IMPLEMENTING THE STANDARDIZATION FRAMEWORK TO SUPPORT THE DEVELOPMENT OF NON-CONVENTIONAL DISTRIBUTION NETWORKS / MICROGRIDS

Raffael LA FAUCI
ewz – Switzerland
Raffael.lafauci@ewz.ch

Xavier YANG
EDF – France
xavier.yang@edf.fr

Wenyuan MA
CEPRI - China
mawenyuan@epri.sgcc.com.cn

Wenpeng LUAN
CEPRI – China
luanwenpeng@epri.sgcc.com.cn

ABSTRACT

Microgrids are evolving into an integral component of the power delivery system of the 21st century. The availability of standards will greatly simplify the implementation of microgrids and lower the cost of equipment, controllers and communication infrastructure. However, existing standards do not fully cover the specific needs of microgrids and therefore additional standards should be introduced. Based on the findings of IEC SEG6, the gaps in the existing standards are summarised in this paper and collaboration between various standardization groups has been established.

INTRODUCTION

Microgrids projects are conducted in various countries and have the potential to become an important part of electrical distribution systems. These newer understanding contrasts with the earlier, more limited view of microgrids as "islanded systems" of generation and load, valued mostly for their ability to disconnect from the grid to serve individual customer facilities during outages. Microgrids are now seen as part of distribution system operations, interacting with the distribution grid through advanced control and distribution management systems.

The standard management board (SMB) of IEC has decided in 2014, that the system evaluation group 6 (SEG 6) should be established with the mandate to address the following subjects: identification of the status of standardization concerning microgrids, the stakeholders involved in microgrids, current market assessment, identification of use cases and specific needs for microgrid technology and standardization gaps. Three working groups were established consisting of over 60 experts from various countries. The first working group made the situation assessment by conducting a worldwide online survey. The second working group has investigated challenges that various regions in the world are facing. This approach allowed it to define diverse business use cases. The third working group has identified existing standards and the gaps in standards.

This paper summarizes the outcomes of the SEG 6 report.

MARKET ANALYSIS

SEG 6 has started an online survey on microgrids in order to identify its stakeholders, evaluate the market status review the standardization status from the perspective of practical use.

Information of Participants of online survey

Figure 1 shows the participation by country and that all five continents had at least one participant.

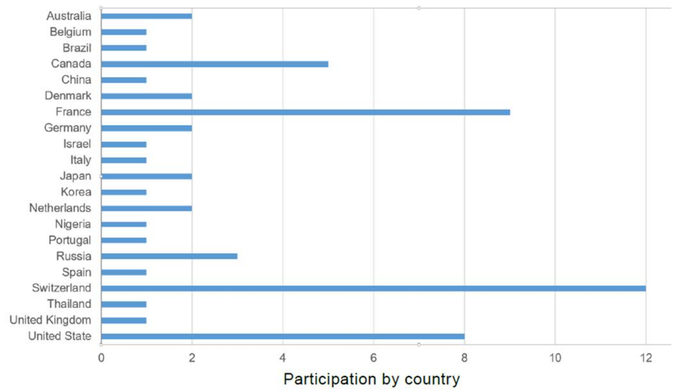

Figure 1 – Participation information of the survey

Figure 2 shows that the variety of the participants was large. The largest groups consist of engineering firms, utilities, standard organizations, equipment vendors, academia and government.

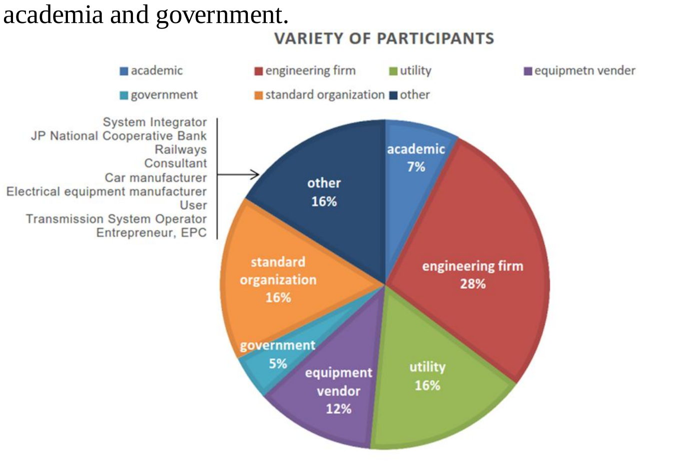

Figure 2 - Types of business of the survey participants

Outcome of online survey

Two important questions of the group was whether microgrid standardization is driven by market or another reason. Most participants believe that the microgird standardization is strongly market driven:

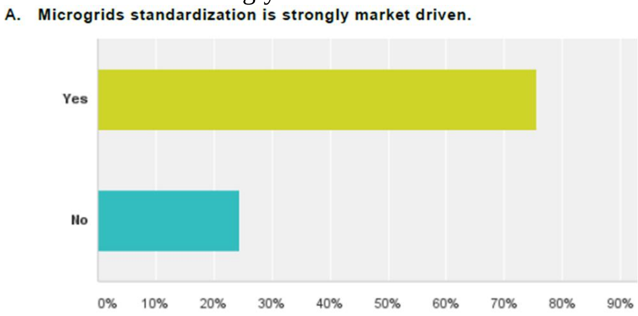

Figure 3 – General view of the microgrid projects implementation in countries (the data is provided based on personal knowledge from the participants)

Nearly 75% of the participants already have microgrids in their countries, and according to the participants, the market has great potentials. In the following, the scale and roadmap up to 2020 of the microgrid market in the participant's country are listed according to the participants. As no source for the information was requested, the information should be only indicative. 31 out 62 participants have answered the question.

China
At least 100 projects are under progress. China's National Energy Administration (NEA) has released the National Action for the construction of the distribution network (2015- 2020) in July 2015. The intention is to "build one or two microgrid demonstration projects in each province, that installed renewable energy generation should exceed 50% of the load demand".

Switzerland
According to the Swiss survey participants, the current scale of microgrids is 1,000,000 USD and the roadmap to 2020 10,000,000 USD.

Thailand
The Thai participants have indicated that currently 7,500,000 USD for the 1st upcoming project will be invested with the prospect that about 3 more projects may be added.

USA
In the US, apparently 20,000,000 USD to 10 Billion USD are currently invested. Until 2020, 4-5 times of the present level might be added.

India
According to the Indian representative, at the COP21 meeting held at Paris, India unveiled its plans to meet 40% of its installed electric power generation using renewable energy by the year 2030. The magnitude of measures the country undertook to meet those targets include its proposal to install renewable energy powered Micro and Mini Grids. The move allegedly installs a minimum of 10,000 renewable energy sources using microgrids and minigrids to achieve 500 MW yield in the next five years.

Israel
The Israeli participant has written that Israel has today in the country 300 local distribution networks that act as a microgrid but not controlled yet. In the other hand they are already regulated as a microgrid. They are connected to the grid in a single point.

After the pilots are running in the country the participant assumes that the government will allow to more entities to aggregate as a microgrid. He further assumes that this will give approximately 200 additional microgrids: campus, hospitals.

Germany
The German participants have written that over the past ten years, Germany's renewable energy sector has grown more than threefold and the country is now an undisputable leader in renewables in Europe and globally. The current energy mix sees renewables accounting for 50% of total capacity, with small scale PV at this time representing 15% and expected to further grow thanks to declining solar costs.

Conclusion
Many microgrid projects are currently reported to be conducted. The market is highly likely to expand and grow and there is a political desire to accelerate the development. As mentioned above, the results of the survey should be considered only as indicative, as no sources were provided.

Microgrids are deployed for much diversified reasons

The participants of the online survey have been asked about the motivation to build a microgrid. The replies have been:

- Power supply to remote area
- Utilization of renewable energy/managing DER
- Improve reliability, resilience, power quality and security
- Reduce transmission losses
- Encourage demand management
- Disaster recovery
- Improve distribution system
- Verification of new technologies
- Decreasing operations and maintenance costs
- High penetration RES resiliency

One of the key features that make microgrids stands out from the many new technologies is that it is not just suitable for a developed economy, but also for emerging economies. From the drivers listed above, it can be observed that microgrids have been considered as a solution to:

- reach clean energy goal
- power un-electrified population
- elevate grid performance and energy consumption

Thus, they have even greater potentials in future development.

