IElectrix project – SHAKTI demonstration

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Abstract

Indian and European Local Energy CommuniTies for Renewable Integration and the Energy Transition thereby referred to as ***IElectrix*** *is a project answering a European Horizon 2020 call about "Integrated Energy Systems - Energy Islands". The objective is to develop innovative technical solutions and economical business models to facilitate the implementation of Citizen Energy Communities (CEC).*

IElectrix falls within the European Clean Energy Package ambition in significantly increasing the role of the consumers by a user-centric approach, notably through the CEC. This is also a way to speed up the integration of Renewable Energy Sources in Smart Grids and to take part in the decarbonisation of the energy system. In this context, Distribution System Operators (DSO) need to ensure an appropriate connection of CEC within the grid.

The IElectrix project brings together 15 European partners (DSO, Research Centres, Universities, Consulting firms, Suppliers, a SME, and an Energy agency), and one Indian partner (DSO). Through 5 demonstrators in Europe and India, it will experiment, the technical and economical relevance as well as the replicability of the implemented solutions in medium and low voltage networks.

The 5 demonstration sites are based on different regulatory and ecosystem contexts: one is located in India, two in Hungary, one in Germany and one in Austria.

The project started officially on 1st May 2019 and should be completed by 30th October 2022.

This paper presents an overview of the main purposes and challenges of the project, as well as, a technical presentation of the demonstration pilots, with a particular focus on the demonstrator that will be implemented in Delhi.

Keywords

Energy storage, Smart grids, Renewable energy, Grid digitalization, Citizen Energy Communities, microgrids

I. INTRODUCTION

The IElectrix project gathers Indian and European partners towards the achievement of a common technical and economical goal. It consists in implementing different Smart Grids demonstrators to test a set of functionalities required to keep up with the current energy sector transformation (renewable intermittent energies, digitization, decentralization, and consumer's implication).

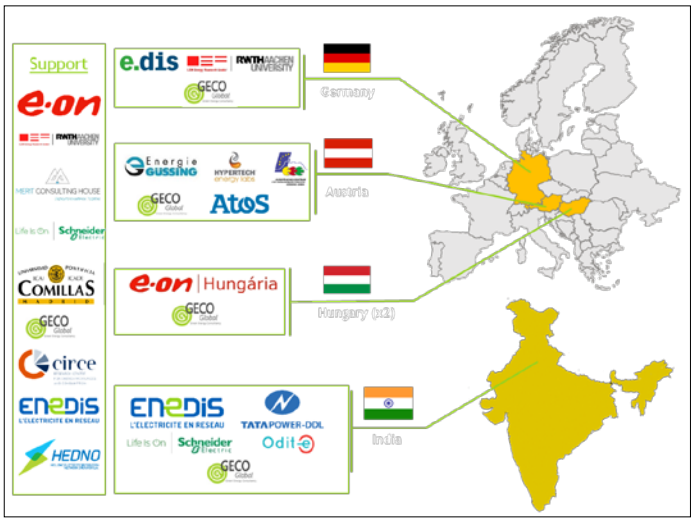

Fig. 1. IElectrix demonstration map

To reach such goals, IElectrix project brings forward innovative technical solutions:

- Mobile storage systems and digital substations
- Implementation of demand-side management schemes
- Microgrid and islanding solutions
- Low voltage grid digitalization

The 5 demonstration pilots are based on different regulatory and ecosystem contexts: one is located in India, two in Hungary, one in Germany and one in Austria:

- The Indian demonstration pilot anticipates the large amount of photovoltaic panels (PV) which will be connected at the low voltage level in the coming years following recent governmental plans.
- The Hungarian demonstration pilots address issues that are located at an early stage of renewable deployment in two distinct regions.
- The German demonstration pilot is carried out in a region with a high amount of Renewable Energy Sources (RES) already integrated in the grid. Within the demonstration, a mobile storage system

is used in order to both postpone costly network reinforcements and integrate more RES in a faster way.

- The Austrian demonstration pilot involves an existing energy community in the Güssing District where RES investments have already been made.

The energy transition has an impact not only on the energy sources and on the utility sector but also on the roles of the different stakeholders. For instance, it makes making the end-prosumer a key decision maker in the process. And this is why it is important to integrate the demand response management mechanisms within the experimentation scope. This is an essential element for the achievement of the project's objectives.

The aim of this document is to give the reader the main insights to understand the objectives and the challenges of the project.

It presents the use case methodology used for defining the functional requirements of each demonstrator, followed by a technical presentation of the real-scale pilot that will be implemented in Delhi and finally the conclusions.

II. The Use Case Methodology

The partners of the IElectrix Project have jointly decided to implement the standardized use case methodology [1] to define the requirements and the functional specifications of each demonstration pilot. The use case methodology was firstly developed for software and systems engineering in the 1990's. It has extensively been used within the power supply industry for Smart Grid standardisation purposes by International and European Standardisation Organisations and Smart Grid projects, such as IEC and the CEN-CENELEC-ETSI Smart Grid Coordination Group. The architectures of the demonstrations and the use cases are collected simultaneously and mapped using the Smart Grid Architecture Model (SGAM) [2] layer representation.

