Dr. Wenpeng LUAN
SEG6 Convener

Microgrids for rural electrification
Oct 14 2015
Minsk, Belarus

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

Agenda

1. Microgrid
2. Implementation Status
3. Standardization Demand
4. IEC SEG 6

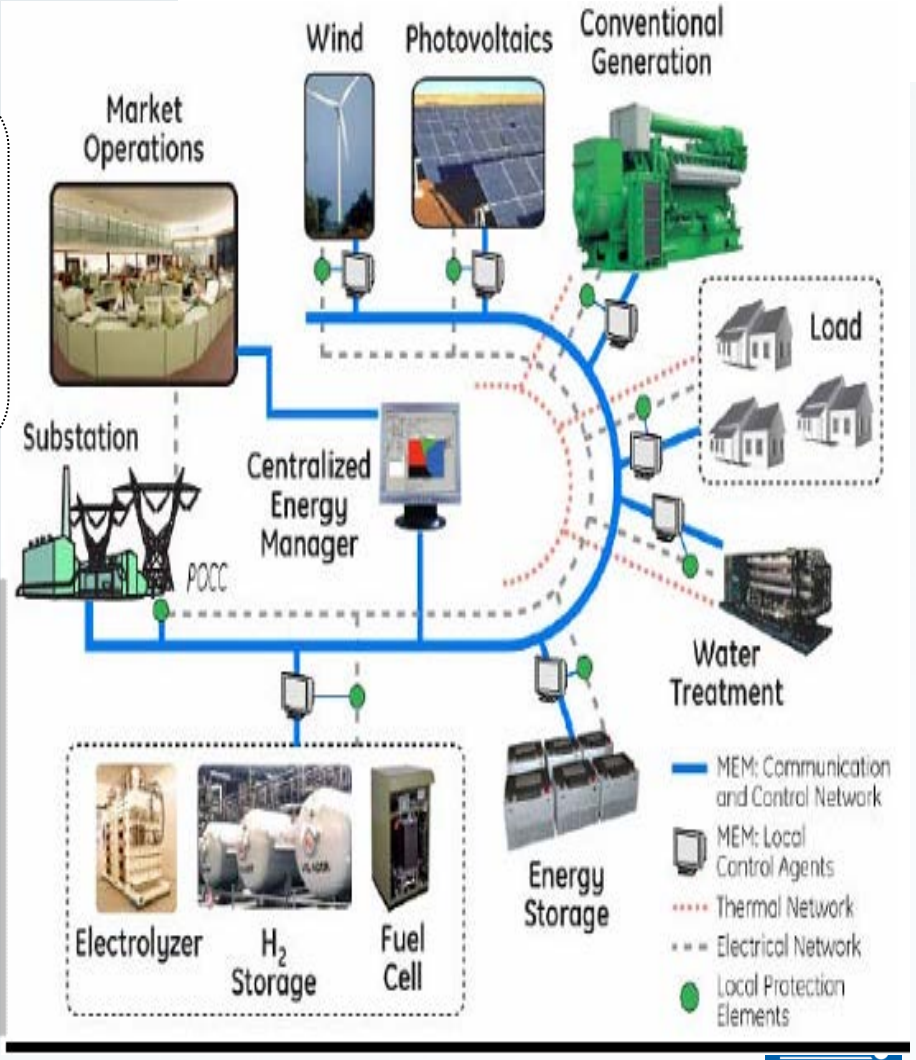
1. Microgrid

Microgrid

Microgrid is a power supply and consumption system consisting of DER, energy storage, load and other related control and protection equipment. It can operate in grid-connected/islanding mode, serving as an effective way of DER utilization.

