Potential regulatory incentives for DSOs simplifying the connection process for distributed generators to the DSO's network

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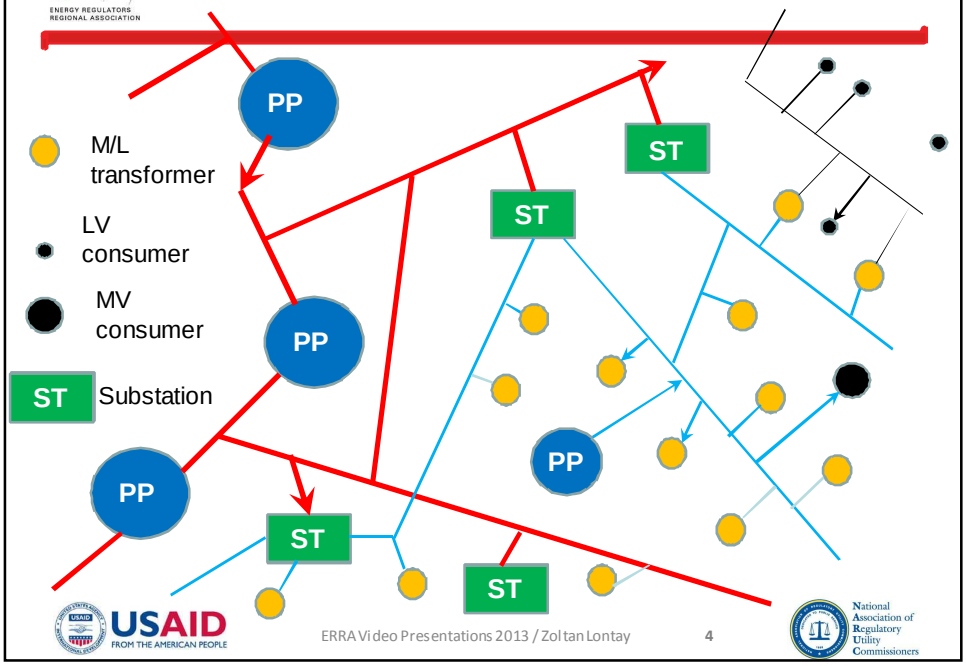
Topics

- Concept and categories of distributed generators (DGs).
- Why to provide preferential treatment for certain types of DGs ?
- Technical conditions and administrative processes of integrating DGs into electrical networks.
- Sharing costs between the actors.
- Opportunities for ERRA countries.

Electrical networks

- The electric systems (networks) were originally constructed to distribute electric energy of large capacity generators to end-users.
- Energy flow was definite and uni-directional from big power plants to the end-users through
  - high voltage transmission lines;
  - high-to-medium voltage substations and MV distribution systems; and
  - medium-to-low voltage transformer stations and LV distribution systems.

Scheme of a network



Distributed generators

- Distributed generators feed energy into the networks at various points of it.
  - They can only reach the end-users through the grid.
  - If the distributed generators are subsidized, the necessary metering and accounting functions can only be accomplished reliably by the help of the public grid.
- Main categories:
  - CHP plants;
  - Waste-to-energy plants;
  - Renewable Power Generators (RPGs).

CHP plants

CHP plants, like this gas engine plant, take advantage of local (distributed) heat end-users.

Waste-to-energy plants

Waste heat of industrial processes can be used for power generation.

The picture shows a steam turbine, which generates 800 kW power from steam produced by a hazardous waste incinerator.

Renewable power generators

- Renewable energy supply (RES) is a key strategy of sustainable development.
- Most of the countries have policies to support RES and within that RPG.

The distributed generators…

- …change the operational conditions of the networks, so that they have to operate in modes they were not designed for.
- The RPGs have impacts on the networks, influence the quality of supplied energy and the safety conditions.
- The networks have impacts on the generators, too. (In case of network disturbances the RPGs have to be isolated from the network.)
- The flow of energy is reversed in some parts of the system affecting the security conditions.

