of operational experiences

Deployment

Modeling (e-impacts, DNCalc, Mathematica,...)

Pilot deployment

Integration of outputs into DSO concept and standardization

Evaluation

Standardy
Technické informace z oblasti standardů a podpory rozvojem určené souvisejícího odborníkům
a pro společnost ČEZ Distribuce a s. v oblasti distribučních sítí

Všechny v sekci Standardy
Zobrazení všech pokynů pro přístup k příslušných standardů
Příslušné standardy pro území ČEZ Distribuce

InterFLEX
NEW TECHNOLOGY PROJECTS

Pilot projects

Roll out projects
NEW TECHNOLOGY PROJECTS

Pilot project – implemented (currently in the operational and evaluation phase)
Description:
The introduction of new technologies at certain locations within the distribution network/system, which were not used so far, and use them for functionalities which are currently utilized only at high voltage levels.

Objective:
- Verification of functions, technical properties and advantages for possible future deployment,
- Increase in supply quality level,
- Reduction of losses in the network,
- Increasing the network reliability,
- Reduction of the blackout / interruption times.

Scope:
- **Low-voltage distribution network automation** – impact on 64 customers (between 2 transformer stations)
- **High-voltage distribution network automation** – 4,900 customers (the town of Vrchlabí)
- **Island operation management** – 1,800 customers (7 DTS in the Vrchlabí – Liščí Kopec region).
**BPL COMMUNICATION FOR OUTDOOR HIGH-VOLTAGE NETWORK 2013-2016**

**Description:**
With the development of new technologies also data volumes which need to be transferred are increasing. This project represents additional options for communication connections of DSO objects, in this case it refers to BPL communication using outdoor high-voltage power line.

**Project objective**
Verification of the available options of BPL communication between DTS Malá Skála and TR Jeřmanice and transfer of measuring data into DSO systems. Selected parameters to be transferred to DŘS using protocol 104.

**Scope**
Along the route of the 17 km long above-the-ground high-voltage power line from TR Jeřmanice to DTS Malá Skála, a communication route using BPL technology provided by Corinex was successfully created. Data load was provided by the installed AMM technology and MEg40 universal monitors.
Description:
Measurements focusing on operational data quality are currently manually read out in approximately one third of DTS. This method is no longer sufficient and it is necessary to test measurements for all DTS including remote data transfers.

Objective:
- To design and propose system and long-term solutions for:
  1. Training, operational management (measurement, control, signaling, protection, automation, connection optimization) and evaluation of network operation (continuity, events, quality)
  2. Measurement, data collection and analysis for key departments of ČEZD (JVS, NTZ, EE quality, HDO…)
- To determine space requirements in LV and HV technologies used in DTS for installation of measurement and communication components
- To test the latest measuring and communication technologies on the market - to verify possibilities of modular solutions allowing integration of components provided by various suppliers
- To verify data transfer independently of mobile operator (GPRS) using own digital radio network into target systems (DŘS, HDO, DAM, XENERGIE, IDSpecto)
- To verify expected benefits defined by end users who use the measured data

Scope:
19 DTS and 8 suppliers:
- 9 DTS Děčín Region (4 end and 5 loop)
- 8 DTS Hradec and Pardubice Region (7 end and 2 loop)
- 1 DTS Šumperk (1 loop under mesh network analysis)
VOLTAGE STABILIZATION IN DS 2015-2016

Description:
Each supply provided by a power plant increases the voltage. thanks to the instability of the source of OZE (wind, solar) it also creates voltage alternations.

Objective:
to verify possibilities of voltage stabilization systems (removal of fluctuations in the network)
Low voltage:
- Using advantages of newly connected solar power plants (FVE /PPP)
- Using a regulatory distribution transformer in DTS
High voltage
- Regulation through the use of reactive power of power plants

Scope:
- Location in the power supply area TR Aš at high-voltage level regulation Q (FVE, VTE) + low-voltage, regulation DTR in DTS
- Vrchlabí:
  - high-voltage - regulation Q at KGJ ČEZ Energo at Liščí Kopec
  - low-voltage – cooperation with several FVE with modern inverters
Description:
Adverse effects of the integration of the centralized power sources for electric cars on the voltage quality may be solved to a certain extent by parallel operation of the network. To quantify this effect, the mesh network in Šumperk was equipped with a measuring system with remote transfer.

Objective:
- Analysis and low-voltage mesh network measurements (flows, EE quality)
- Comparison which a standardly operated network
- Confirmation of the benefits in the area of better connectivity of decentralized sources for electric vehicles

Scope:
- Installation of a portion of the mesh network with measurement system in Šumperk:
  - 33 disconnection boxes
  - 15 DTS
  - 2 high-voltage power sources
Description:
When power plants with unstable supply diagram are operated (wind, solar), the flows of energy change in both directions. In case of larger production the excess of energy is not used at that location but in remote locations. This creates unnecessary losses in DS.

Objective:
- To verify a hypotheses whether it is possible to optimize flows in LV networks by switching on low tariff individually for the given drawing points based on the expected production versus consumption rate under individual DTS.

