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Microgrid and System Operation

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The views and ideas presented in this paper are authors point of view an not necessarily view of the employer

Microgrids

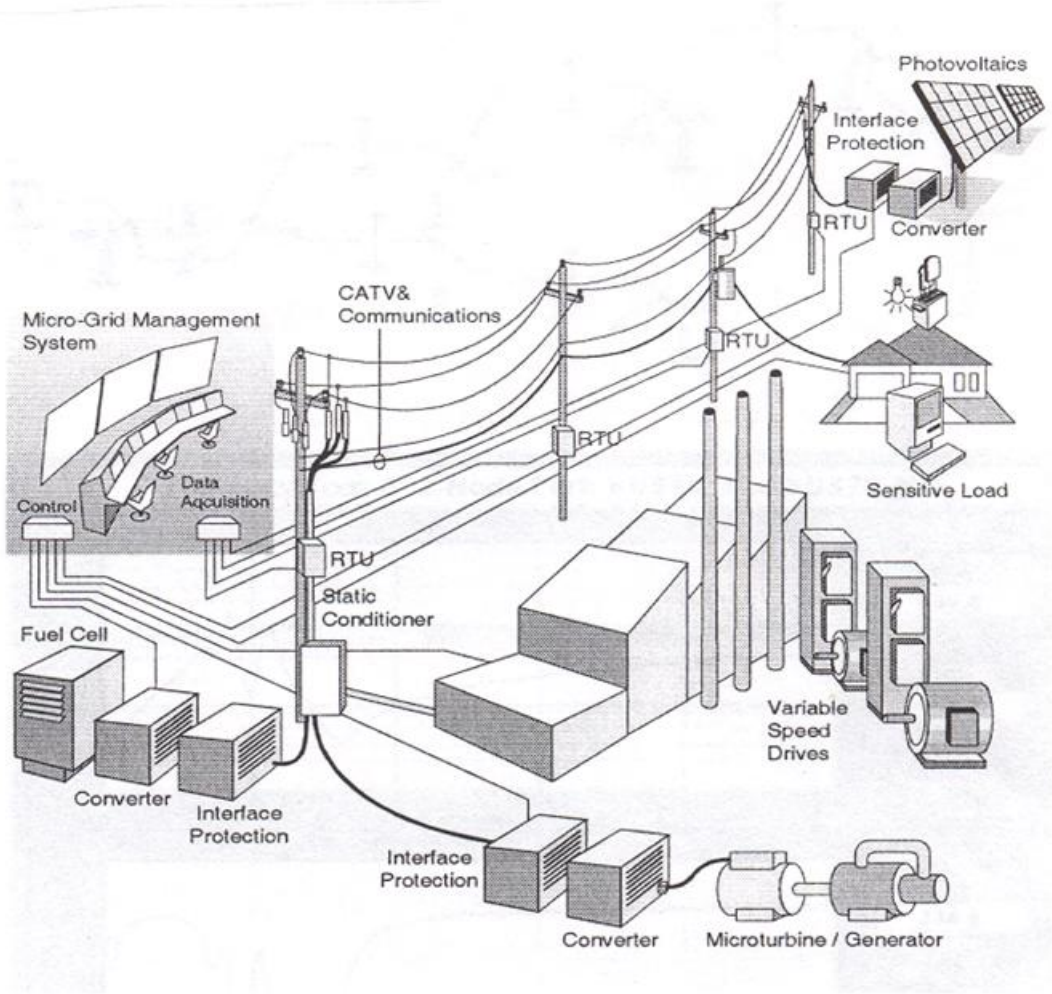
- What are Microgrids
- Boundaries of Microgrids
- Stakeholders and their interest in Microgrids
- Operational challenges posed by Microgrid
    - technical
        - Monitoring and Control
        - Power Quality
        - Balancing
        - Stability and Dynamics
        - ICT
    - Organizational
        - Disturbances and Restoration
        - Security of Supply
- Integration in Energy Markets

What are Microgrids

http://www.microgrids.eu

Microgrids are electricity distribution systems containing loads and distributed energy resources, (such as distributed generators, storage devices, or controllable loads) that can be operated in a controlled, coordinated way, either while connected to the main power network and/or while islanded.

