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# The new INOGATE Project

## Electricity & Gas: AHEF 110.MD


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BUILDING PARTNERSHIPS FOR ENERGY SECURITY

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# Scope AHEF 110.MD

- Appraise the ANRE of Moldova in EU mechanisms for establishing reasonable estimates for technical and non-technical distribution losses
- Identify the dataset required to validate loss levels claimed by distribution companies
- Establish methods of profiling load on consumption that has no interval metering
- Review methods of incorporating losses in EU distribution tariffs
- Develop recommendations for the revision of the measuring and estimation of losses in Moldova and of options for inclusion of cost of losses recovery in the distribution tariff

# Agenda

- EU Loss Estimation Practices
- Accuracy of Loss Estimation
- Tariffs & Losses

# EU Loss Estimation Practices

# Regulation

- Regulation is 'strategic' in nature – it begins by asking what needs to improve?
- Use Ex-Ante Method to reduce losses
  - An optimal loss level is a function of a well-designed network operating within a design loading – whenever excessive voltage drop occurs losses will be relatively high
  - Use model network for estimating losses and setting loss reduction targets (in line with Capex allowance)
- Use Ex-Post Method to recover the cost of losses equitably
  - Ensure that losses are correctly estimated, allocated to customers by voltage and recovered as part of the energy tariff through a reconciliation
  - In some EU countries, settings in the allowed revenue equation provide an incentive to reduce losses

# EU Loss Estimation

- The Ex-Post approach is the most common

| | Ex-Ante | Ex-Post | Losses |
|---|---|---|---|
| AT | Yes | | 4.5% |
| BE | | | |
| CH | | | |
| CZ | | Yes | 7.0% |
| DE | | | |
| DK | | Yes | <5% |
| EE | | | |
| ES | | Yes | 7.0% |
| FI | | Yes | 4.7% |
| FR | | Yes | 5.0% |
| GR | | Yes | 6.8% |

| | Ex-Ante | Ex-Post | Losses |
|---|---|---|---|
| IT | Yes | Yes | |
| LT | | Yes | 10.0% |
| NL | | | |
| NO | | Yes | 5.0% |
| PL | Yes | | 11.8% |
| PT | Yes | | 6.4% |
| RO | Yes | Yes | |
| | | Yes | |
| SE | Yes | Yes | 2.3% |
| UK | Yes | Yes | <6% |

- There is no correlation between the method used to estimate losses and out-turn; there is a correlation between losses and incentives

# EU Tariffs, Incentives & Losses

<table>
<tr><th></th><th>Regulatory Incentives</th><th>Incentive Mechanisms</th></tr>
<tr><td>FI</td><td>None</td><td>None</td></tr>
<tr><td>SE</td><td colspan="2">Standard losses are included in network performance assessment model (ex-ante)</td></tr>
<tr><td>NO</td><td colspan="2">Yardstick regulation. Costs of network losses treated same as other costs</td></tr>
<tr><td>FR</td><td>Incentive for theft reduction</td><td>None</td></tr>
<tr><td>AT</td><td>None</td><td>None</td></tr>
<tr><td>CZ</td><td colspan="2">Allowed rate of losses capped in tariff to maximum value (%)</td></tr>
<tr><td>PT</td><td>Allowed rate of losses capped in tariff to maximum value (%); incentive to reduce in distribution networks</td><td>Tariff Code includes incentive mechanism to reduce losses in distribution networks; rewarded if losses lower than a reference year value set by Regulator</td></tr>
</table>

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# Regulation

| Total Losses | EU Country |
|---|---|
| <6% | Finland, Luxembourg, Belgium, Netherlands, Germany |
| 6-8% | Italy, Denmark, Switzerland, France, Austria, Slovenia |
| 8-10% | Sweden, Great Britain, Spain, Portugal, Norway, Ireland, Czech Republic, Slovakia |
| 10-12% | Estonia, Lithuania, Latvia, **Moldova** |
| 12-14% | Croatia, Poland, Hungary, Romania |
| 14-16% | Bulgaria, Montenegro |
| >16% | Albania, Bosnia& Herzegovina, Serbia, Turkey |