Main Characteristics

- An integrated unit based on DER technology, combining storage, control and protection devices.
- Close to load
- Integrated at low/medium voltage level
- Grid-connected or islanding



1. Development Drivers

2. Microgrid Implementation

China

- 15 projects completed/ongoing by the end of 2013
- Expect to complete 30 microgrid demos by the end of 2015 (planned installation capacity 150MW)

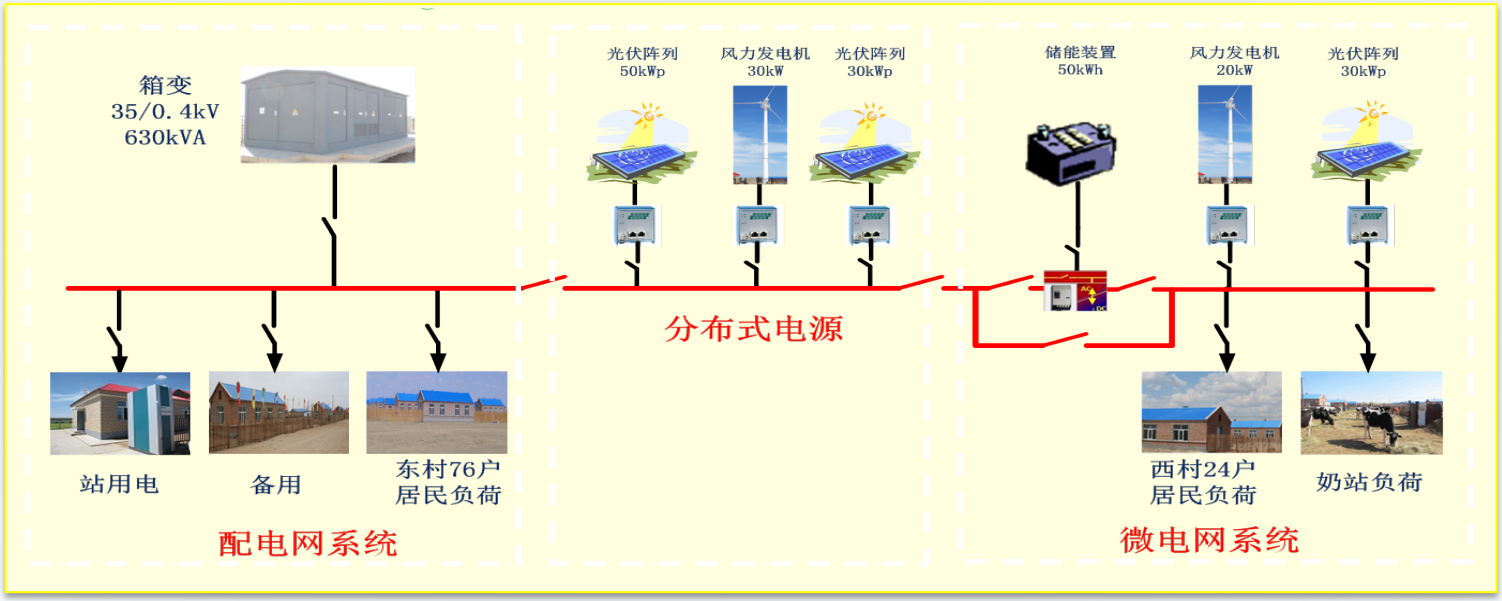
2. Microgrid Implementation

China

No.	Projects
1	PV and Storage pilot projects in Henan
2	CCHP Microgrid system in Foshan, Guangdong
3	Wind/PV/Diesel/Storage Microgrid in Dongao Island in Guangdong
4	Smart business hall Microgrid projects in Sino-Singapore eco-city
5	Wind/PV/Diesel/Storage and Desalination project in Dongfu Island, Zhejiang
6	Immigrant village Microgrid in Inner Mongolia
7	Langfang Eco-city Microgrid project
8	Zuoan Microgrid pilot project in Beijing
9	Wind/PV/Storage Microgrid project in Xian International Horticultural Exposition Park
10	PV and storage Microgrid project in Yangzhou development zone
11	Microgrid pilot project in Gongqing, Jiangxi
12	PV and storage Microgrid in Xiamen Island in Fujian
13	Wind/PV/Storage/Diesel and super capacitor island Microgrid in Nanlu, Zhejiang
14	Wind/PV/Storage/Diesel and super capacitor Microgrid in Luxi island in Zhejiang
15	Wind/PV/Storage village Microgrid projects in Chengde

2. Microgrid Implementation

- Remote area microgrid, Inner Mongolia, China



- Voltage: 380V
- **PV:** 110kW ；Wind: 50kW ；Lithium battery storage：42kW/50kWh
- **Supply power for 100 households and dairy farm**