(CIGRE WG C6.22)



EU Microgrids (ENK5-CT-2002-00610) and MOREMICROGRIDS (PL019864)

Microgrids Myths 1/2

- *Microgrids are exclusively isolated (island) systems*
  - Although Microgrids must have capability to sustain its operation in Island mode, it is not necessarily an Island system
- *Microgrid shall be made by Customers who own renewable micro-sources and want to profit from that*
  - There are various stakeholders which are interested in developing and operating Microgrids. (details later in the presentation)
- *Based on distributed and intermittent nature of the Renewable Energy Sources Microgrids must be unreliable and easily subject to failures and total black-outs.*
  - If efficient energy storing and intelligent balancing mechanisms are used then high level of reliability can be achieved.
- *There is no business case for Microgrids, too expensive to build, restricting it to field tests or only to remote locations.*
  - The microgrids do not have to be built from scratch, it is a combination of existing and new components coming in place

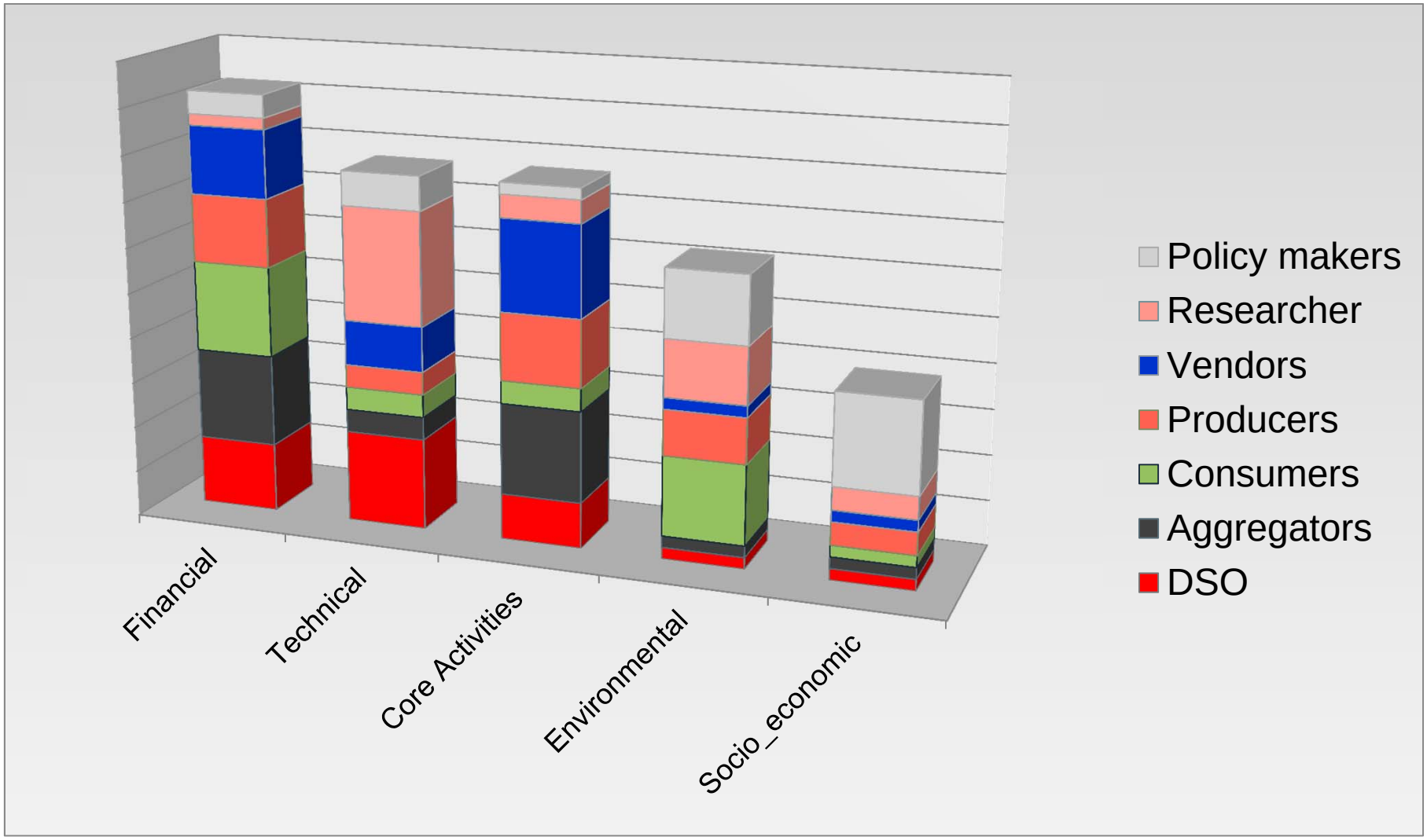
Microgrids Myths 2/2

- *Consumers shall be forced to adapt their demand to the availability of renewable generation, (Sunny / cloudy weather, Wind Strength…)*
  - This would be the case if we do not have good storage and demand side management strategy
- *System Operators will have to redesign and rebuild the networks to accommodate revolutionary idea of Microgrid*
  - Existing networks will be used and increasing number of intelligent devices and control applications shall
- *Microgrids loads will never face any supply interruptions*
  - The high availability can be designed but it is always a result of sound engineering practice and optimizing the costs and benefits.