2000 - 2005

Reducing

- Economic development
- Living standards
- Per capita consumption

# Ex-Post Methods

- For EU countries 'energy balance' principle is fundamental → losses = metered purchases less metered sales
- At LV circuit level
  - $W_{techloss} = W_{import} - (W_{billed} + W_{pilferage})$
  - $W_{import}$ can be measured or estimated
  - $W_{billed}$ is known
  - $W_{pilferage}$ is unknown
  - $W_{techloss}$ varies with $W_{pilferage}$, particularly when pilferage is high
- In practice $W_{techloss}$ is computed and $W_{pilferage}$ is determined as a net quantity

# Pilferage Losses

- Where pilferage is low it is estimated as a fixed percentage
  - UK /Australia / NZ; level is low at 1 – 3%
  - Latin America; no appreciable LV network
- In countries where pilferage is > 5%, Regulators either
  - Estimate technical losses accurately with pilferage determined on net basis, e.g. Eastern Europe
  - Estimate pilferage based on audit inspections, e.g. Spain

# Technical Losses

- Distribution networks have many ‘register’ meters which do not support net energy measurement; thus some method of computation is always needed
- Estimation and allocation of losses by voltage follows naturally due to metering practice
- Common practice is to use continuous metering for MV feeder Watts, Vars, Amps, kWh and sampling for LV circuits
- The technical loss computation method depends on the availability of measurand data but not all EU countries make use of HV / MV metering to estimate losses

# EU Country Metering / Profiling Practice

| | HV / MV Metering | Profiling |
|---|---|---|
| AU | Yes | |
| BE | | |
| CH | | |
| CZ | Yes | |
| DE | Yes | |
| DK | Yes | |
| EE | | |
| ES | Yes | |
| FI | Yes | Yes (by Ministry decree) |
| FR | Yes (MV) | |
| GR | Yes | |
| IT | Yes | |
| LT | | |
| NL | | |
| NO | No | |
| PL | No | |
| PT | Yes | Yes (Approved by Regulator) |
| SE | No | Yes (LV customers) |
| UK | No | |

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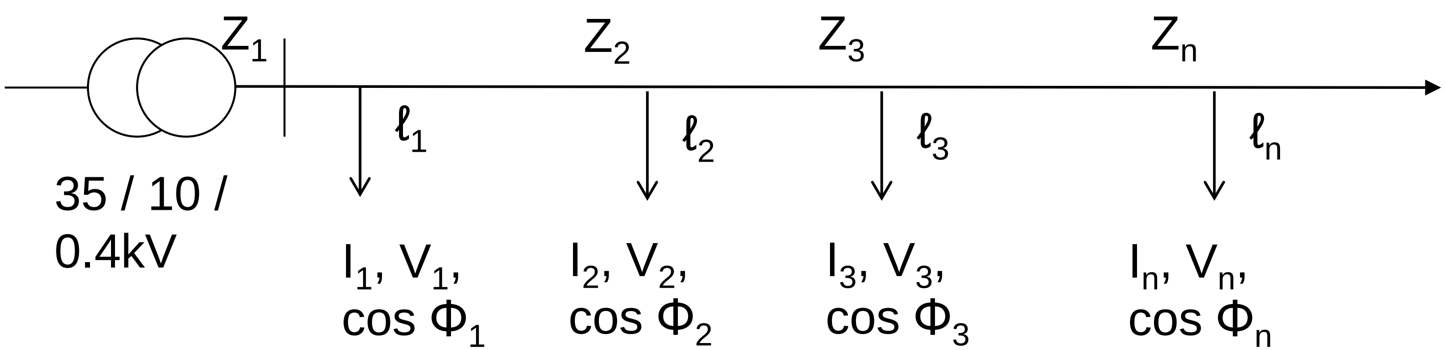
# Russia - Unbalanced Load