Standardization of the field is in urgent need of improvement

The survey had also revealed that most participant believe that standardization of microgrids need improvement. Comments have been received which state the participants have not found direct microgrid standards yet.

D. Standardization of the field is in urgent need of improvement.

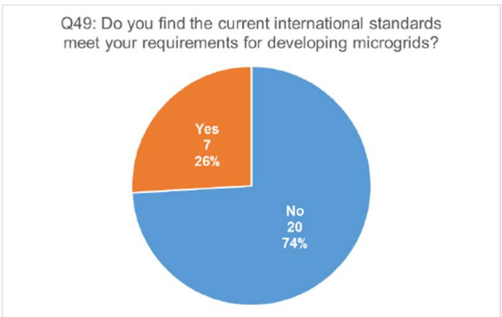

Figure 4 - Standardization satisfaction in the area

Market Outlook

As only few participants answered the question regarding the market outlook and hence a quantitative assessment of the market could not be provided. However, the obtained answer indicates a trend of fast and wide development in every country participating in the survey. Figure 5 shows that also external references expect an increase of microgrids [1].

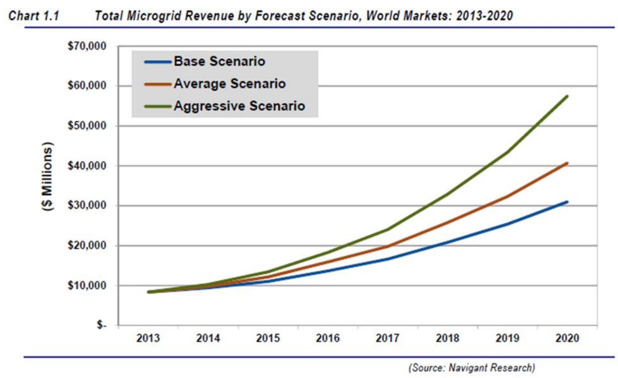

Figure 5 - Total microgrids revenue by forecast scenario, world markets: 2013-2020 [1]

USE CASES AND TYPICAL MODES

SEG 6 has identified six different business use cases (BUC) which are illustrated in figure 6:

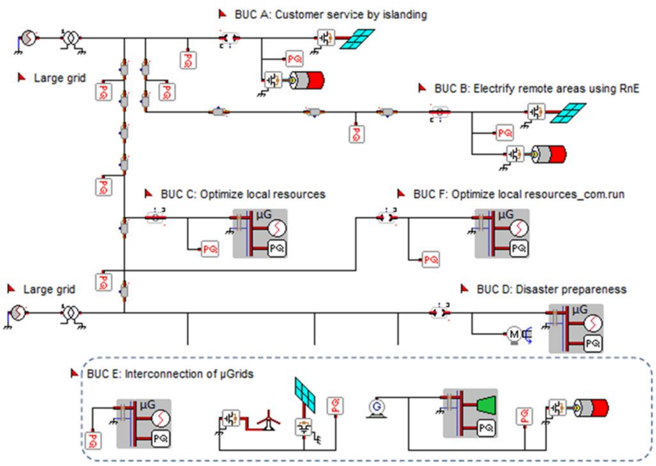

Figure 6 – Overview of the business use cases

In the following, all six use cases are summarized.

Use Case A: Microgrid -Guarantee a continuity in load service by islanding

This use case has the following objectives:

- Improve reliability of power supply of customers.
- Facilitate maintenance of network assets, by enabling downwards customers to stay supplied during an intervention.
- Maintain critical loads supplied during blackouts.
- Improve continuity of electricity supply for customers of the microgrid area.
- Reduce the outage time for customers of the microgrid area.

Three kinds of islanding start are possible:

- Preventive islanding if a supply interruption is planned (e.g. due to maintenance), or a grid outage is expected (e.g. storms that could damage overhead lines, damages by third parties, line congestion).
- Automated islanding in case of unplanned grid failure.
- Black Start recovery to re-supply loads after grid failure if the microgrid is technically not capable to automatically island without any outage.

Use Case B: Electrify remote areas using Renewable Energy Sources

Objectives of this use case are:

- Local electrification in developing areas, eventually before the construction of main distribution network

- Electricity supply in islands or areas where there is no possibility to have connection to main distribution network
- Electricity supply in islands or areas where there is main distribution network but its power reliability and power quality are very poor.

