CIGRE e-Session 2020

Key Take Away's

SC C6 Session

Distributed Energy Resources (DER) and Active Distribution Systems

cigre

For power system expertise

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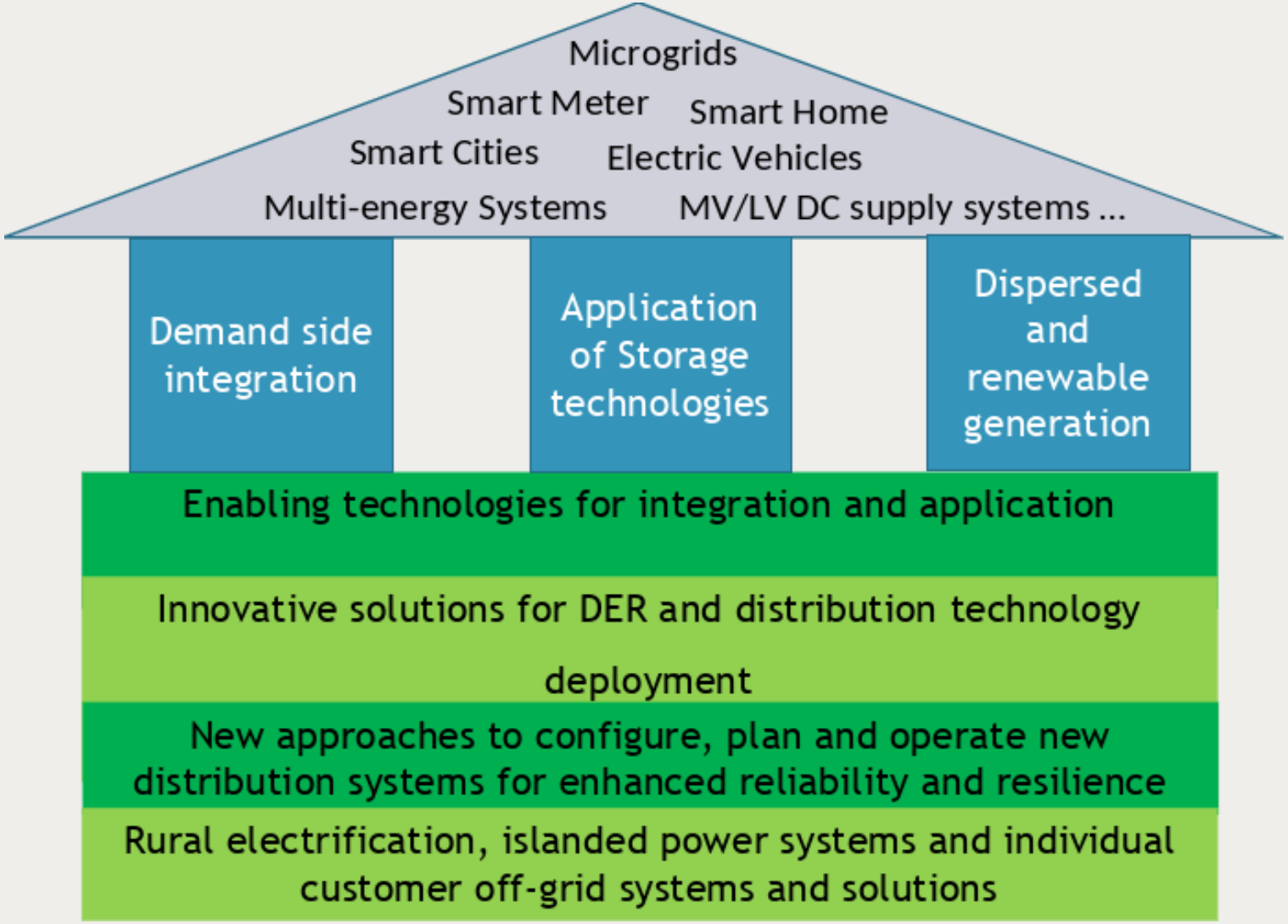
Activities of SC C6

The rooftop:
Applications of interest

The pillars:
DER in distribution systems

The base:
Areas of attention



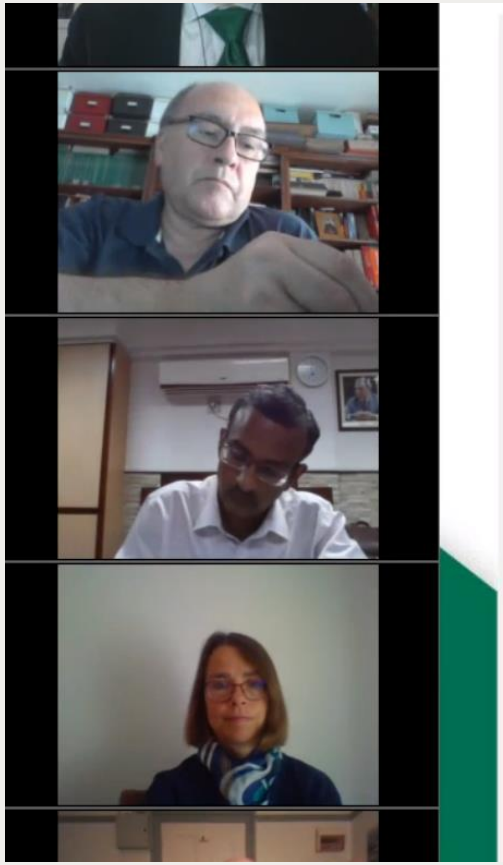
CIGRE 2020 e-session

Workshops

Tutorials

Paper Sessions

C6 workshop

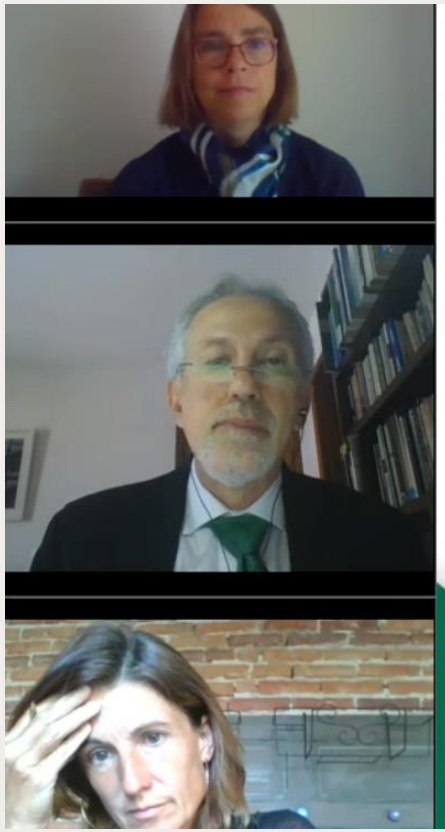


SC C6 workshop - Panel on End-to-end power systems enabling the energy transition and market transformation