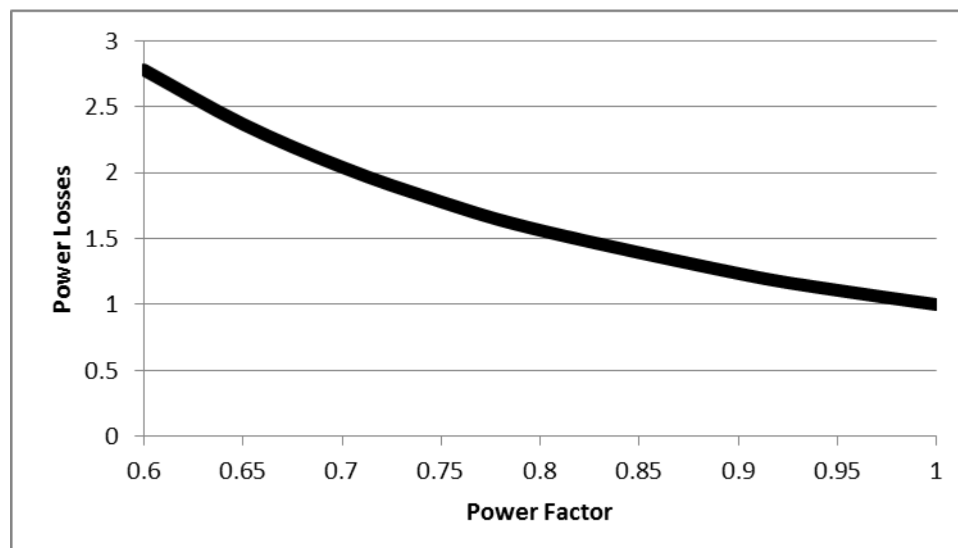
- Unbalanced loading tends to increase losses but generally treated by a scaling factor
- $\delta = \Delta W \,.\, (k_{i1} - k_{i2})$
  - $\delta$ is the feasible power loss reduction after balancing
  - ΔW is the power loss in the LV network with balanced load
  - $k_{i1}$ balancing factor before load is balanced
  - $k_{i2}$ balancing factor after load is balanced
- $\Delta W = 1.63 \,.\, \frac{W_P^{\,2}}{V_N^{\,2}.T} .\, R_{eq}$ if reactive power is unknown
- $k_i = \sqrt{3} \,.\, \frac{\sqrt{(I_A^{\,2}+I_B^{\,2}+I_C^{\,2})}}{I_A+I_B+I_C} .\, (1+ 1.5 \,.\, \frac{R_0}{R_{PH}}) - 1.5 \,.\, \frac{R_0}{R_{PH}}$
  - $I_A, I_B, I_C$ are MV phase amps supplying transformer's LV networks
  - $\frac{R_0}{R_{PH}}$ is the ratio of zero sequence resistance to phase resistance
  - If no phase currents $\frac{R_0}{R_{PH}}=1$, $k_i = 1.13$ ; $\frac{R_0}{R_{PH}}=2$, $k_i = 1.2$

# Israel – Power Factor

- Power factor is an indicator of losses



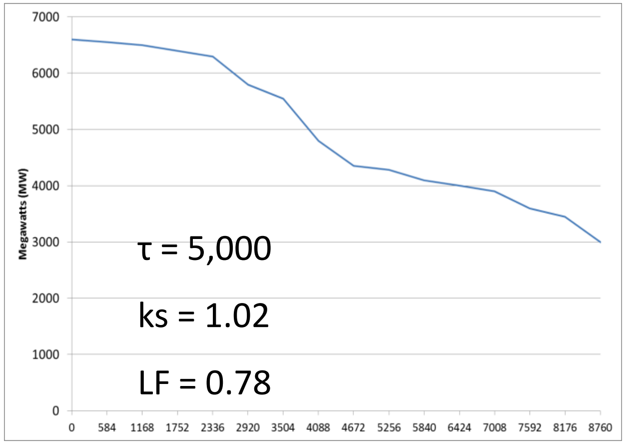

  - Losses inverse to square of power factor
  - Requires field measurement program