Typical connection voltages

Capacity of RPG	Connection voltage
< 30-50 kW (household)	Low
Up to 1-2 MW	Medium
Up to 15-20 MW	Medium or high
> 15-20 MW	High

Connection points

Capacity of RPG	Connection point
< 30-50 kW	Low voltage line or end-user terminal
Up to 1-2 MW	Medium voltage line with „T" connection
Up to 15-20 MW	Medium voltage line or **substation**
> 15-20 MW	High voltage line or **substation**

Integration of RPGs into the networks…

- ...involves
  - preparatory activities;
  - administrative processes;
  - execution of hardware changes; and
  - modified operation of the network.
- The key actors are the **developers** and the **DSOs**.
- **Costs occur**, which have to be covered by one or more of the players:
  - the developers,
  - the DSOs (ultimately the system users) or
  - the states (ultimately the tax-payers).

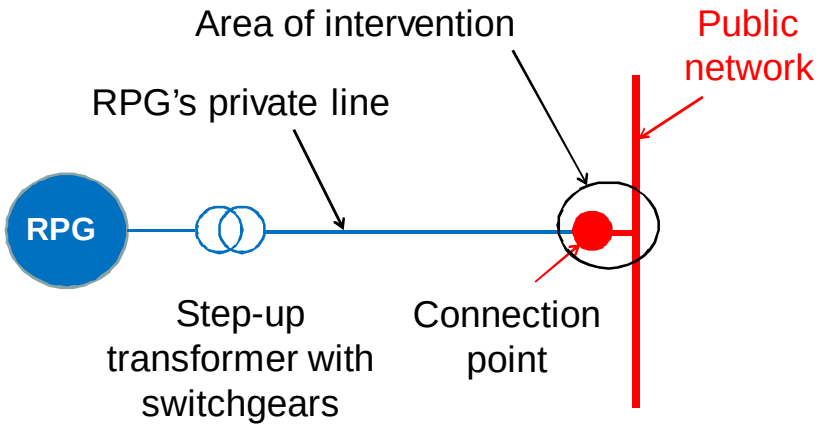
Supporting RES…

- …is the interest of the society. Various support techniques are known from investment subsidies to feed-in-tariffs.
- Access to the network (integration of RPGs) is a fundamental condition for RES.
- Integration may not put the stability and safety of the networks in danger and affect the quality of electric energy supplied to the end-users.
- It is **regulation**, which can incentivize the DSOs, so that they provide **preferential access** to the network for the RPGs.

Hardware works…

- …are necessary to create physical contact.
- The network can only recieve energy at certain physical points → CONNECTION POINT (interface between the infrastructure assets owned by the developer and the DSO).
- Existing network infrastructure may need reinforcement or new infrastructure has to be installed.
- A connecting power line has to be installed between the RPG and the connection point, typically as part of the RPG project.

Scheme of RPG connection



Balancing distributed generation

- Unpredictable or intermittent generation has to be balanced, typically by the TSO.
- The integration of wind and solar power generation capacities into the networks is limited by the availability of balancing capacities.
- Intermittent generators have to be encouraged or forced to improve predictability, to operate according to reported schedules.

The financeability of the networks…

- …may not put at risk.
- DSOs are subject to price cap regulation with revenue allowances for CAPEX and OPEX.
- Advance expenditures on network developments are not possible within the framework of conventional regulation.
- Based on firm renewable energy strategies the states may provide funds for network developments from tax money or allow the developments within the regulatory environment.

Renewable Energy Zones (REZs)

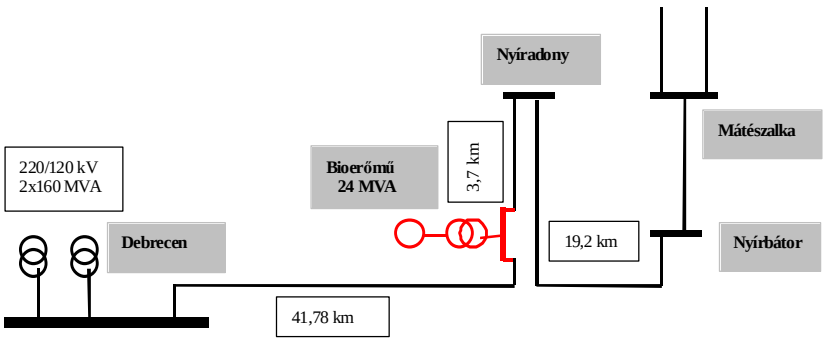
- The RE interests are usually not represented in network development planning. Networks are developed only when demand appears.
- REZs are special areas designated for RE generation.
- Electric infrastructure is constructed prior to the development of RPGs.
- The process is initiated by political will, and implemented with the use of public money.
- Example: Texas Competitive Renewable Energy Zones.