2. Microgrid Implementation

- Island microgrid, Nanlu island, China

PV generation 500kW

Marine generation 100kW

EV charging/swap station (storage)

Wind generation 11*100kW

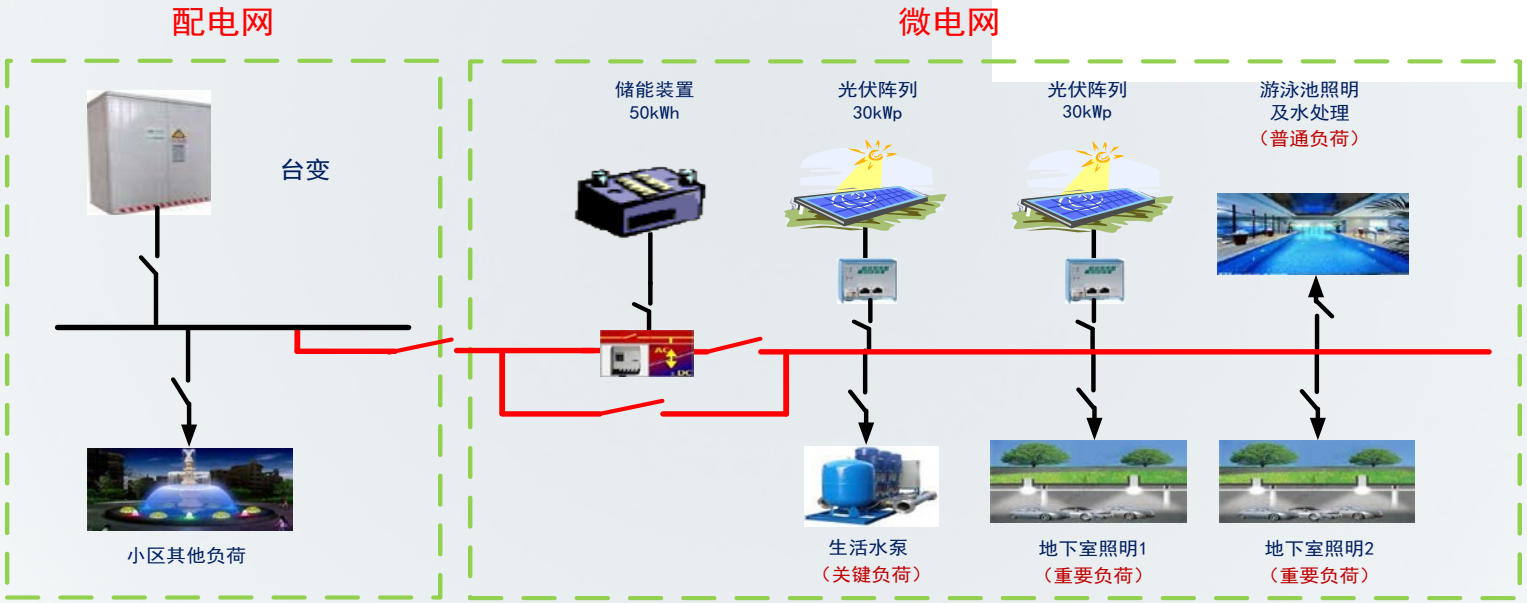
Diesel generation 1.1MW

Characteristics

This project is a comprehensive island microgrid system with high reliability requirement and integrated various DER, and thus is a test and verification base for Microgrid design method, control and protection strategy, energy management, optimal operation strategy and performance evaluation system.