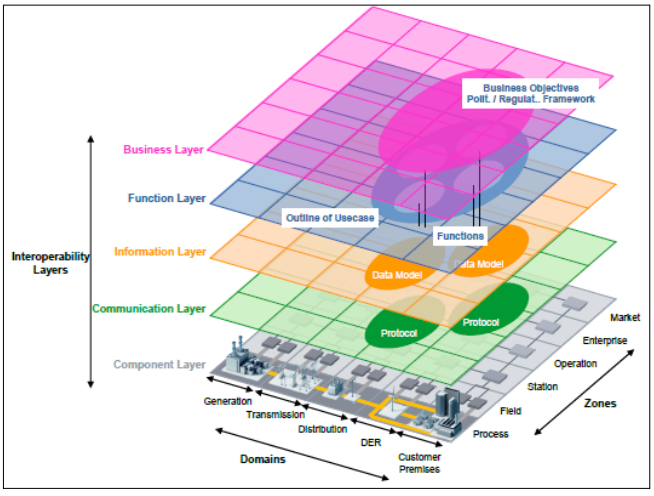

Fig. 2. SGAM framework

This method is used to develop a unique and consistent framework representing the demonstration functional requirements, the communication and the data model standards among all the demonstrations.

III. The Indian Demonstration SHAKTI

In India, the power sector sustenance is majorly dependent on the cash flow coming from its distribution sector. Nevertheless, this is the weakest link of the power sector and it faces major challenges such as the increase in the power purchase cost, high Aggregate Technical & Commercial (AT&C) losses, lack of cost reflective tariffs and the recent being energy transition. Due to the intermittent nature of the renewables and the variability of charging electric vehicles, this latest requires real-time demand supply management and network flexibility.

The Indian SHAKTI demonstration, located in Delhi, will demonstrate various Smart Grid Technologies including microgrid solutions, RTU, smart transformer and grid digitization techniques to experiment three technical use cases on the LV grid with prosumer support:

1) Forecasting/scheduling Distributed Energy Resources

   The scope is to balance and optimize the electricity supply (rooftop PV units and Battery Energy Storage System) and loads by managing power flows and Volt VAR control through a smart transformer considering the state estimation provided by the LV grid digitization system.

2) Customized, human-centric prosumer participation in Demand Response (DR) programs

   The scope is the participation of local final customers in innovative DR models involving the demo infrastructure and smart meters.

   Tata Power Delhi Distribution Limited (Tata Power-DDL), the Indian DSO, will use the flexibility of the system for the Availability Based Tariff mechanism applicable in India for unscheduled electric power transactions. The demonstration will focus on benefits for both DSO and final customers.

3) Ensured energy system resilience

   The objective is to ensure the resilience of the microgrid. It is done through three levels:

   - An islanding capability in case of outage on the upstream grid.
   - A condition monitoring technique in the MV/LV substation through an indication of early failure conditions that may occur.
   - A deeper knowledge of the condition under which the LV grid operates through four digital services performed by the LV grid digitization system: the grid identification, the impact prediction tool, the state estimation and the non-metered energy estimation.

The architecture of the system is represented below according to the SGAM mapping.

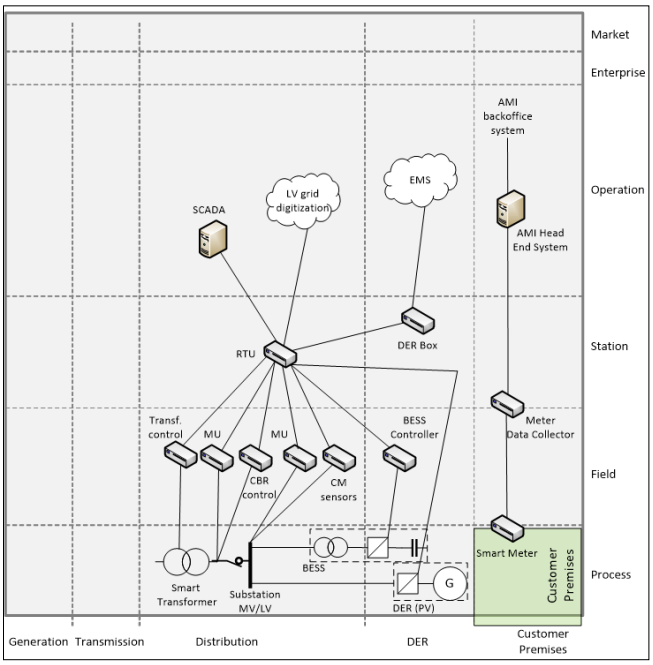

Fig. 3. SHAKTI demonstration system architecture

IV. Conclusion

This paper presents how the IElectrix project intends to address the actual challenges of energy transition in India and Europe by using a proven methodical approach and a set of innovative solutions that respond to the specific geographical, social and economic needs of each country concerned. The further step of the project will consist in the technical on-site implementations and the beginning of experimentations. The results obtained are expected not only to create new business models but also enrich the panel of solutions available to enable the establishment of India and Europe as leaders in the new energy era.

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This paper reflects only the authors' view and the Agency and the Commission are not responsible for any use that may be made of the information it contains.

References

[1] IEC 62559-2:2015 International Standard - Use case methodology - Part 2: Definition of the templates for use cases, actor list and requirements list.

[2] CEN-CENELEC-ETSI Smart Grid Coordination Group - Smart Grid Reference Architecture Technical Report, 2012.