The challenges grow with more RPGs

- Network constraints (**hardware bottlenecks**) may limit the amount of new generation that can be connected without incurring extra costs.
- Renewable power fed into the networks can create **operational congestions**.
- Generation and distribution planning ought to go together, however, the method of financing makes it difficult.

Assessment of connection possibilities…

- …may be complicated, requiring expensive and time consuming network analysis.



Difficulties in the practice

- Some parts of the distribution system may be in such bad technical condition that no intervention is possible without major upgrade.
- Some substations cannot be extended because they do not have a bus. They have to be restructured first to the bus type.
- Land may not be available for the extension of substations.

Integration as the developers see it

- Connection costs (investment and operational) are part of project costs, which must be kept low.
- The developers require information about network connection possibilities, so that siting can be optimized.
- Connection costs/charges shall be tolerable.
- Connection procedure shall be predictable, transparent, and manageable.
- Mechanisms shall be available for settling disputes with the DSOs.

Integration as the DSOs see it

- Integration of several unreliable generators may have an adverse effect on the stability of the network and the quality of supplied energy.
- Integration causes additional investment and operational costs, the acknowledgement of which is not always easy, depending on regulation.
- Treatment of unserious developers' requests takes up expensive human resources.

The interest of the society

- RES shall develop in line with the renewable strategies.
- Regulation, as a policy tool, shall help the implementation of the strategies.
- Social costs of connection shall be kept at minimum. Unreasonably expensive network developments shall be avoided or charged on the developer.
- The relevant regulation has to be transparent and consistent to comfort the private investors.

Fields to be addressed by regulation

- **Administrative processes** of connection.
- **Technical requirements**.
- **Cost sharing**.
- **Preferential treatment** of RPGs.
- Rules of maintaining the **connection rights**.
- Mechanisms to **settle disputes** between the parties.

Administrative processes of connection

The usual process includes the following steps:

1) Fundamental network information is made available by the DSO.
2) The developer requests connection information from the DSO.
3) Information is supplied in the form of a **connection offer**.
4) The offer is negotiated.
5) Agreement is reached.

Administrative processes (cont'd)

6) Right of connection is established for the developer for a period of time. The right is lost if the developer does not progress with his project. In this case the right becomes free for other developers.
7) A connection contract is signed including
   – technical conditions;
   – costs sharing etc.
8) The developer builds the line up to the identified connection point according to technical standards set by the DSO.

Interventions on the network

- **Sensitive works**, which may influence the reliability of the network, may only be executed by the DSOs themselves or by contractors selected by the DSOs. These works are ***non-contestable***.
- **Less sensitive works** may be executed by qualified third parties, as well. Developers prefer third party involvement for the optimization of costs. This is the ***contestable*** scope.

Technical requirements

- Generators have effects on the network, e.g.:
  - size and export level has to fit into the network;
  - additional thermal load;
  - issues in voltage control;
  - contribution to fault levels;
  - reverse power flows;
  - voltage flicker and harmonic distortions.
- **Connection, start-up, operation, load change, scheduled and unscheduled outages may not disturb the operation of the network, and pose security hazards.**

The most sensitive issue: sharing costs of connection

- Cost categories:
  - preparation;
  - implementation (construction);
  - operation.
- Depending on the method, the costs are loaded on the RPGs (developers), the DSOs or the taxpayers.
- Proper cost sharing can incentivize the network operators and keep the financial burden on the developers at tolerable level.
- The costs shall be possibly handled within the electricity sector.

Preparatory costs…

- …from data request up to signing the connection contract are usually shared between the developer and the DSO.
- Both parties are responsible for their own costs.
- The developer covers the costs of project planning and development.
- The DSO covers the costs of providing network information and running the administrative processes.