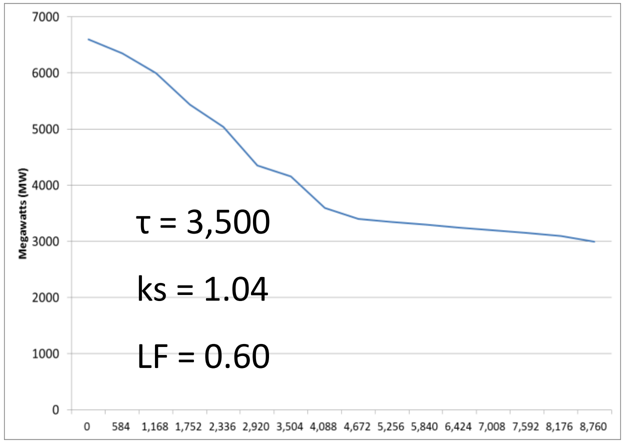


# Load Profiling

# MV Feeder Load Profiles

- For MV technical loss estimation by calculation it is required to know
  - The time duration of the highest load flow losses (τ factor)
  - The load curve shape ( shape co-efficient ks )
- SCADA or interval meters can determine hourly energy flow data to distribution network



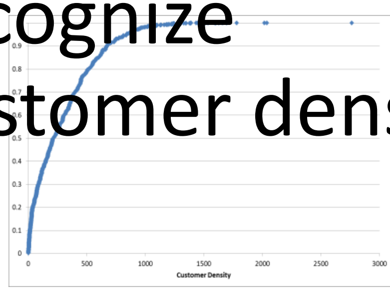
# LV Network Load Profiles

- There are two methods that can be used to estimate LV network load

1. Use of Interval Meters on LV terminals of DT
    - Use statistical sampling
2. Use ‘typical’ residential, commercial and industrial profiles to build DT load estimate
    - Requires load research over several years
    - Requires software linked to the billing system
    - Load projections useful for transformer management

# Method 1: Interval Meters & Sampling

- Apply homogeneous finite population sampling method to LV Network populations of 2,000+
- Samples to recognize customer density




| Sample Size | Confidence Level |
|---|---|
| 65 | 90% |
| 92 | 95% |
| 238 | 99% |

| ***Example*** | | |
|---|---|---|
| **Customer Density** | **Sample Size** | **Confidence Level** |
| Less than 100 | 65 | 90% |
| 101 to 400 | 65 | 90% |
| Greater than 400 | 65 | 90% |

# Method 2: Consumer Load Profiles

- Residential
  - Select 10 consumption ranges (kWh's, eliminate outliers)
  - Determine frequency distribution of ranges from billing records for all towns
  - Group towns by similar frequency distribution; take measurements of daily load profiles from each group on statistical basis
  - Aggregate profiles and measure load at aggregation point (difference equals losses)
  - Expect high standard deviation amongst profiles due to diversity of appliance use

# Method 2: Consumer Load Profiles

- Commercial
  - 50 categories
  - Sort by MWh per month within and across categories
  - Typically 60% - 70% consumption in one grouping of categories
  - Sample from this group

| | Activities |
|---|---|
| 1 | Pubs |
| 2 | Restaurants |
| 3 | Grocery / Bakery |
| 4 | Bank |
| 5 | Clothes & Shoes |
| 6 | Meat and Fish |
| 7 | Supermarket |
| 8 | Gas Station |
| 9 | Surgeries / Vets |
| 10 | Hotels |
| 11 | Car Maintenance |

# Method 2: Consumer Load Profiles

- Industrial
  - 25 to 30 categories
  - Ranked by total MWh consumption
  - No aggregation
  - Separate profiles
- Interval meters preferable

| | Category |
|---|---|
| 1 | Large Bakery |
| 2 | Textiles |
| 3 | Building Construction |
| 4 | Timber Mill |
| 5 | Wooden Furniture |
| 6 | Cement |
| 7 | Electronics |
| 8 | Plastics |
| 9 | Sugar Mills |
| 10 | Iron / Steel |
| 11 | Bricks |