Block 1: 14.10 – 15.55

Topic	Speakers
Technical impacts of a more widespread adoption of distribution connected energy resources on the whole distribution energy system / enabling technologies and innovative solutions for active distribution systems	Joao Pecas Lopes (INESC TEC, Portugal)
Price signals for the economically efficient integration of DER	Lance Hoch (Oakley Greenwood, Australia)
ICT and cybersecurity for the observability and controllability of distributed energy resources	Giovanna Dondossola (RSE, Italy)
ICT and Smart Grid Technologies for Distribution – An enabler for Business Transformation	Ganesh Srinivasan (Tata Power, India)

C6 workshop



SC C6 workshop - Panel on End-to-end power systems enabling the energy transition and market transformation

Block 2: 16.15 – 17.40

Topic	Speakers
Flexibility provision by Distributed Energy Resources	Pierluigi Mancarella (University of Melbourne, Australia)
Experiences of pilot projects in Norway with provision of flexibility for TSOs and DSOs	Kari Dalen (Statnet, Norway)
Electromobility in France: an opportunity for the power system	Maïté Jaureguy-Naudin (RTE, France)

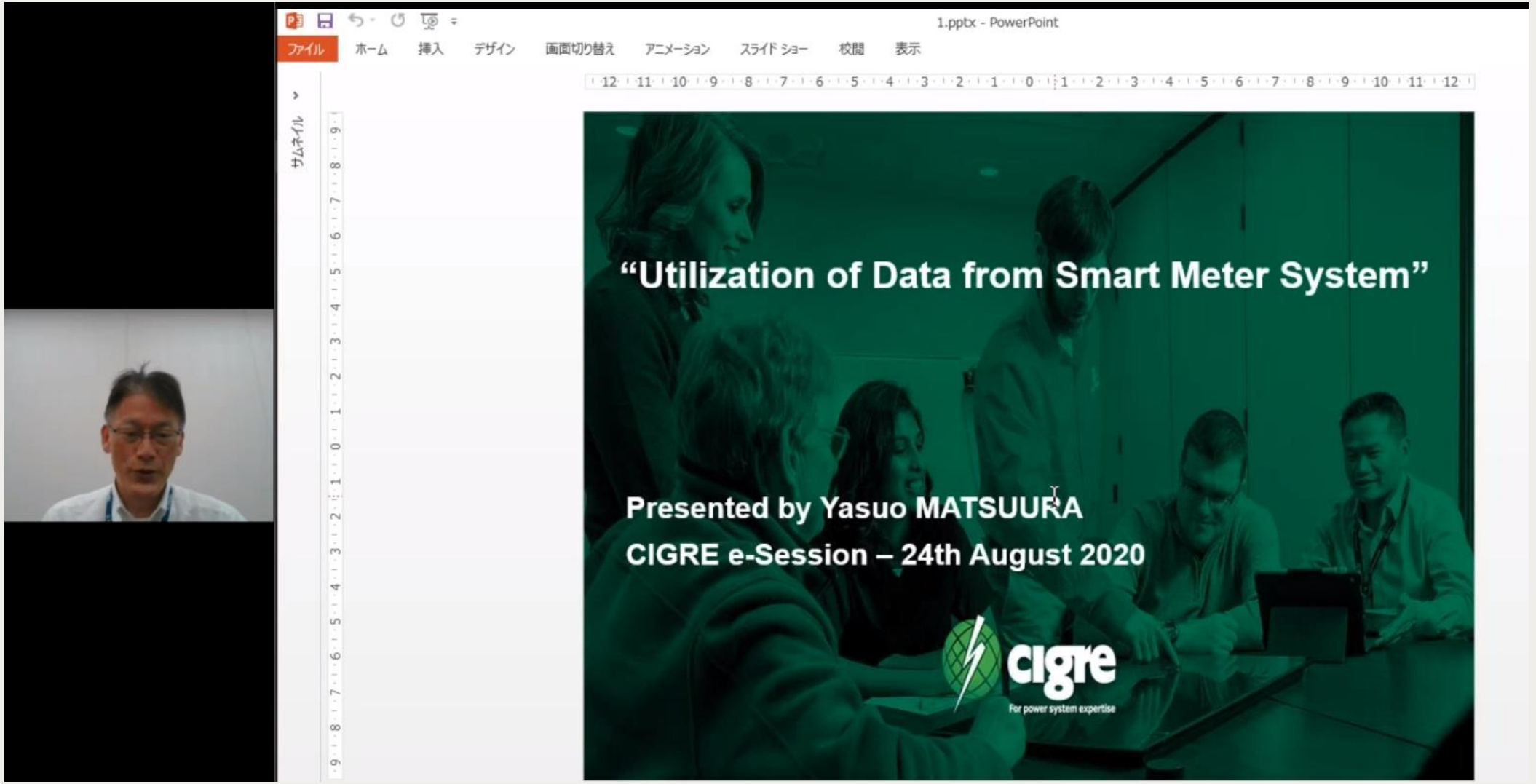
Enabling technologies

- Inverter based interfaces will be enabling technologies to leverage renewable grid penetration and to enable islanding operation.
- Battery storage systems to allow increased RES integration and islanding operation.
- Active demand response.
- Advanced communication infrastructures
- Distributed advanced distribution management systems (Ex: forecasting tools → predictive control).
- MV and LV DC microgrids to allow interconnection with DC loads and generation devices.
- Smart-transformers to provide high flexibility when controlling power flows and enabling islanding operation.