Implementation costs…

- …include design, equipment, construction, etc. costs up to commissioning of new/modified network hardware and shared according to regulatory model.
- The connection line to the connection point is usually financed by the developer.
- Costs of works on the network are shared between the developer and the DSO. The method of sharing is determined taking into account other support mechanisms for distributed generators. Double subsidizing shall be avoided.

Operational costs

- Operating the networks with integrated distri-buted generators may cause costs and cost savings for the DSOs.
- Typical costs:
  - metering/accounting/reporting;
  - balancing;
  - supervision of technical issues.
- Possible cost saving:
  - lower energy losses at transportation and distribution;
  - this is a key advantage of distributed generation.

The goal is to provide preferential treatment for RPGs

- Preferential treatment **in connection**:
  - The RPGs may enjoy preferential access to network capacities. In constraint capacity situations not the RPGs, but the traditional network users have to pay for the development of the network.
- Preferential treatment **in dispatching**:
  - In low system load situations the RPGs are allowed to operate, while the other generators have to turn down or stop.

Preferential treatment - issues

- The developers may abuse the connection rights → unnecessarily high network capacities may be upheld for RPGs.
- Shutting/turning down conventional generators in order to make operation of RPGs possible in low load situations may cause extra social costs.

Network management strategies

- **Conventional approach: Fit and Forget** – the connection shall be able to operate under any possible network situations.
- **New approach: Active System Management** – by the help of modern IT technologies the energy flows are continuously monitored and the operation of the system is optimized. Both the RPGs and the end-users may be influenced.

Fit-and-forget (FAF)

- The network is prepared for all possible events (element failures, outages, maintenance, etc.).
- The RPG is allowed to operate freely (at any capacity) within the limits set in its license.
- There is no real time network management.
- Significant reserves are maintained in the network to avoid disturbances in case of element failures.
- The average utilization of the network is below the optimum.

Active Network Management

- With the help of state-of-the-art IT solutions (smart metering) the energy flows, demands, and available capacities in the network are monitored.
- Both the decentralized generators and the consumers are involved in optimization of system operation by the help of real time management techniques.
- With better utilization network development and maintenance costs can be saved.
- ANM has great importance in growing systems with hardware bottlenecks.

Integration of big wind parks

- **Wind power: intermittent generator**, the capacity can change rapidly. The average utilization of the connecting infrastructure is rather low.
- The integration of big wind parks (>50 MW, up to several 100 MW) may require development of the transmission system, too.
- Scheduling and balancing is a major challenge.
- Active network management, including limitation of capacity in certain operational situations may be unavoidable.

However good the regulation is, disputes occur

- The parties, the **developer** and the **DSO**, may have asymmetric powers.
- The DSOs, if the processes are not well regulated, can cause delays for the developers.
- „Minimum cost" can be understood differently:
  - minimum for the network or
  - social minimum.
- The DSO may insist to unrealistic technical conditions or upgrade of obsolete network elements.

Settling disputes

- There shall be a body, which issues determination to settle disputes between the developers and the DSOs.
- The **jurisdictional regulator** has to work on the basis of appropriate legislation.
- The decision of the regulator has to be binding for the parties.

Conclusions

- **Integration of distributed generators into public electric networks can be and shall be assisted by proper regulation.**
- **The costs of connection shall be shared between the developers and the DSOs in such a way that developers do not get discouraged, while the costs of the DSOs are acknowledged.**

Conclusions (cont'd)

- **Good regulation can help to make the inherently complicated processes of system integration as simple for the parties as possible.**
- **The regulation of distributed generators has to be in complience with the general rules of electricity market regulation.**

Opportunities for ERRA countries

- Some ERRA countries are in the process of establishing new **electricity market regulation**.
- Several ERRA countries are in the process of formulating or developing their **renewable energy strategies**.
- They have a level of freedom in selecting the policy tools for the promotion of RES.
- Simultaneous and coordinated development of **policy and regulation** may lead to good results.

Opportunities (cont'd)

- The experiences – achievements and mistakes – of other countries may help in formulating effective regulation.
- **Comparative studies** about the regulatory systems of several countries are available.
- The networks of ERRA countries can be developed in such a way that they can accommodate easily distributed generators.