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# Accuracy of Loss Estimation

# Accuracy of Loss Estimation

- Computation methods are based on dis-aggregation
  - MV feeders
  - MV / LV transformers
  - LV lines
  - Customer connection
  - Meters
- Appropriate formulae are applied to each network component
- The formulae can be embedded in a network planning package or applied in spreadsheets

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# Technical Loss Framework

| Losses | Losses |
|---|---|
| 110 / 35kV Transformers | Fixed & Variable |
| 110 / 10kV Transformers | Fixed & Variable |
| 10kV Feeders (overhead lines) | Variable |
| 10kV Feeders (cables) | Variable |
| 10kV Feeders (overhead lines) | Variable |
| 10kV Feeders (cables) | Variable |
| Losses in auxiliary equipment | Variable |
| **Technical Losses in MV Networks** | |
| 35kV / 0.4kV Distribution Transformers | Fixed & Variable |
| 10kV / 0.4kV Distribution Transformers | Fixed & Variable |
| 0.4kV Networks | Variable |
| Consumer Premises | Average Variable |
| Commercial Metering | Variable |
| **Technical Losses in LV Networks** | |
| Pilferage Losses in LV networks | Variable |

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# Technical Data Constraints

- 110kV / 35kV / 10kV Power Transformers
  - No load and load loss performance available from manufacturers test sheets
  - Measurements by utility uncommon
- 35kV / 10kV Feeders
  - Feeder lengths, conductor type, branching readily available if GIS / AM-FM well developed
- LV Distribution Transformers and LV Circuits
  - Distribution transformer capacities usually known; no load and load loss performance usually unknown due to age and variability of manufacture
- LV circuit lengths, conductors types, branching usually known from GIS or distribution maps but often inaccurate

## Energy Data Constraints

- 110kV / 35kV / 10kV Power Transformers
  - SCADA logs data on HV and MV side of power transformers
- 35kV / 10kV Feeders
  - SCADA or continuous metering provides power / energy / amps / voltage at the feeder exits
- LV Distribution Transformers and LV Circuits
  - Continuous meters sometimes fitted to DT's & large customers, increasing with smart meter programs
  - Energy flows on the LT side of a distribution transformer can only be determined as a net quantity including pilferage
  - Consumer 'register' meters measure energy sold (kWh) for energy balance computation but nature of reading gives non-coincident energy data

# Accuracy: Technical Loss Computation

- Power Transformers
  - Power losses are the summation of ‘no load’ (Fe magnetizing loss) and ‘load’ losses (Cu electrical loss)
  - Accuracy of loss estimates for 110 / 35 / 10kV transformers relatively high
  - Usually continuous metering on HV and MV side, thus losses can be by difference, or
  - Use engineering computation

# Accuracy: Technical Loss Computation



- Power Transformers

  - $$W = \frac{(W_P{}^2 + W_Q{}^2).P_{Cu}}{S_N{}^2.T}.k_S{}^2 + P_0.T$$
    - $W_P$ and $W_Q$ are active and reactive power delivered during the estimation period (12 months)
    - $P_{Cu}$ is the load loss (Cu losses)
    - $S_N$ is the transformer rating (MVA)
    - $k_s$ is the load duration curve shape co-efficient
    - $P_0$ is the rated no-load loss (Fe losses)
    - $T$ is the time the transformer is loaded and operating

# Accuracy: Technical Loss Computation

- Distribution Transformers
  - LV distribution transformers present difficulty
  - Lack of transformer rated copper and core loss data due to variety of transformer models and ages
  - Typically no energy metering on high or low side of the 35 or 10/0.4 kV transformers - estimated energy must be used instead of metered transformer loading for loss estimation purposes
  - Lack of data available to allow determination of load profile (can be developed using customer profiles, or deemed as feeder profile)