2. Microgrid Implementation

- Community microgrid, Xiamen China

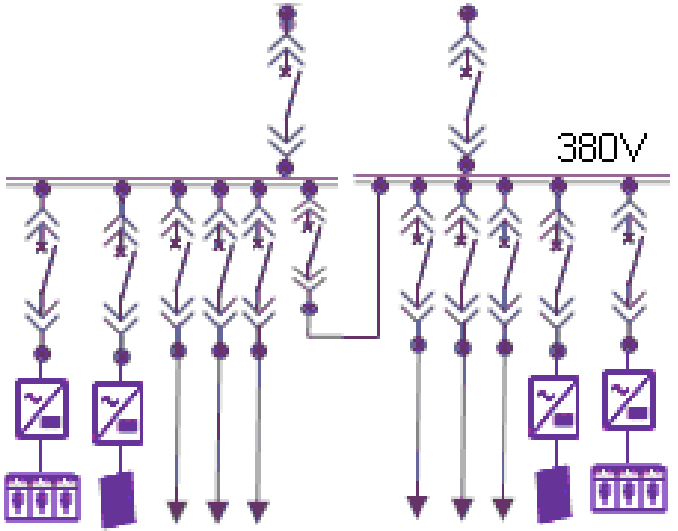


- Voltage: 380V
- PV: 60kW ； Lithium battery storage： 50kWh
- Characteristics: load level based coordinated control strategy and energy management, enabling the islanding operation for important load, ensuring the power service for the community.

2. Microgrid Implementation

- Campus microgrid, Henan, China

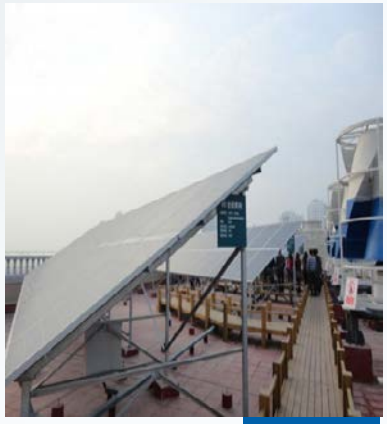
- 380V system
- 520kW PV, 100kW×2h Lithium battery storage
- Using storage as main power
- Enables grid-connected/islanding operation and transition
- Research focus: coordinated control of PV and storage



2. Microgrid Implementation

- Business microgrid, Sino-Singapore eco-city, Tianjin, China
  - **Voltage:** 380V
  - **PV:** 30kW；Wind generation 6kW；Lithium battery storage 15kW/60kWh
  - **Characteristics:**

    demonstration on grid-connected microgrid with business agent, realizing stable and safe operation in islanding/grid-connected mode.



2. Microgrid Implementation

- Main Characteristics of the microgrid projects in China

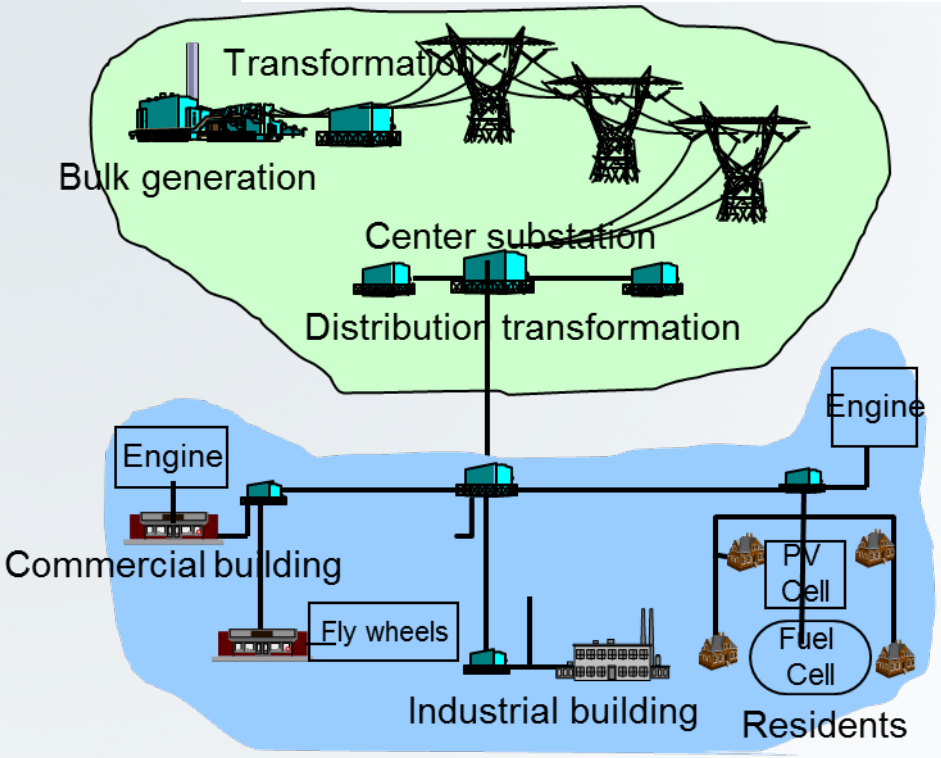
① Micro-source: use renewable energy such as wind and PV