Scope:
- 3DTS (Hradec Kr., Plzeň Lhota, Lázně Bohdaneč)
- IEM L+G E350 with BPL complication (drawing points)
- IEM LZQJ equipped with GPRS (FVE / PPP power plants)
- SIEM LZQJ with communication RS 485 (installation in DTS)
- Intelligent data concentrators (IDK / IDC)
- DC server
NEW TECHNOLOGY PROJECTS

Pilot projects – currently being implemented
Description:
Insulated cables allow operation even if they are touching tree branches but the distributor does not know about it. However, if this contact (touch) lasts for a long time the insulation is damaged and a defect occurs. The detector identifies this problem in time and allows the operator to apply corrective measures.

Objective:
- To increase safety of persons and equipment in DS,
- Reduction in repair cost (prevention of small faults within a large area)

Scope:
- 20 applications at 16 HV power lines
Description:
The expanding high-voltage network increases capacity currents in the network. Under certain circumstances the existing compensation system may be operating at maximum capacity. The new compensation system for HV networks should eliminate this problem and provide other features as well.

Objective:
To find new compensation possibilities of the reactive component in high-voltage network to ensure safe operation.

Scope:
Location in the power supply area TR Kralovice.

ICING AND ADDITIONAL CLIMATIC VALUES MEASUREMENT 2016-2017

**Description:**
An important phenomenon, which significantly influences the safety and reliability of the operation of outdoor power lines at all voltage levels, is the actual weather. The main impacts includes wind speed, wind direction, icing or any combination thereof. Establishing incorrect impact levels significantly influences the design of the power line and therefore the final price of the project. These levels may be used to remove icing by putting certain loads on the power line.

**Objective:**
- To obtain and evaluate information both for the proper definition of operational measures as well as for follow-up statistics work.

**Scope:**
Installation of 24 whether stations alone the high-voltage power lines around the entire territory of ČEZ Distribuce, a.s.

Measured values:
- Icing weight
- Temperature
- Relative humidity
- Wind speed and direction
- Sunlight intensity
ANALYSIS OF THE POSSIBILITIES OF USING DRONES TO CHECK POWER DEVICES  2016-2017

Description:
To check the condition of insulation on certain insulated high-voltage power lines using flying automatic devices (drones). To evaluate the offered technologies and cost, and based on the obtained results analyze other options (for example certain activities under ŘPU etc.).

Objective:
- Evaluation of the potential of using drones with the intention to increase the efficiency of the operation of the distribution system, and defining condition for drone deployment.
- Definition of real options offering efficient use of drones in activities performed by ČEZ Distribuce and identification of the possible areas of use.

Scope:
Two high-voltage power lines included in the High-voltage insulated cable fault detector program (estimated length 6.5 km) were selected under this project.
- Sections around forest intersections with difficult access were selected.
- The inspection of the power line focuses on the identification and location of insulation damages on top of the cables which are not detectable when checking from the ground - a good example for the use of drones.
This project is part of the EU – Horizon 2020 program

- Total of 5 distribution companies participates in the Project.
- The consortium includes 20 partners
- The project term is 36 months.

Tasks:

- The project focuses on testing of functions which are still not standard under DSO
- The main task is to increase the possibility to connect decentralized sources, and better integrate electrical vehicle charging stations into the distribution system

Main goals:

- Integration of FVE / PPP with smart inverters: $Q(U)$ and $P(U)$
- $U/Q$ source regulation at high-voltage level (FVE, VTE, BPS)
- Development and deployment of smart charging stations for electrical vehicles
- Integration of FVE / PPP together with batteries
Description:
The EZ in 2015 amendment defines the option to use measuring equipment for a fee based on customer request. In 2012 under the "Economic assessment of all long-term costs and benefits for the market and for individual customers under the deployment of smart metering systems in the power sector of the Czech Republic," Czech Republic has accepted the commitment of repeated roll out assessments of smart metering, as required by the strategic EK documents. Not only due to these reasons ČEZD has been dedicated for a long time to laboratory researches and to demonstration projects focusing on various AMM technologies and on their implementation methods.

Project objective
- Verification of parameters of the new generation of communication and measuring devices through the pilot project
- Verification of the impacts of the implementation and the required safety level in the technology sector, its operation and protection of personal data

Scope
- Approximately 16 thousand OM + integration of previous projects (total 30 thousand OM)
- Total of 4 new locations
- Large area roll out technologies and selected implementation will be tested
VERIFICATION OF OPTICAL ATTACHMENTS DURING RECONSTRUCTION OF DS 2017-2018

Description:
In connection with the EU objectives the European Decree on the “reduction of cost for the deployment of high-speed electronic communication networks” has been issued. At present, this Decree is being incorporated into the Czech legislature. Under this proposal each network operator must allow access to its physical infrastructure for the purpose of introducing high-speed electronic communication components.

Project objective
To gain experience using a model case with similar / parallel focus - implementation of optical route along with the replacement of power cables. The model may be used to verify cooperation possibilities, ownership and use.

