Microgrid: An active component of the integrated grid

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What is the general context of energy modern systems? The Energy Trilemma

The energy trilemma sums up our difficulty in finding secure energy supplies and catering to rising demand without prices becoming unaffordable, all while reducing greenhouse gas emissions.

- **Energy Equity**
- **Security**
- **Sustainability**

When looking at a network, if one wishes to be good at two of these characteristics, it is at the expense of the third?

For example, a network that is open to anyone and secure will not be economic as it will take resources to confirm the safety of an interaction.
Outline of the Energy Trilemma

- How well the trade-offs are managed?
- What it takes to have a **balanced approach** to the trilemma? 😊

*https://trilemma.worldenergy.org/*
Integrated Energy Network Challenges in Brief

- Greater **variability** in large scale generation
- Locally connected and often **intermittent** generation
- **Active** consumers
- **Electrification** of transport and space heating
- Reduced system **inertia**
- Distributed **storage**
- Integration of **information** technologies into energy supply
- The emergence of **cyber** attacks
New functions transform the network structure and operation

The Future Power System Architectures project (IET) identified **35 functions**.

1 – **Flexibility** to meet changing but uncertain requirements
2 – The **change in mix** of electricity generation
3 – The use of incentives
4 – The emergence of **new parties**
5 – The active management of networks, generation, **storage** and demand.
6 – The **recovery** from major events or emergencies
7 – Coordination across vectors

*https://www.theiet.org/sectors/energy/resources/fpsa/fpsa-project-phase-one.cfm*
The integrated energy network structure transition

Today: Highly centralised power and little DG

Emphasis on Energy Value

Initial stage

Emphasis on Information Value

Intermediate stage

Final stage

Tomorrow: Integrated secure network combining central and DG

✓ Major policy challenges
✓ Advanced technologies
✓ Emerging new business

Establishing the new functions-
Power sector evolution

The following core concepts are the pathways to network evolution:

✓ Power sector adaptation
✓ Power sector leadership
✓ Customer empowerment
✓ Community empowerment
Challenges for delivering the functions

Challenge 1 → Characteristics of the functions
Challenge 2 → Complexity and interdependence
Challenge 3 → Multiple stakeholders and complex delivery landscape
Challenge 4 → Requirements for Research & Development (R&D) and innovation
Modern energy timeframe employed

- Rapid Renewables growth/smart meters.
- Aggregators and other businesses providing DR, heat pumps cluster.
- Growing interaction between smart meters and appliances.
- Advanced Data available to DNOs, load shifting.
- Heat pumps and EVs, complex/dynamic tariffs for DSM / DR.
- Customers accustomed to interacting with DSO/other players.

2020
2025
2030
2035
2040
2050
A new systems approach needed

We need a concept that serves:

- A structural, system wide, long term challenges
- Dynamism
- Complexity
- Uncertainty
- Effective design interfaces across multiple parties
- **Fragmented** and **Disaggregated** power industry
- **35 functions** are highly impacted by externalities
Tackling uncertainty and complexity in Energy Systems through the microgrid concept

Technologies to employ
- Advanced metering infrastructure (AMI)/Cloud Computing to Energy Systems
- Distributed Energy Resources (DG, DR, storage)
- Home/building energy management system
- Electric transportation/V2G services
- Advanced control systems
- Distribution/substation automation
- Asset management

Cross Cutting Technologies
- ICT
- Security and privacy

Micro Grid Concept
- Prosumers
- Energy communities
Microgrids and active contribution benefits[1]

http://eprijournal.com/
Microgrids and active contribution benefits [2]

- Provide distribution voltage support and ride-through
- Optimize distribution operations
- Participate in demand response programs
- Improve voltage quality and reduced system losses
- Reduce environmental impact
- Defer capacity upgrades
- Improve power system resiliency
What microgrids can offer as an active component?

✓ improved whole system efficiency,
✓ increased asset utilization
✓ increased utilization of renewable energy
✓ improved system reliability
✓ improved system flexibility
✓ decision making appropriate to geography/vector.
Conclusions

• Integrated grid is the low cost solutions for achieving the reliability and resilience that our economy and personal comfort desire

...In order to achieve it we need

• Advanced distributed control through the architecture of microgrids.
Thank you for your attention

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