Conclusions

- Distribution grids will become more and more active grids with grid support services playing a key role → **Microgrids**.
- **Flexibility** will be key in the management and planning of the grid of the future.
- Apart from DG units also active demand side management (thermal loads, EV charging) and stationary batteries will become active players.
- **Local energy and service markets** (flexibility included) will develop further.
- **Observability** of DER together with **Distributed control and management solutions** will be key to allow increased resilience in the grid through islanding and black start.
- **TSO/DSO interaction /coordination** are foreseen to play a key role.
- **DSO management tools** will be required like DMS / ADMS functionalities.
- **Interoperability** will become mandatory for having successful communication and control procedures.

Tutorial “Utilization of Data from Smart Meter System”



Conclusions

< Smart Meter System >

- Deployment of a smart meter is progressing all over the world
- Many countries/regions will be finished the deployment in the 2020s
- Primary measurement item is energy consumption
- Regular intervals: 15 min or 30 min
- Transmission interval: 30min., once a day, and so on

< Use Cases >

- Most use cases aim for DSO support
- A few use cases regarded as new business and by a third party

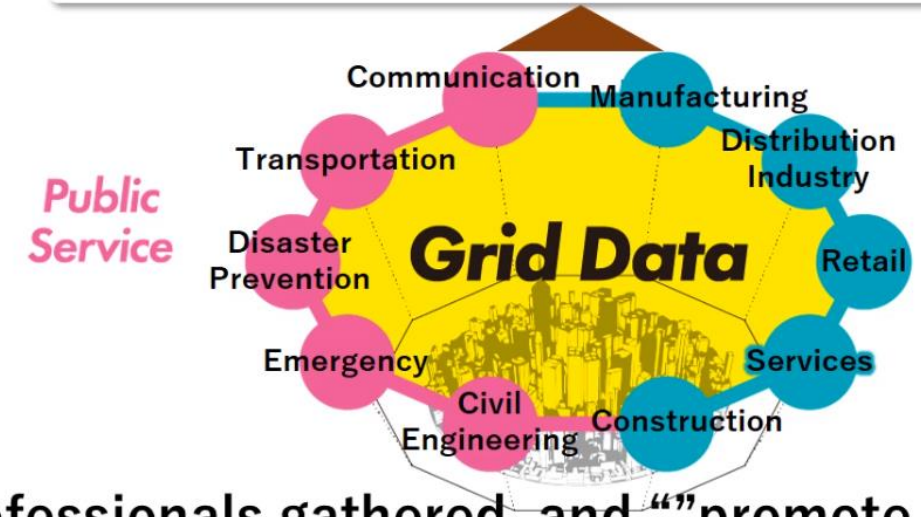
Grid Data Bank Lab

Grid Data Bank Lab. establishment

To contribute society, solve social issue, and develop industries, 3 Power companies and NTT DATA have established Grid Data Bank Lab. that promotes electricity facility data utilization including smart meter data.

東京電力パワーグリッド　中部電力　関西電力送配電　NTT DATA Trusted Global Innovator

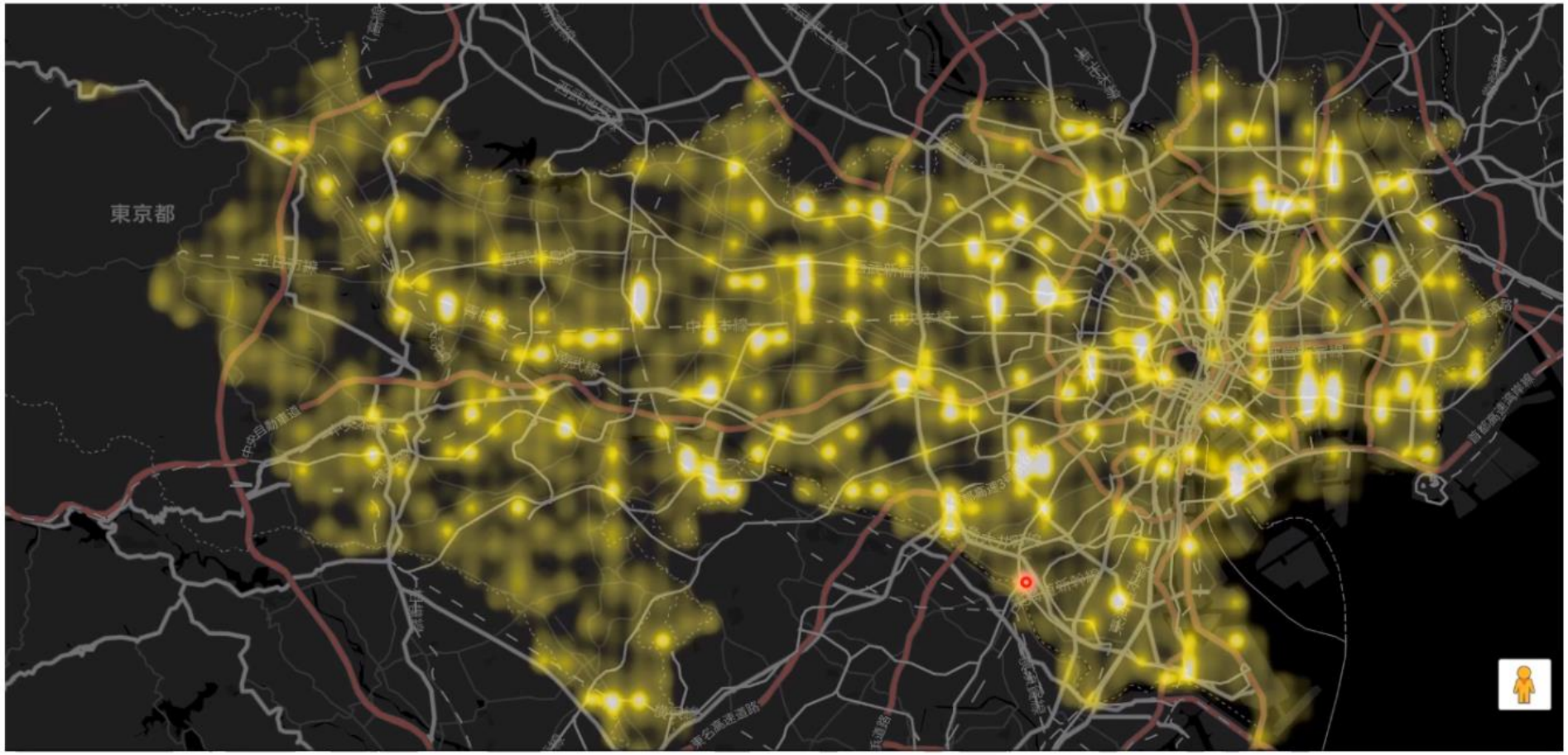
Grid Data Bank Lab.