Activities and business interests of Stakeholders

Actors	Activities	Business interests
System operators **DSO**	• Demand side management • Online monitoring and control • Set standards for the region	• Reduce the total costs low (peak demand, losses, investments..) • Improve the quality of supply • Keep consumers satisfied • Compliance to technical and legal aspects
Aggregators	• Aggregate services and offer them to other actors	• Find business opportunities • Develop and market new services
Consumers	• Install energy efficient equipment • Install two way communication, Control and monitoring devices • Optimize own energy mix	• Cost reductions • Improved power quality • Improved reliability • Reducing Environmental damage
Producers	• Install renewable energy sources • Use energy efficient technology	• Higher turnover • Large and profitable market share
Vendors	• Develop products and services • Produce and Market microgrid components and systems • Install and maintain	• Find business opportunities • Large and profitable market share • Technology leverage
Researcher	• Develop new technology • Test and standardize architecture and systems	• New fields of research • Partnership with industry • Scientific and Technical excellence
Policy makers	• Prepare Policy framework for promoting • Providing Legal and commercial level playing field	• Socio Economics aspects • Promoting environmental friendly sustainable growth

Focus of Actors and their interests



Development, ownership and Operations of Microgrid

Development and Investments in a Microgrid can be done in multiple phases by different actor groups which have financial interest and touches their core activities.

The operation of the Microgrid will be mainly determined by the ownership, market model and environmental consciousness of the region. For examples:

- In Integrated utilities where DSO owns and operates the distribution grid and may also fulfils the retailer function of selling electricity to end consumers
- In liberalized energy market Aggregators / Energy Supply Companies will have the lead which maximizes the value of the aggregated DG participation in energy markets
- Environmentally conscious Consumer(s) and consumers with high energy dependency shall own and operate DG to minimize electricity bills or maximize revenues (Prosumer Consortium) and reduce the environmental impact of the electrical generation