② Voltage: 11 of 380V (71%) , 4 of 10kV (29%)

③ Installation: 11 under 1MW, 4 under 5MW

④ Storage application: 14 deployed

⑤ Operation mode: grid-connected, islanding



Micro Grid

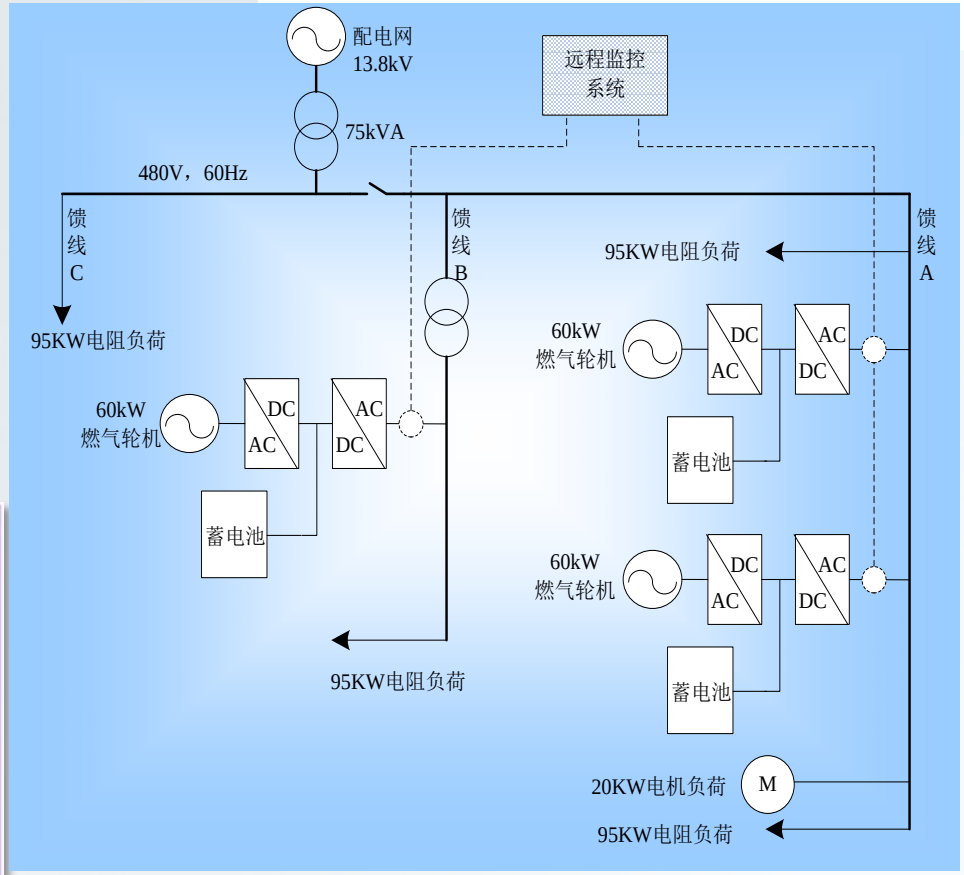
2. Microgrid Implementation

- U.S
  - CERTS
    - Microgrid of University of Wisconsin Madison Lab
    - CERTS microgrid pilot
  - National Laboratory Microgrid
    - NREL，DETL，Palamale
  - Future Plan
    - City of Fort Collins，ATK Launch Systems，Chevron USA，Illinois Institute of Technology, etc. Five projects in total
  - Other Microgrid Projects
    - Mad river Microgrid， DUIT Microgrid ，GE Microgrid