Professionals gathered, and “”promote co-creation”

Visualization of Power Consumption Data by Smart Meters

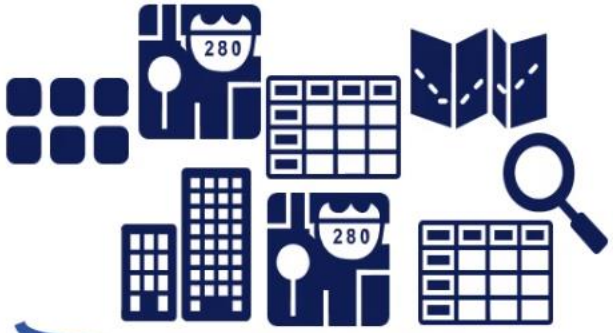
Grid Data Bank Lab.



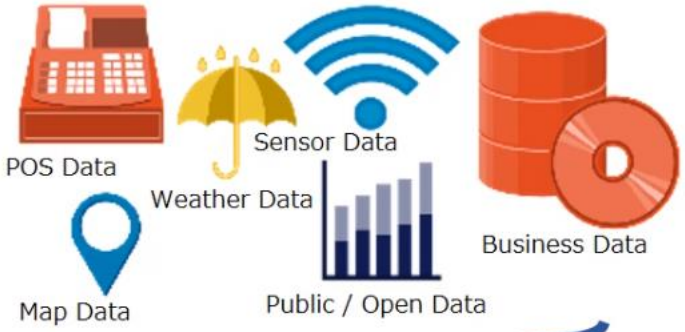
Further utilization through cross-industry data

Grid Data Bank Lab.

Smart Meter Data



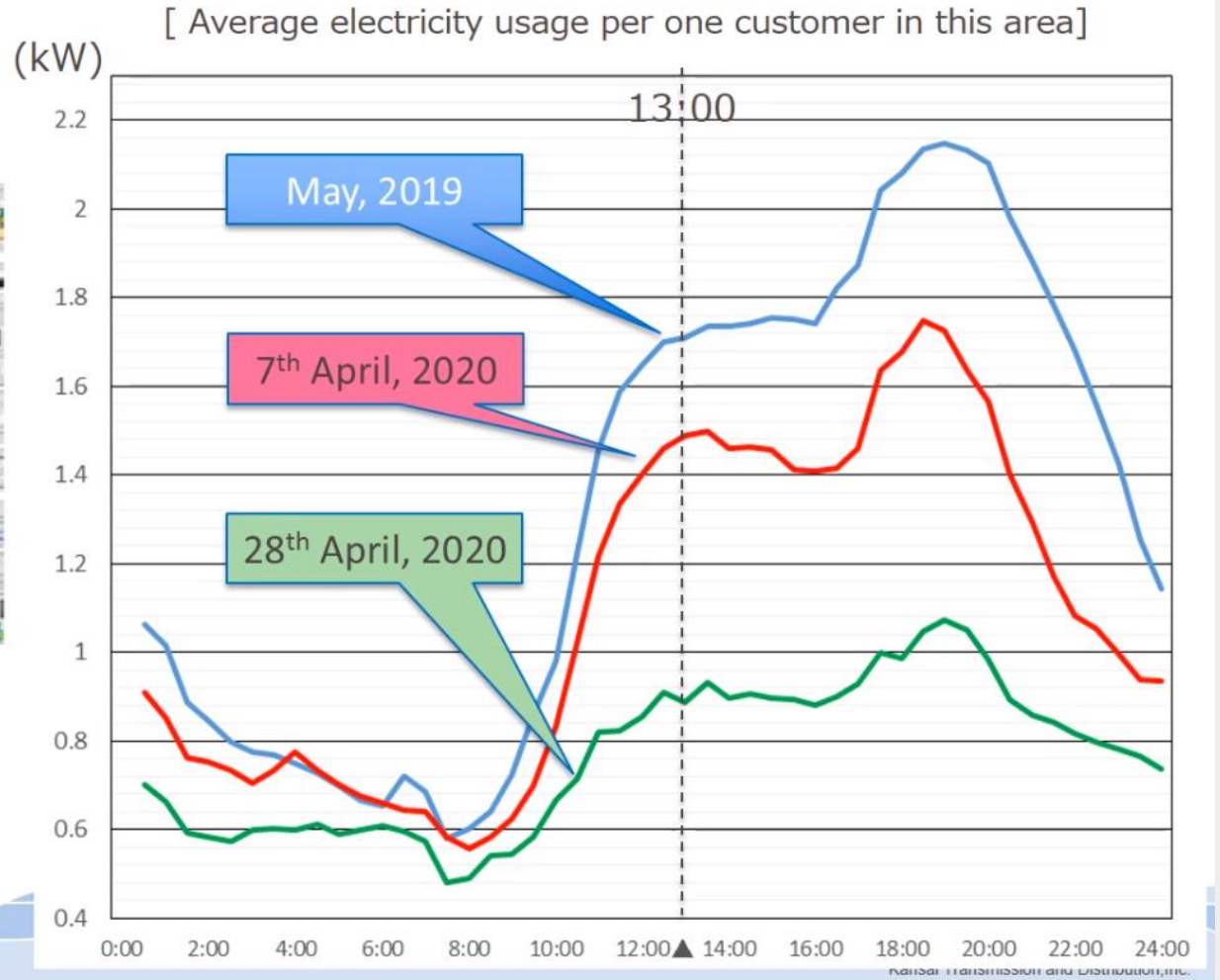
Data from other industry



Urban Development	Disaster Planning	Advanced Pricing	Senior Care
			
Area Targeting	**Real Estate**	**Delivery**	**Credit Analysis**
			

Effect of COVID-19: Commercial Area --- Downtown Osaka ---

Japanese Government issued the declaration of emergency situation as of 7th April, 2020.