Figure 7 shows one actual application case of this kind of micrgrids built in China:

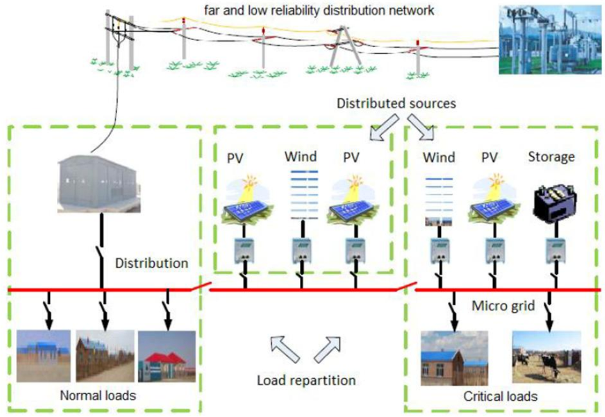

Figure 7 - Actual application case of this kind of microgrids built in China

Use Case C: Optimize local resources to provide services to customers inside the microgrid

This use case can be used to provide services to energy storage, dispatchable loads, reduction of the energy cost, the increase greenhouse gases emissions, etc.

The microgrid power regulation and energy management system shall be installed downstream of the meter and under the microgrid operator's responsibility as shown in figure 8.

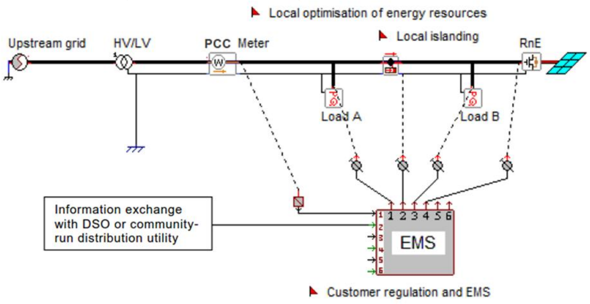

Figure 8 – Microgrid with a customer regulation and EMS

Use Case D: Optimize local resources to provide services to the grid/disaster preparedness

Community microgrids serve critical facilities such as hospitals, police, grocery stores, pharmacies, emergency shelters, police and fire stations, banks and community cell –phone charging centers, and community communication assets.

Use Case E: Develop larger energy systems by interconnection of isolated microgrids

This use case concerns a type of non-conventional electric power grid in which the development of larger energy systems is accomplished by interconnection of isolated microgrids or distributed energy resources.

Use Case F: Optimize energy supply cost and exploitation of local assets inside community-run distribution utility by managing local resources

The first objective is to locally decide capital and operating expenses for the maintenance and the operation of the managed/ owned network infrastructure. As a result, network use tariffs for the community members are also locally defined. The second objective is to locally decide the energy resources mix promoting the use of local assets accounting for the technical, economic and environmental impact of various energy production and transportation techniques.

STANDARDS GAP ANALYSIS

Micrgrids are not as simple as a mini traditional power grid. Key features distinguishing microgrids from traditional power distribution systems include:

- Powered by distributed generation sources including renewable with intermittent and random characteristics, and CHP generators
- Active interaction with end user
- The introduction of dynamic load control systems

Standards that match the unique characteristics of the microgrid are required to allow microgrids to play a larger role in the distribution grid operation and contribute to the electricity access in the remote rural and a geographic island, including coordinated and consistent electrical interconnection standards, communication standards, and guidelines, etc.

CONCLUSIONS AND OUTLOOK

The availability of standards will greatly simplify the implementation of microgrids and lower the cost of equipment, controllers and communication infrastructure. Microgrids are not as simple as a mini traditional power grid. Standards that match the unique characteristics of the microgrid are required. A collaboration between IEC, CIRED and CIGRE is recommended.

REFERENCES

[1] P.Asmus, A.Lauderbaugh, M. Lawrence, 2013, "Forecasts for Commercial/Industrial, Community/Utility, Campus/Institutional, Military, and Remote Microgrids:2013-2020", *http://www.navigantresearch.com/wp-content/uploads/2013/03/MD-MICRO-13-Executive-Summary.pdf [last accessed 16 3 2018]*