Scope
- The project will be implemented thanks to the planned investment event held in Jaroměř, where high-voltage cable power line will be unified in the entire municipal area. During excavation work HDPE pipe will be installed in the section of the route as well as optic cable.
- Communication will be connected to three objects, which are important supply points, suitable for remote control and monitoring of power quality.
Description:
Creation of modeled scenarios using more flexible range of equipment than in the case of traditional evaluation of the development of the power distribution system.

Project objective
- Creation of a system supporting decision-making process in terms of zoning and development of power distribution networks while taking into account technical, economic, political and administrative aspects.
- Assessment of the local regulatory potential and requirements on distribution network for Horizon 2050 located in the Czech-Bavarian region

Scope
Czech-Bavarian region
Distribution system operators
- ČEZ Distribuce a.s.
- Bayernwerk AG (formerly E.ON Bayern AG)
- Selected municipal operators on the Bavarian inside
State authorities
- Plzeňský region, selected municipalities along the border
- Energy Regulatory Office (ERO)
- Bavarian authorities engaged in regional development (to be clarified by German partners)
Description:
A long-term blackout is a modern threat that greatly affects people’s everyday lives and the economy of many companies. The Capital City of Prague therefore made a call for tenders in order to select a proposal for tackling such a blackout.

Project objective
Proposal of the architecture and technical solution for the control of a limited section of the distribution system design of algorithms used to detect fault conditions selection of optimal interventions that maintain safe operation of the system and ensure supply of electric power under emergency situations.

Scope
The capital city of Prague
Partners: ČVUT Prague, PREdi and Alpiq Generation
VERIFICATION TEST OF THE SYSTEM USED TO IDENTIFY LOSSES IN DS - II: PROJECT PHASE

Description:
Detection of unauthorized consumptions / draws and optimization of non-technical losses has been historically addressed only randomly by field workers moving around the distribution system and draw points. The aim is to implement a large-area monitoring system focusing on non-technical losses while using all measured data of the distribution system and through the application of balancing analysis.

Project objective
- Verify currently measured data obtained from source systems (DŘS, CONVERGE, DAM, SAP) and to verify their suitability for the use under balancing analyses
- Verify the defined algorithms of balancing analyses with the intention to identify problematic areas in DS
- Verify outputs from balancing analyses while using temporary measurements at specific nodal areas
- Identify problem areas in the distribution system with significantly higher non-technical losses

Scope
3 selected nodal areas - 110 kV/HV/LV
Partners: partners will be addressed through the tender proceedings

Connection of a illegal draw point to low-voltage cable distribution network
NEW TECHNOLOGY PROJECTS

Pilot projects

Roll out projects
Description:
In case of a breakdown in the outdoor high-voltage power line the entire output is turned off - all customers receiving power supply are turned off. For example, by installing switches with protection systems in the middle of the network, only certain number of customers will be turned off. Cooperation between components may be automated.

Objective:
- To accelerate the location of fault / breakdown areas in the distribution network
- Reduction of the number of draw points affected by the breakdown
- Reducing the amount of “undelivered” electric power to customers.

Project description:
- Installation of approximately 950 remote-controlled components at 180 High-voltage outputs
- Remote-controlled switch off, measurements, control unit
- Connecting and disconnecting component with dimming chamber, automatic shutdown option in 2,3 OZ pause, transfer — through GSM or radio
- Remote-controlled recloser
Description
Decentralized sources connected to the distribution system have negative influence on the voltage stability at high-voltage level. Utilization of voltage control via reactive power component will provide a cost-effective way to minimize the negative reverse effects on the voltage quality and changes caused by the operation of the source.

Project objective
- To ensure voltage stability at high-voltage level and to increase connectivity of decentralized sources
- Preparation for the launch of a dispatch control system managing voltage and reactive power for decentralized sources (U / Q control)

Project description
- Adding measurement of electrical values P, Q, U, I at high-voltage outputs / terminals in selected 110 kV / MV CEZ Distribution stations
- Securing on-line transfer of actual measurement values into DŘS
- Adjustment of the optimization functionality so that the voltage value may be entered in the source. The source has to ensure the value at the connection point up to a contractually secured power factor
**Project objective**

- Mapping the quality and energy flows and low-voltage level necessary for the development of networks, connection of OZE, operational management, and evaluation of the operation in terms of continuity of supply, events and voltage quality
- Gradual improvement of quality, reliability, security and sustainability of electric supply to end consumers and reducing the volume of undelivered electric power

**Project description**

- Installation of quality measuring system with remote communications up to ~ 22 thousand of end DTS
- Adding ~ 8 thousand communication units in end DTS already equipped with quality measuring system
- Integration with dispatch control system and Asset Management systems

**References**

- Roll-out of technologies in DSO series, for example Enexis (NL), Enel (IT), Stedin (NL), Iberdrola (SP) - 75 thousand DTS
- The project also builds on EDSO4SG Technology Committee - Smart Secondary Substations Lite (10/2015) outputs - recommended minimum requirements and functionalities in the area of measurement, implementation and DTS maintenance