Paper sessions

Preferential subjects SC C6:

- **PS 1 /** ADVANCED DISTRIBUTION SYSTEM DESIGN INCORPORATING DER
- **PS 2 /** ENABLING TECHNOLOGIES AND SOLUTIONS FOR DISTRIBUTION SYSTEMS

JOINT PS C2 AND C6

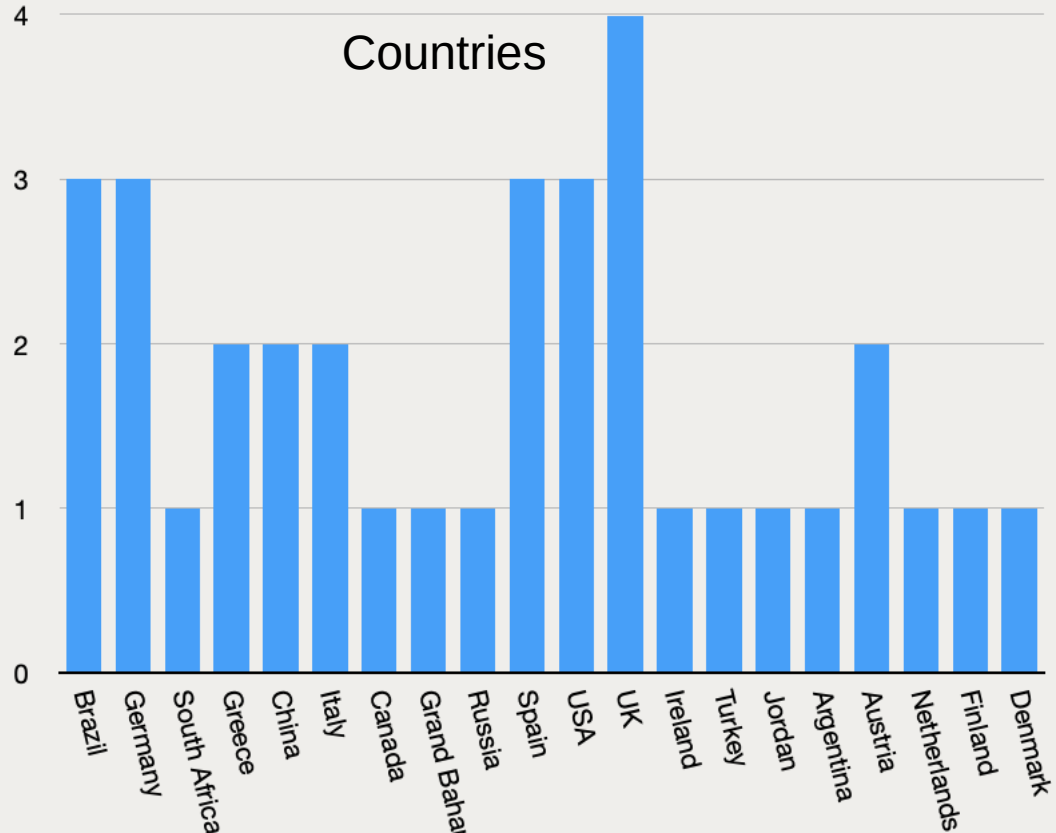
- **PS 3 /** SYSTEM OPERATION CHALLENGES WITH INCREASING DISTRIBUTED ENERGY RESOURCES

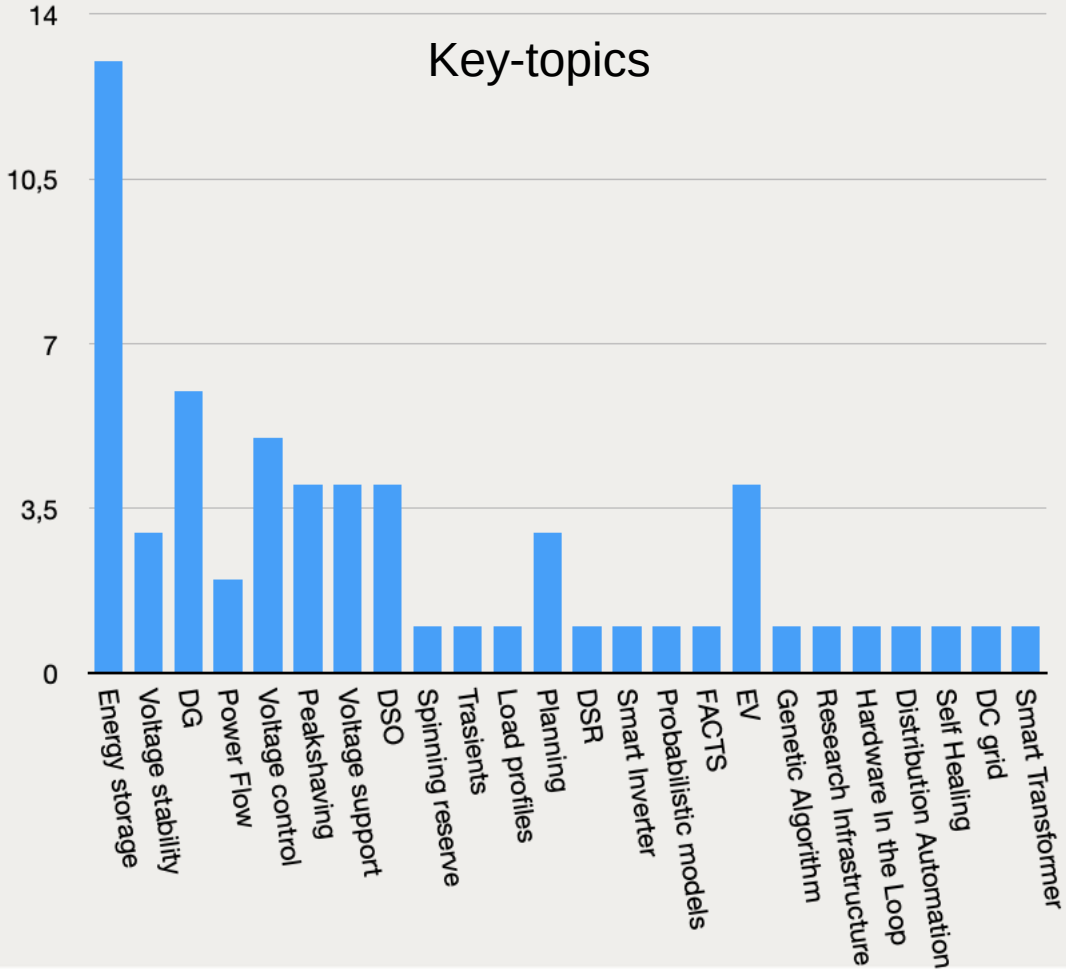
PS 1
Advanced distribution system design incorporating DER