2. Microgrid Implementation

CERTS Microgrid

- 0.4kV system, 3 feeders
- 3 micro gas turbine, 180kW in total
- Storage connected to DC side
- Single connection to the main grid, one way power flow
- Realizing comprehensive and optimal control via energy manager and power flow controller

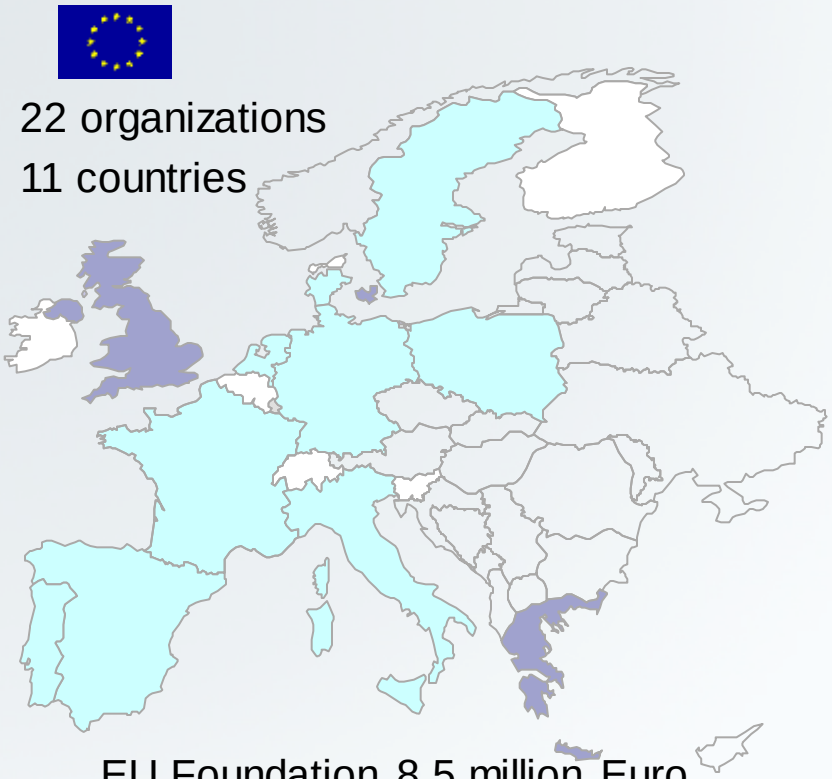


location: Dolan Tech. Center, Columbus, Ohi

2. Microgrid Implementation

EU Microgrid

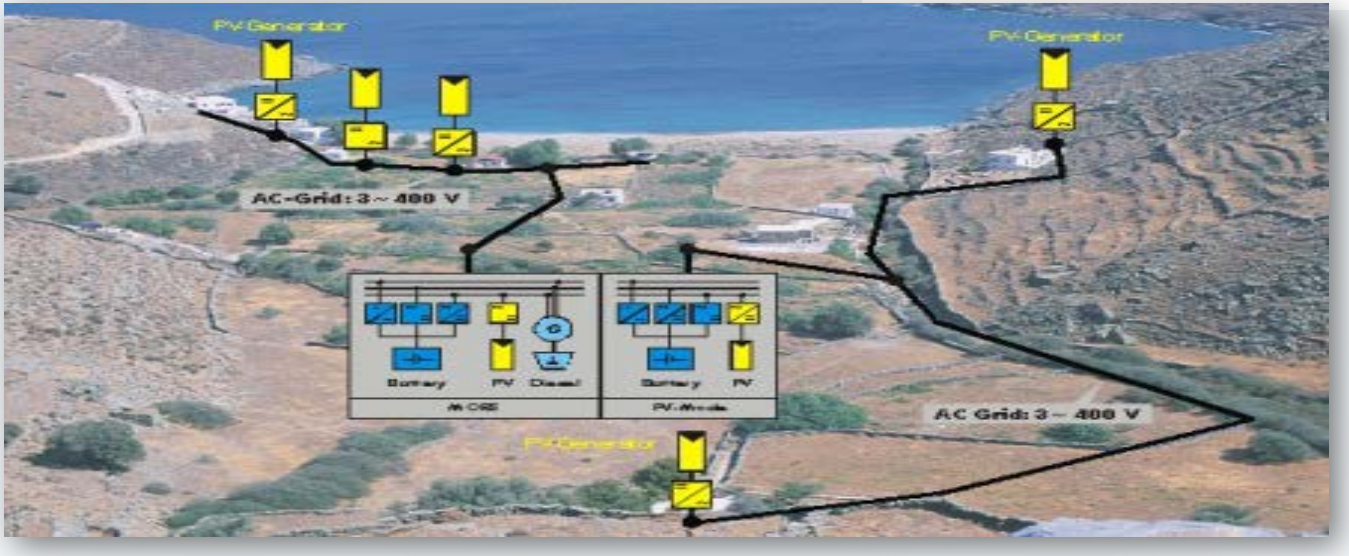
- 8 Projects
  - Greek- Kythnos
  - Spain- Labein
  - Portugal- EDP
  - Italy- CESI
  - Denmark- Boroholm
  - Germany- Manheim
  - Netherland- Continuon
  - Macedonia- Kozuf