Technical challenges : Monitoring and Control

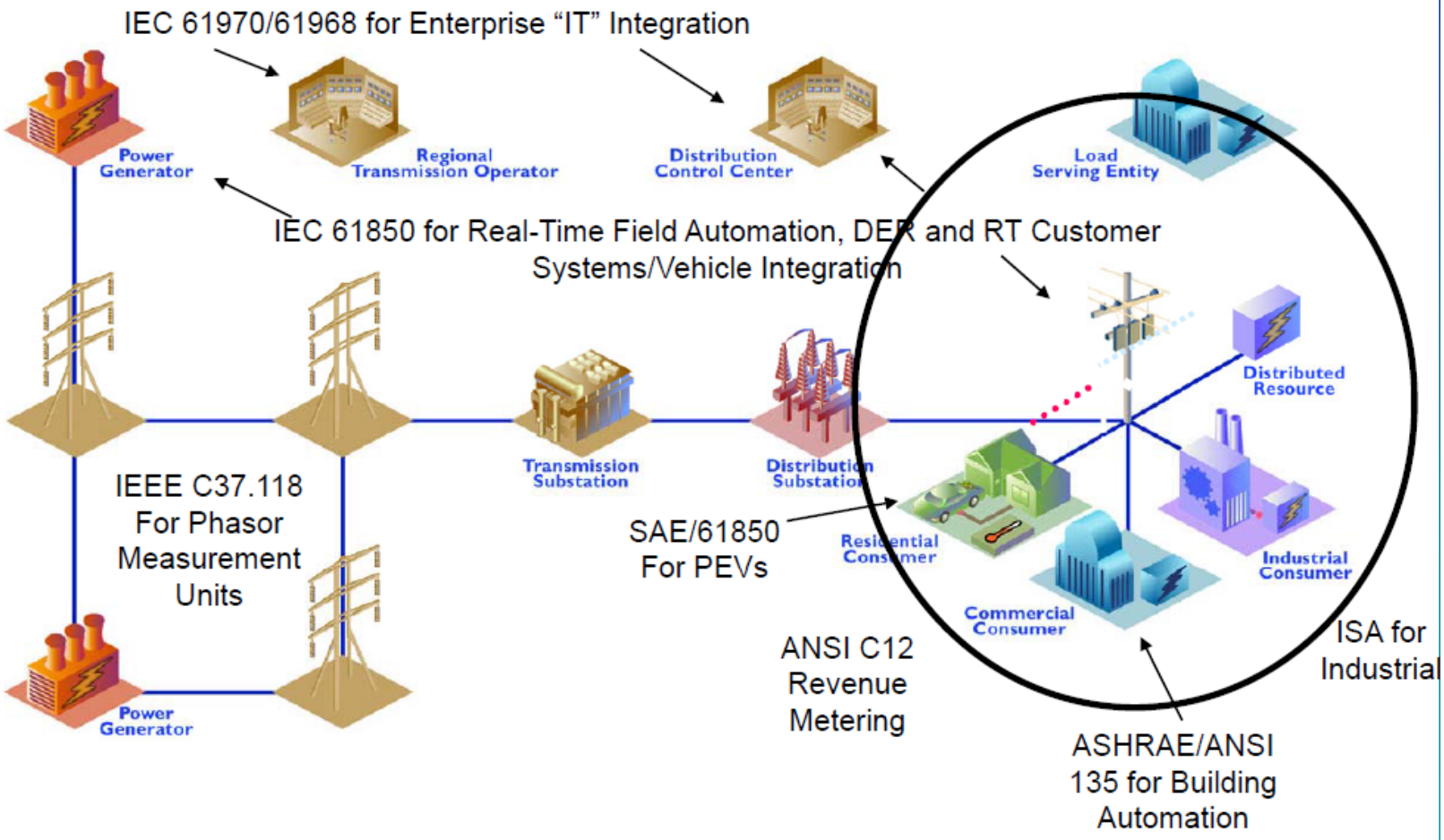
Monitoring and Control

- Distributed and centralized control
- Complex and dynamic architecture
- Small size and large number of devices
- Two way communication
- Standardization of system components
- No predetermined flow direction

Stability and Dynamics

- Low inertia contribution of PV generations
- Poor voltage support
- Sudden drop of Wind generators in high wind scenario

Domains Where Standards Are Needed



Source NIST

Technical challenges :

Power Quality

- Lot or electronic equipment introducing Harmonics
- Sensitive loads and control systems

Balancing

- Low contribution to balancing power
- Difficult to predict intermittent Generation
- Lack of storage possibilities

Protection systems

- Classical Overcurrent protection is unidirectional and topology static
- Micorgrids have Dynamic topology, dynamic infeeds from renewables and changing flow direction
- Adaptive protection schemes are needed with higher selectivity and speed

Technical challenges

Information and Communication Technology (ICT)

- Broadband two way communication
- Lack/ multiplicity of standards
- Cyber security
- Data privacy and ownership issues
- Distributed control
- Large data volume

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Organizational challenges : Disturbance and Restoration

- System restoration is lead by TSO and supported by DSOs.
- TSO ensures and organizes black-start and islanding capabilities
- In liberalized energy market these services are acquired and contracted to service providers typically a Generator companies
- In presence of Microgrids the coordination of restoration becomes more complex and requires
    - Clear command and control structure
    - Procedures and guidelines for restoration
    - Training and preparedness for such procedures

» Security of Supply responsibilities are diffused
    - Transparent and binding Service Level agreements required
    - The Microgrid management has to share the operational responsibility

Integration of Microgrids in Energy Markets

The energy trading should be
- coordinated, but decentralised energy trading

Market Mechanisms should be in place to ensure
- efficient, fair and secure supply and demand balancing

Market based arrangements for
- energy,
- ancillary services arrangements
- congestion management

Network access should be
- secure and open
- efficient and transparent allocation of network costs

Framework is needed for
- ownership structures and energy service providers
- new roles and responsibilities of all stakeholders

Conclusions

The Microgrids have potential to

- increase energy efficiency
- integrate environmental friendly DGs
- allow consumer participation
- increase reliability
- Reduce investment in Infrastructure

Provided

- we can overcome operational challenges
- Setup a framework which promotes and encourages DER and DSM integrate them in Energy Markets.

This session is focussed on Operational challenges