- Configuring demand response and intelligent loads for customer empowerment.
- Exploiting local energy storage possibilities and managing uncertainties.
- Enabling multi-energy systems using intelligent inverters and controls.

PS1 - Statistics

- 24 presentations





Active Distribution System and Planning

- Active Distribution System and Planning Considering Energy Storage
- Planning for Electric Vehicles and Demand-Side Response in Active Distribution Systems

Papers from Greece, Italy, Russia, Spain, UK, Turkey, Jordan, China, Gulf States

Key discussion topics included:

- deterministic vs probabilistic capacity assessment methods,
- stacking services for energy storage systems
- energy storage for resiliency
- energy storage for reactive power provision
- criticality of time-of-day for DSR
- the use of EV loads for managing PV export peaks (as well as the need for managed charging at peak EV loading times of day)

Control and modelling in Active Distribution System

- Control Considerations in Active Distribution System Planning and Multi-Energy Systems
- Active Distribution System Modelling Accounting for Distributed Energy

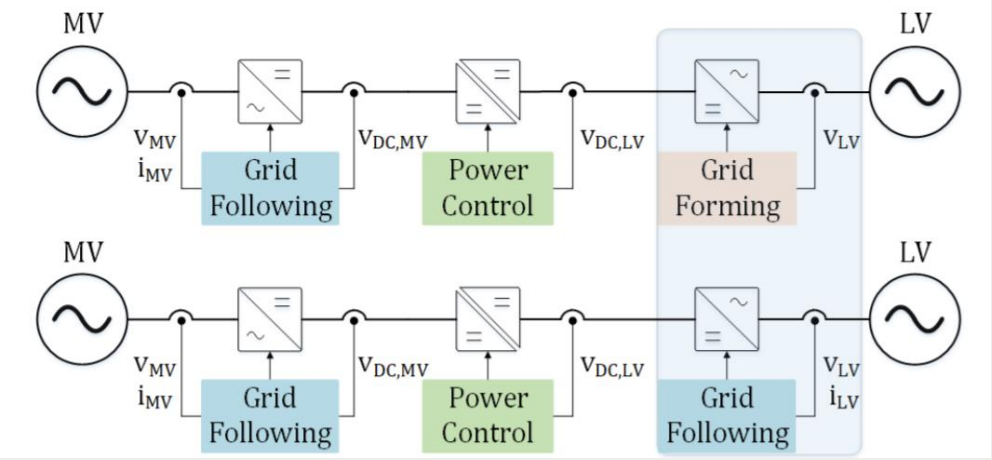
Papers from Austria, Spain, Germany, UK

Key discussion topics included:

- how to achieve net-zero carbon emissions via multi-energy systems
- the application of planning/control techniques to virtual as well as physical assets
- accounting for net-zero operation in power system planning and modelling
- the handling of ‘big data’ for power system modelling

C6-126. **Smart Transformer Use in Net-Zero Energy Factories**. Germany

- About 11% of the European small and medium enterprises produce electricity through solar energy.
- The generated electricity might be directly integrated into the manufacturing system instead to be fed into the grid. This is the main characteristic of the concept Net Zero Energy Factories,
- In order to operate manufacturing systems as “net zero”, new flexibility options need to be planed and sized. The more efficient flexibility might be gained if the manufacturing system is realized as DC grid and if the voltage is controlled through a smart transformer.
- A Smart Transformer, due to its capability to shape the load consumption by means of controlled voltage variations, introduces new flexibility concepts in the Net Zero Energy Factories. Varying the DC voltage, the smart transformer can shape the voltage-dependent load consumption (e.g., constant current loads), thus introducing further energy flexibility, without recurring to continuous battery power cycling.



PS 2
Enabling technologies and solutions for distribution systems

- Management and aggregation platforms for Distributed Energy Resources.
- Individual microgrid, multiple microgrid, and virtual power plant design and control.
- Rural electrification and off-grid distribution systems.

- 19 presentations
- Authors from:
  - 13 different countries
  - 5 continents of South America, North America, Europe, Asia and Australia.