EU Foundation 8.5 million Euro

2. Microgrid Implementation

- Greek Kythnos Island Microgrid



- Provide power for 12 households, 0.4kV system, includes, 11kW PV, 5kW diesel engine, 3.3kW/50kWh battery system. Currently the system can only operate in islanding mode
- Master-slave control mode, battery inverter pack operates in frequency dip mode
- Perform load shedding when battery is low; limit PV output when battery is full

3. Standardization Demand

- Key technology areas of Microgrid

  - Optimal planning and design
  - Coordinated operation and control of multiple DER
  - Hybrid energy storage
  - Power quality control and improvement
  - Smart protection
  - Economic operation and optimized energy management

3. Standardization Demand

- The industry calls for standards support. Currently, microgrid application is still on pilot and demonstration stage, further global development requires the guidance of international standards.
- Microgrid needs specific standards. Unique characteristics of Microgrid (various/intermittent power sources, operation mode transition, heavy adoption of power electronics, etc) require microgrid specific standards.
- Top-level design and systematic approach are required for standards development. Microgrid should be considered as an independent system. It requires systematic approach to clarify the system boundaries in various application scenarios, identify existing standards gaps and duplications, and develop the standards roadmap.

4. IEC SEG6

- Background

The SMB is invited to **decide on the recommendations** submitted in in Part A of the report **at the November SMB meeting 151 in Tokyo**.

Item 1: A1. AhG 53 recommends that the SMB agree that new work projects for standardization of design and operation of microgrids should be directed to TC8 (Nominally TC8 / WG7)

Item 2: A2. AhG 53 recommends that in order to avoid duplication and added burdens on experts, the SyC on Smart Energy should continue its efforts in the following activities:

a. Maintain and update the microgrid portion of the Smart Grid roadmap
b. Collect and align concepts, scopes and functionalities
c. Monitor the related work in IEC TCs &,SCs and identify standardization gaps
d. Collect and define use cases under various application models of microgrids

Item 3: A3. AhG 53 recommends that the SMB approve the formation of the SEG titled: Nontraditional Distribution Networks / Microgrids

[*The term "nontraditional Distribution Network" is intended to convey networks other than AC distribution systems firmly connected to a large interconnected grid*]

4. IEC SEG6

- Scope and Membership

Scope

The scope of SEG 6 is to
Assess aspects of non-traditional distribution networks for applications such as:
- Rural and developing markets that serve potential huge market needs (notably in Asia and Africa) including networks that may be connected in the future to a traditional / interconnected grid.
- Facility or campus grids capable of operating in an isolated mode with respect to a large interconnected grid.

The SEG is requested to closely collaborate with TC 8 and SyC Smart Energy and other microgrid activities in IEC and to provide the SMB with its recommendations on an approach to standardization in this area. The SEG will work in close collaboration with SEG 4 in the area of LVDC.

