Project challenge:

Automation Level Improvement of Belarus Distribution Network

Country challenge-provider: Belarus
Challenges of Belarus distribution network

Low reliability

SAIDI: 33.6min/y/c, SAIFI: 0.45times/y/c

- Aging equipment: 52% (>30y)
- Low automation coverage: <10%

High OPEX (€25mln/y)

- High failure rate: 5.94/(100km·y)
- Manual line fault location

NO financial support
Technology roadmap

Automation level

Cost

1. Preventive control based on existing data
2. Fault location based on user info
3. Local Feeder Automation
4. Distribution Terminal Unit (DTU)
   Feeder Terminal Unit (FTU)
   Distribution Management System (DMS)

SAIFI↓  SAIDI↓  SAIDI↓  SAIDI/SAIFI↓  +
Scenario 1: Preventive control based on existing data

- Historical fault info
- Monitoring data
- Equipment info

- Equipment risk assessment
- Load forecast
  - Weather forecast

- Preventive control
  - Condition-based maintenance
  - Reduce the load of equipment at high risk

- Ageing equipment
- High failure rate

- Reduce the failure rate
Scenario 2: Fault location based on user information

- Manual line fault location
- Low smart meter coverage

Motivation mechanism:
- Priority of recovery
- Game credits
- Price reduction

Automatic fault location

SAIDI ↓
Scenario 3: Local feeder automation

Feature: no communication/cheap
Application scope: long and higher fault rate line, high rating load

Local feeder automation
To restore the highest amount of customers based on the cooperation of delay between the breaker and load switch

Manual recovery

Self-healing SAIDI / OPEX ↓
Scenario 4: DMS

Application

Maintenance

Distribution management system

Customer service

Communication

Physical network

1. Substation
2. Customer
3. Breaker
4. Public wireless network

Scenario 4: DMS
Task forces

R&D Group

- Developing technologies
  - APP based fault locating
  - Preventive control algorithm

Manufacturers

- Mature technologies
  - DTU
  - FTU
  - SCADA
  - Wireless communication

Finance Group

- Financial issues
  - Funds management
  - Financing
Participators and business model

- Grid company
  - Increased tariff
  - Service
  - Devices and services
  - Saved OPEX + Increased tariff

- Electricity Consumers

- Equipment manufacturers
# Pilot project in Maryina Gorka

**Location**
60 km south of Minsk

**Power consumption**
188 GWh/y

**No. of 10kV lines**
210

**Expected goals**
- SAIDI(avg.): 108 → 58 min
- SAIFI(avg.): 1.3 → 1
- OPEX: €100k → 50k

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## Solution and cost

<table>
<thead>
<tr>
<th>User</th>
<th>Device</th>
<th>Cost /€</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Data center</td>
<td>DMS (include preventive control), €300k/set</td>
<td>300k</td>
</tr>
<tr>
<td>11 Lv.A users</td>
<td>FTU, €5500 /set</td>
<td>60.5k</td>
</tr>
<tr>
<td>132 Lv.B users</td>
<td>Local feeder automation, €300 / set</td>
<td>39.6k</td>
</tr>
<tr>
<td>~44000 Lv.C users</td>
<td>Fault location based on user information, Free</td>
<td>Free</td>
</tr>
</tbody>
</table>

**Total cost**: 400k
Pilot project in Maryina Gorka

Total cost: € 400k

Grid company

Saved OPEX
~ € 50k/y

Increased tariff
~ € 30k/y

SAIDI ↓
SAIFI ↓

Pilot project in Maryina Gorka

SAIDI/min

108 108 108
10 50 80
Lv.A Lv.B Lv.C

SAIFI

1,3 1,3 1,3
0,8 1 1,2
Lv.A Lv.B Lv.C

ROI: 20%, 5 years
Appendix
Overall Background

**INSTALLED CAPACITY** (MW)

- Minsk: 6681; 73%
- Else: 2419; 27%

**ANNUAL ELECTRICITY LOAD** (HUNDRED MILLION KWH)

- Minsk: 278.4; 75%
- Else: 91.6; 25%

**LINES** (THOUSAND KM)

- 110kV and above: 24.5
- 35kV: 11.87
- 6-10kV: 123.3
- 400V: 123.5

**SUBSTATIONS**

- 110kV and above: 771
- 35kV: 582

**MAIN TRANSFORMERS**

- 110kV and above: 1429
- 35kV: 966
- 6-10kV: 73696

**EQUIPMENT OUTAGE IN SUBSTATION** (10kV AND BELOW)

- Climate: 53%
- Equipment Aging: 26%
- External: 15%
- Else: 6%

**LINES TRIP** (10kV AND BELOW)

- Climate: 48%
- Equipment Aging: 11%
- External: 30%
- Else: 11%
Challenges of Belarus

Present Situation

Low Reliability (6-35kV)
- Aging Equipment: 52% (>30y)
- Low automation coverage: <10%

High OPEX
- High failure rate: 5.94/100(km·y)
- Manual line fault location

Objective

High Reliability
- SAIDI: 33.6→16min/y/c
- SAIFI: 0.45→0.3times/y/c

Low OPEX: 25→12mln €/y

Low investment
Electricity Price

➢ 1. Electric energy in apartment houses (apartments) equipped in according to the established procedure by electric plates:
   1.1. one-rate tariff – 0.0517 €/kWh
   1.2. differentiated tariff for temporary periods:
       minimum loads (from 10 pm to 5 pm) – 0.03618 €/kWh
       maximum loads (from 5 pm to 10 pm) – 0.1033 €/kWh

➢ 2. Electric energy for needs heating and hot water supply with connected power of equipment more than 5 kW:
   the period of minimum loads (from 11 pm to 6 am) – 0.04254 €/kWh
   Other periods of the day – 0.07901 €/kWh

➢ 3. Electric energy except for specified in items 1 and 2:
   3.1. one-rate tariff – 0.06077 €/kWh
   3.2. differentiated tariff for temporary periods:
       minimum loads (from 10 pm to 5 pm) – 0.04254 €/kWh
       maximum loads (from 5 pm to 10 pm) – 0.1215 €/kWh