# Accuracy: Technical Loss Computation

- Distribution Transformers – Option 1
  - Aggregate approach based on law of averages for large population
  - $W = (P.\tau + W_0)$ . N
    - P is the calculated average variable technical loss
    - τ is the duration time of the highest load flow losses
    - $W_0$ is the sum off all transformer no-load losses; equals average transformer rated no-load losses multiplied by operating period T
    - N is the number of distribution transformers
    - Load measurement is required to set τ

# Accuracy: Technical Loss Computation

- Distribution Transformers – Option 2
  - Simpler empirical alternative
  - $P$=0.05544.$P_D^{0.7644}$
    - $P_D$ is the average estimated electrical load of all distribution transformers (or a selected group)
  - $P_D$=$W/(T.N)$
    - W is the active energy delivered to the Low Voltage network
    - N is the number of transformers
    - T is the time period of estimation (12 months)
  - Field measurements on statistical sample basis verifies empirical factors

# Accuracy: Technical Loss Computation

- LV circuits – Option 1
  - $W_{loss} = \frac{W_P{}^2 + W_Q{}^2}{10^3 . V^2 . T_{max}{}^2 . N^2} . k_A . k_{as} . r_{AV} . L_{\Sigma} . \tau$
    - $W_P$ and $W_Q$ are active and reactive power – must be estimated
    - V is nominal voltage at source
    - $r_{AV}$ is average resistance per km of conductor
    - $L_{\Sigma}$ is total length of circuits supplied by single DT
    - $\tau$ is the duration time of the highest load flow losses
    - $k_A$ allows for diversity of LV circuit characteristics (typically 0.51)
    - $k_{as}$ is a load phase current asymmetry factor (1.05 to 1.55 – typically 1.2)
    - $T_{max}$ is equal to $W_p$ / $P_{max}$ where $P_{max}$ is the maximum power demand
    - N is the number of LV circuits per DT
  - $k_A$ empirical factor - circuit and feeder topology, current density, and load diversity – typical value 0.51 may not be typical
  - Voltage measurement start-to-end can be used for calibration check

# Accuracy: Technical Loss Computation

- LV circuits – Option 2
  - Define an empirical factor $k_x$ for LV circuits to avoid the need to estimate $W_Q$
  - The approach depends on the consistency of the relationship between $W_P$ and $W_Q$ across LV networks
  - Consideration can be given to networks of different customer density i.e. there may be more than one $k_x$
  - Simplified formula as follows:-

$$W_{loss} = k_x . \frac{{W_P}^2}{10^3 . V^2 . {T_{max}}^2 . N^2} . r_{AV} . \mathrm{L}_{\Sigma}$$

  - Voltage measurement start-to-end can be used for calibration check

# Accuracy: Technical Loss Computation

- Measuring Devices
  - $W_{loss} = \sum_{i=1}^{TV} . P_{TV} + \sum_{i=1}^{TA} . P_{TA} + \sum_{i=1}^{ME} . P_{ME}$
    - $P_{TV}$ is the energy loss in potential transformers
    - $P_{TA}$ is the energy loss in current transformers
    - $P_{ME}$ is the energy loss in auxiliary metering devices
    - *TV*, *TA* and *ME* are total counts of devices in service

# Accuracy: Technical Loss Computation

- Commercial Metering
  - Single phase meters example
    - Measuring error at a loading of 10 % found to be in the range from -2.5 % to -12.9 %
    - At loading of 100 % found to be from +0.5 % to -3.1 %
  - Three phase meters example
    - At loading of 10 % errors in the range from +0.7 % to -3.7 %
    - At the loading of 100 % - from +0.9 % to -1.1 %
  - Monte Carlo simulation used to determine commercial metering losses based on load duration consideration and bench measured error ranges at 10% and 100% loading