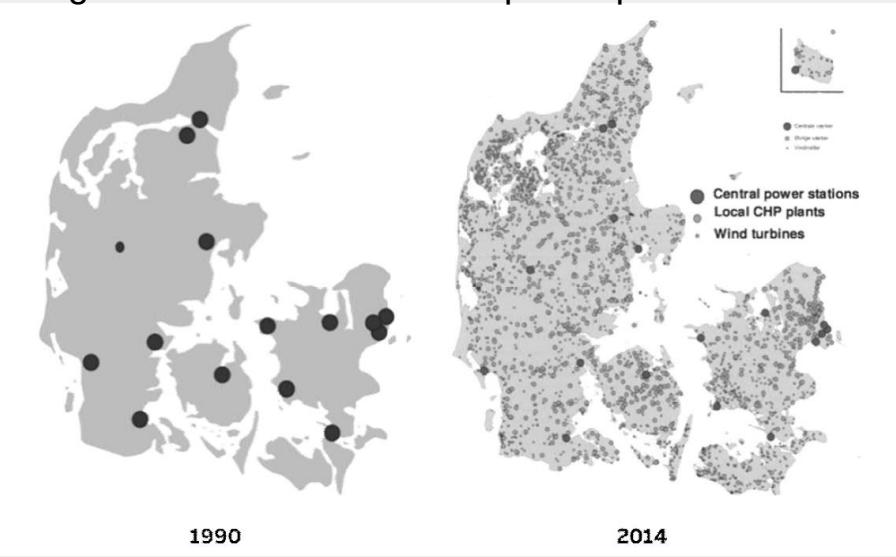
Innovative power and energy management solutions

The session covered mainly innovative power and energy management solutions of applications with high shares of distributed energy resources based on renewables like PV and wind and battery energy storage systems.

- Paper C6-201 presents the working group results on aggregation platforms to provide flexibility services in different countries and contexts.
- Further, variable speed diesel engines were introduced to keep isolated systems stable with high shares of renewables in Australia in Paper C6-212.
- The promising technology to tap power from overhead earthwire of EHV transmission line for remotely located loads was presented for India in Paper C6-216.

C6-201 **Distributed Energy Resources aggregation platforms for the provision of flexibility services.** Working Group C6.35

Changes in number and size of power plants in Denmark



Solutions for supply chain in DER aggregators

Metering and sensing	Communication	Data storage	Control	Centralized software solutions
Inverter	IEC 61850	Cloud server	SCADA	Unit commitment
Smart meter	OpenADR	Data storage server	Master Control Unit	Peak shaving
Current and voltage	Modbus		Field Control Unit	Price forecast
transformers	IEEE P2030.5		PLC	VRES forecast
	DNP3		Microcontroller	User interface
	VTN (Server)		IED	Battery management systems
	VEN (Client)			Asset optimization
	RTU			Ramp rate management

- A contribution of DER to an overall power supply is steadily increasing. A cumulative effect of large number of small units might become challenging.
- Important to coordinate an overall performance of DER in order to avoid system issues and unsecure operations. Coordinated DERs can increase a flexibility of power supply and positively contribute to the transmission grid.
- Technological improvements are needed, which will allow DER aggregation process moving towards next level of scale and flexibility.
- Regulatory environment for DER aggregation needs to be omproved. Uncertainty on policies and regulations is the biggest issue.

Strategic planning & basic engineering

- The first phase in developing projects is the **strategic planning & basic engineering**, i.e. building scenarios in a techno-economic feasibility study in order to dimension the different distributed energy resources, battery energy storage system.
- Paper C6-215 presented such a feasibility study for the very representative application of a European remote village based on the widely used simulation tool “HOMER”. In different countries and regions, different simulation tools are available for that purpose.

- In the session, we discussed the impact of the regulatory context and barrier of connecting more distributed energy resources to distribution grids, because of a variety of causes:
  - delays of 2 years due to long queues of connection requests, where renewable energy projects wait in the same queue as fossil fuel-based projects (NAM),
  - high fees on electricity in case of grid connected renewables (Germany).
- Various industries are committed to decarbonization and choose to connect renewables together with storage in an isolated grid first, until above barriers will be removed.

New developments

New developments include:

- research on algorithms cyber physical systems and for nested microgrids in North America (C6-204),
- or research on “Cellular systems” in the German KOPERNIKUS program (C6-207),
- Multi-microgrid system´s resilience in Austria (Young Member contribution)
- and Energy management for off-grid systems in Spain (C6-217).

There is a diversity of names and definitions for such systems in different geographies in the world. The papers show, how technology follows the regulatory context in a certain country or region.