SEG 6 Officers	
Convenor	Mr Wenpeng LUAN
Secretary	Mr Pierre Sebellin

4. IEC SEG6

Scope and Membership

Name	NC
Mr Jeferson Marcondes	BR
Ms Wenyuan MA	CN
Mr Ming WU	CN
Mr Liang Zhang	CN
Ms Hui Yu	CN
Mr Gunnar Kaestle	DE
Mr Wolfgang Niedenzu	DE
Mr Torben Dalsgaard	DK
Mr Knud Johansen	DK
Mr Hervé Rochereau	FR
Mr Richard Schomberg	FR
Mr Vimal Mahendru	IN
Mr Giuseppe Dell'Olio	IT
Mr Hideki Hayashi	JP
Mr Shuji Hirakawa	JP

Name	NC
Mr Jong-Bae Park	KR
Mr Hyo-Sik Yang	KR
Mr Harry Stokman	NL
Mr Somphop Asadamongkol	TH
Mr Chakphed Madtharad	TH
Mr Att Phayomhom	TH
Mr Ryan Franks	US
Mr Jianhui Wang	US
Mr Géza Joós	XP
Mr Ralph Karhammar	XP
Ms Sommapun Khuantham	XP
Mr Arindam Maitra	XP
Mr NAND KISHORE NARANG	XP
Mr Alexandre Oudalov	XP
Mr Paul Johnson	ZA

12 NC, 30 experts

4. IEC SEG6

- Target Deliverable

A group report for SMB to

- Provides guidelines on how the emerging business cases and market needs for developing non-traditional distribution networks and Microgrids be addressed in international standardization
- Rationalize terminology, produce a roadmap and action plan and identify the current activities, gaps, and interfaces between parts of the network in order to engage the community of experts, identify the relevant stakeholders and define the general architecture and boundaries of the problem to be addressed

4. IEC SEG6

Kick-off Meeting

SEG 6 held its first meeting in Beijing, China, on June 22 and 23, 2015.

--- hosted by the China Electric Power Research Institute

- Work plan
- Work team structure
- Draft outline of SEG report

4. IEC SEG6

Work Plan

1. January – March 2015, call for experts (would like to invite members from TC 8, SyC 1, SEG 4)
2. April 2015, Circulate the proposed work plan
3. June 2015, first face to face meeting, Beijing (open to other invitation), determine the structure and work distribution (set up task groups) of the group report.
4. August 2015, Set-up Working Teams
5. 23 to 24 November 2015 (France), second meeting of SEG 6, to discuss the outlines of groups reports and adjust the work plan if necessary.(after TC82, 1st to 7 Nov)
6. March/April 2016, third meeting to discuss the 1st draft (With TC8/WG7 ?, or 2nd African Smart Grid Forum)
7. Sept/October 2016, 4th meeting, group reports and CAG recommendations discussed at the meeting.(Ask Germany for GM)
8. December 2016 Final report sent to SMB for review/comments
9. February 2017, SMB makes decision on the report

4. IEC SEG6

Work Team Structure

Work Team 1: Situation assessment

- Status of standardization (list of existing standards)
- Stakeholders
- Market assessment

Work Team 2: Use cases

- Electricity access
- Disaster recovery
- Etc.

Work Team 3: Specific needs for Microgrid technology standardization (gaps)

- Safety
- Monitoring
- Control
- Etc…

Convener advisory group: The Members of this group are the Convenor, the Secretary, and the WT Conveners.

4. IEC SEG6

IEC Liaisons

- TC 8, SC 8A, TC 64, TC 22, TC 120, TC 23, TC 82, TC 88, TC 114, TC 57, TC 95, TC 18, SC 77A, PC 118
- SYC Smart Energy, SEG 1, and SEG 4

Stakeholders external to IEC

- IEEE Power & Energy Society
- IEEE SA (2030, 1547)

Consortia / Regional / National organizations

- Emerge Alliance (USA)

4. IEC SEG6

- Meeting Plan

Meeting #	Dates Finalized	Format	Host (City)
1	June 22-24, 2015 (Done)	Lunch to next day	CEPRI (Beijing)
2	November 23-24, 2015	Lunch to next day	EDF (Paris)
3	March 8 to 10, 2016	afternoon to last day	2nd Africa Smart Grid Forum (Cairo) To be confirmed
4	October 2016	1.5 day from Moon	IEC General meeting (Frankfurt) To be confirmed
5	January 2017	1.5 day from Moon	To be confirmed

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