# Accuracy: Technical Loss Computation

- Consumer Premises

- $$W_{loss} = \sum_{i=1}^{n} \frac{W_{Pi}^{2}.R_{eq}}{N_{i}^{2}} \cdot \frac{k_{s}^{2}.k_{as}.k_{A}}{10^{3}.V_{N}^{2}.T}$$
  - $W_{Pi}$ is the energy supplied to a defined customer group
  - $R_{eq}$ is the equivalent resistance of a group of service connections
  - $N_i$ is the number of service connections in a group
  - *n* is the number of customers in a service group
  - $k_s$ is the load duration curve shape coefficient
  - $k_{as}$ is a load phase current asymmetry factor (1.05 to 1.55 – typically 1.2)
  - $k_A$ allows for diversity of service connection size and loading
  - $V_N$ is the nominal voltage of the supply to the customer group
  - *T* is the time period of estimation (12 months)

# Accuracy: Technical Loss Computation

- Consumer Premises
  - There are usually many consumer groups defined as a group supplied by service connections from a single LV pole
  - Losses in consumer premises can only be calculated on average loss per service connection
  - A representative range of service connection lengths and loadings will be modelled
  - Utility not accountable for losses in consumer premises but this loss energy is reflected in the upstream distribution network as a higher loading - therefore the losses in consumer premises should be calculated and netted from upstream losses

# Accuracy: Technical Loss Computation

- Validation by ANRE
  - Participation in statistical sampling
  - Audit calculations
  - May need independent engineering consultant to verify

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# Tariffs, Losses & Incentives

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# Tariffs & Losses

| | Separate Component in Tariff for Losses? |
|---|---|
| AT | Yes |
| BE | |
| CH | |
| CZ | Yes |
| DE | Yes |
| DK | Yes |
| EE | |
| ES | Yes |
| FI | Yes |
| FR | Yes |
| GR | No |
| IT | No |
| LT | Yes |
| NL | |
| NO | Yes |
| PL | Yes |
| PT | No |
| SE | Yes |
| UK | Yes |

# Tariffs & Losses

- Germany (<5%)

  $EO_t = KA_{dnb,t} + (KA_{vnb,0} + (1 - Vt) * KA_{b,0}) * (VPI_t / VPI_0 - PF_t) * EF_t + Q_t + (VK_t - VK_0) + S_t$

  - VK represents volatile costs
  - Losses are part of the volatile costs
  - No incentive to reduce losses, increased losses increases allowed revenue $EO_t$

# Tariffs & Losses

- Norway ('wires only', < 5%)

$$C_t = (OM_{t\_2} + CENS_{t\_2}).\frac{CPI_t}{CPI_{t\_2}} + PL_{t\_2}.P\,t + DEP_{t\_2} + RAB_{t\_2}.WACC_t$$

  - $PL_{t\text{-}2}$ is a lagged power loss term
  - $P_t$ is the price of energy
  - Losses are valued at a reference price of energy taken from Nord Pool; incentive to buy at a more efficient price than the spot price
  - $CENS_{t\text{-}2}$ is a customer WTP term (supply quality)

# Tariffs & Losses

- Spain (8 – 10%) $R_t = R_0.(1 + A_t) + Y_{t\_1} + Q_{t\_1} + L_{t\_1}$

  - $R_0$ represents O&M and Capex cost; $A_t$ is an indexation factor
  - $Y_{t-1}$ is an adder for additional Capex
  - $Q_{t-1}$ is a quality of supply measure
  - $L_{t-1}$ is a loss factor

$$L_{t-1} = 0.8.p_{el}(l_{ind} - l_{t-1}).(e_{imp}+e_{gen})$$

  - $P_{el}$ is the average electricity price and the actual losses of the previous year $l_{t-1}$ calculated as a ratio

$$l_{t\_1} = ((e_{imp} + e_{gen}) - e_{sup})/(e_{imp} + e_{gen})$$

    - $e_{imp}$: electricity obtained from the upstream network
    - $e_{gen}$: electricity generated by facilities directly connected to the distribution network;
    - $e_{sup}$: electricity supplied to customers
    - $l_{ind}$ (target loss ratio) agreed between Ministry and DSO; constant for reset period