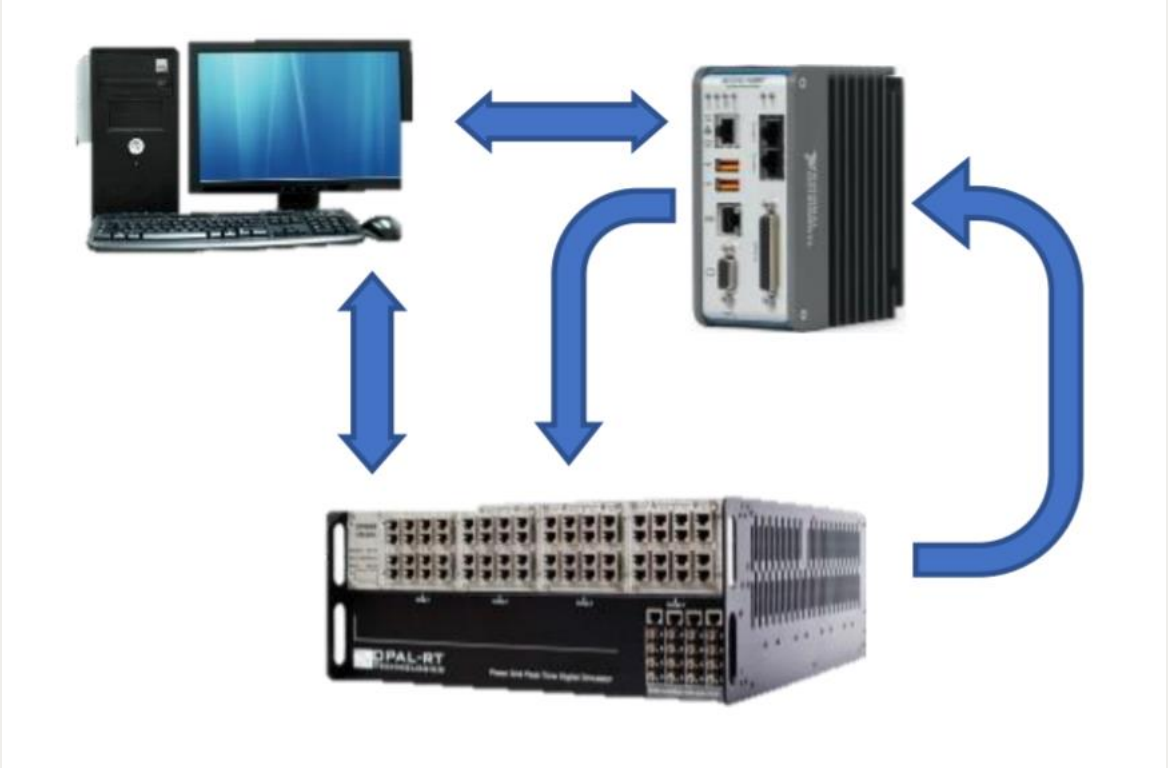
Power system studies

- When developing a project, based on power system studies, the control strategy for the application is implemented in the control application engineering.
- The control system is then tested in
  - a Hardware-in-the-loop (HIL) test facility,
  - some with “Control HIL”,
  - others even with “Power HIL”.
- Authors presented such test set-ups at the Distribution System Operator facilities in Colombia (C6-218) and USA (C6-205), at an industrial site in Germany (C6-206) and also at research facilities in Spain (C6-210), Korea (C6-203), New Zealand (C6-221) and USA (C6-204).

- In the discussion, the authors explained why such test facilities have different targets. System operators are responsible for stable operation and maintenance of their industrial or distribution systems, and need to familiarize their staff and management with new technology, including change of processes. Further, tests are important to create confidence in the new technology. At research sites, focus lies on application and further development of benchmarks and standards.

C6-218. **Hardware in the loop microgrid controller testing.** Colombia

- Real Time Hardware in the Loop (HIL) simulation is used by engineers and researchers for the development and evaluation of controllers.
- Advantages of using HIL simulations: it reduces the costs and risks of the development process, therefore, engineers can try innovative designs and gain important insights on the operation of the system.
- The real – time simulation in HIL with the microgrid controller allowed the validation of some cases of use and the better understanding on how the operation will be when it is implemented. It was possible to study the applicability of BES to microgrids and what their benefits are.



Hardware in the loop simulation

Demonstration sites

Following laboratory tests, demonstration sites are the next step.

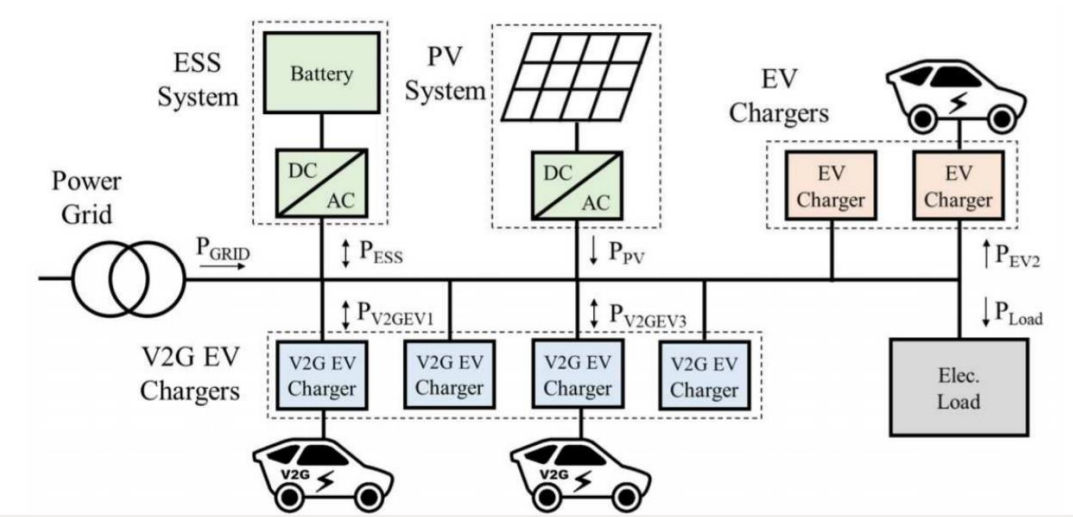
- Paper C6 202 presented demonstrations for an industrial site in USA with advanced microgrids control system, that will be operated as isolated grid until grid connection will be approved.
- The demonstration project for a virtual power plant of the European island of Scilly in UK is described in Paper C6-208.

The best paper award

- Paper C6-203 Optimal Energy Management and Control for Load Management in V2G EV-integrated Microgrid.
  This paper shows a very good example for project development from sizing over system studies, HIL test and demonstration for a site in Korea.

C6-203. **Optimal Energy Management and Control for Load Management in V2G EV-integrated Microgrid**. Korea

- Vehicle-to-grid (V2G)
- The paper proposes energy management strategies for V2G EV-integrated microgrid. The V2G EV uses renewable energy and grid power to charge other EVs and supply electrical loads. The proposed energy management strategy is to maximize the revenues of the V2G EV-MG and mitigate the impact on adjacent power systems



Preferential Subjects 2022

- PS1 : DER solutions and experiences for energy transition and decarbonisation
  - Electric mobility charging systems configuration and operation
  - Demand response and intelligent load configuration for customer empowerment
  - Electrification of transportation, heat systems and industrial processes

- PS2 : Innovative planning and operation of active distribution systems
  - Aggregation and management platforms for active distribution systems with DER
  - Strategies and tools for DER integration, hosting capacity, congestion management, and system service provision by DER
  - Greening rural and greenfield electrification, off-grid distribution and zero emission industrial systems

- PS 3: Aggregated DER for enhancing resilience, reliability and energy security of distribution systems
  - Configuration of local energy storage systems for managing uncertainties
  - Coordination of multi-energy systems supported by state-of-the-art technologies including intelligent inverter controls
  - Individual AC and DC microgrids, multiple microgrids, virtual power plant and local energy communities control and network integration


Thank you
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For power system expertise