# Tariffs & Losses

- Africa (22%)
  - Distribution network tariff incentive to reduce losses below fixed %
  - Energy component includes loss factors but energy purchases fully compensated by reconciliation

$$PSP_{c,q} = \frac{1}{1 - \boldsymbol{LF_c}} . \left\{ \sum_t LD_{t,c} . \left[ BST_{t,q} . HVE_{B,q} / HVE_q \right] + \boldsymbol{R_q} / HVE_q \right\}$$

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## Tariffs & Losses

- # Allowed Revenue: Moldova

$MAR_t$ = costs of electricity purchase+ transmission costs+ distribution costs+ supply service costs

- PP = Weighted average purchase price in relevant accounting period
- TT = Weighted average tariff paid by Licensee for Transmission Network Services
- $LF_i$ = Loss Factor in DN at specific voltage class i
- $ST_j$ = Supply Tariff applicable to customer group j
- $RT_{ij}$ = Retail Tariff for customer group j supplied at voltage class i
- R = Amount of kWh required to reconcile
- $U_j$ = Amount allowed for uncollected consumer bills delivered to customer group j

## Tariffs & Losses

- Ideal Tariff Form for Moldova
  - Losses around 10%
  - Unbundling of network and supply activities yet to take place
  - Appropriate to retain current tariff form

# EU Network Tariffs

| | Fixed Charge | Capacity Charge | Energy Charge | Reactive Energy | Comment |
|---|---|---|---|---|---|
| | Euro | Euro / kW | Euro/kWh | Euro/kVArh | |
| BE | Yes | Yes | Yes | Yes | N.A. |
| CH | Yes | Yes | Yes | Yes | N.A. |
| CZ | No | Yes | Yes | Yes | N.A. |
| DE | No | Yes | Yes | Some utilities | N.A. |
| DK | Yes | No | Yes | No | N.A. |
| EE | No | Yes | Yes | Yes | N.A. |
| ES | No | Yes | Yes | Yes | N.A. |
| FI | Yes | Yes | Yes | Yes | Metering fee |
| FR | Yes | Yes | Yes | Yes | Exceeding of the contracted power |
| GR | No | Yes | Yes | No | cos phi |
| IT | No | Yes | Yes | No | N.A. |
| LT | No | Yes | Yes | No | N.A. |
| NL | Yes | Yes | Yes | Some utilities | N.A. |
| NO | Yes | Yes | Yes | Yes | N.A. |
| PL | Yes | Yes | Yes | Yes | Exceeding of the contracted power |
| PT | No | Yes | Yes | Yes | ToU for energy and capacity charges |
| SE | Yes | Yes | Yes | Yes | N.A. |

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# EU Network Tariffs

| | Fixed Charge | Capacity Charge | Energy Charge | Reactive Energy | Comment |
|---|---|---|---|---|---|
| | Euro | Euro / kW | Euro/kWh | Euro/kVArh | |
| BE | Yes | Yes | Yes | Yes | N.A. |
| CH | Yes | Yes | Yes | Yes | N.A. |
| CZ | No | Yes | Yes | Yes | N.A. |
| DE | No | Yes | Yes | Some utilities | N.A. |
| DK | Yes | No | Yes | No | N.A. |
| EE | No | Yes | Yes | Yes | N.A. |
| ES | No | Yes | Yes | Yes | N.A. |
| FI | Yes | Yes | Yes | Yes | Metering fee |
| FR | Yes | Yes | Yes | Yes | Exceeding of the contracted power |
| GR | No | Yes | Yes | No | cos phi |
| IT | No | Yes | Yes | No | N.A. |
| LT | No | Yes | Yes | No | N.A. |
| NL | Yes | Yes | Yes | Some utilities | N.A. |
| NO | Yes | Yes | Yes | Yes | N.A. |
| PL | Yes | Yes | Yes | Yes | Exceeding of the contracted power |
| PT | No | Yes | Yes | Yes | ToU for energy and capacity charges |
| SE | Yes | Yes | Yes | Yes | N.A. |

# Thank You !

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