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TUTORIAL N°2

Renewable Energy Communities: What? Why? How?

Background

Renewable Energy Communities consist of organized entities of consumers and prosumers of electricity **established on the public electricity distribution network**. Local exchanges of renewable electricity can occur using private or community-owned assets without necessarily resorting to the wholesale/retail market structure.
This emerging local market design has been promoted by the EU Commission in its Directive 2018/2001 and is expected to:

- **allow citizens to play an active and central role in the electricity supply chain**: by collectively owning the energy assets (renewable generation, storage), by expressing their preferences (economic, environmental, social preferences) for sourcing electricity, etc.
- **create a local stable economic framework, less subject to wholesale price spikes**, which stimulates investment in local renewable generation and storage assets
- **unlock Low Voltage/Medium Voltage flexibility provision** (e.g., by implementing demand-side management schemes coordinated at the community level) to help the other system actors to ensure the balance and the safe operation of the electricity system (Balance Responsible Parties or BRPs, Flexibility Service Providers or FSPs, Distribution System Operators or DSOs, Transmission System Operators or TSOs, etc.)

The EU member states are currently transposing that directive into national/regional decrees/legal frameworks so that more and more projects of communities are presently deploying throughout Europe.

Aim of the tutorial

This tutorial comprehensively reviews the current state-of-the-art on Renewable Energy Communities. It is motivated by the diversity of points of view, definitions, and hypotheses adopted by academic and industrial professionals, mainly associated with the uncertainties in terms of legislation and regulation, which are still well present.

The tutorial will be presented by a team of speakers from academia, as well as from the public (DSO) and commercial sectors.

Content

The tutorial is divided into three parts.

1. **Renewable Energy Communities: definitions, tools, and research challenges**
    - **General definitions**: Renewable Energy Communities VS Citizen Energy Communities, key assets in Energy Communities, actors of Energy Communities
    - **Internal Market designs**. Different internal rules to exchange energy within communities can be applied based on cooperative sharing mechanisms or competitive local markets (centralized or decentralized such as peer-to-peer). This section will review the most prominent internal market designs and their advantages and drawbacks.
    - **Relation with external entities**: commercial actors (Balance Responsible Parties or BRPs, Flexibility Service Providers or FSPs), regulated actors (network system operators, with a focus on distribution)
    - **Tools and methods for managing energy communities**. The available tools and methods to manage energy exchanges within communities will be reviewed here. These approaches will be categorized according to the target time horizon:
        i. **Investment and sizing in energy assets** (from month-ahead to year-ahead): What is the optimal sizing of (individually or jointly owned) energy assets to add to the community?
        ii. **Operational management of communities**: from day-ahead (how should the energy resources be dispatched in an energy community to fulfill the community objectives, which may be economical, environmental, or social?) to real-time settlement (how should we charge community members based on actual realizations?)
    - **Research challenges and emerging trends**. Many research challenges are still to address and will be discussed in this tutorial: inclusion of other energy vectors (e.g., heat and cold), modeling of uncertainty (about renewables but also demand behavior), heterogeneous preferences (e.g., environmental, economic, or social) and bounded-rationality behaviors of community members, regulatory challenges, the impact of RECs on distribution grids (see also 2), etc.

2. **The DSO vision.** This section will detail the roles of a DSO in a context where more and more RECs established on the public grid are expected to emerge. Firstly, the DSO will be considered as a facilitator for the operational management of the contractual power/energy flows between parties (distribution keys) and for the establishment of communities. In this part, the effect on the retail market will be discussed (hedging risk), and a focus on the social role of communities for low-income consumers will be given. Secondly, the potential effect of the communities on physical power flows and their possible impacts on the DSO investment plan will be discussed. Then, the benefits and drawbacks of the expected massive roll-out of communities on the DSO financial balance will be shared. Finally, reflections on the dynamic evolution of a community through its lifetime (tariff changes which may lead to rebound effects, changes in the REC composition, etc.), will be stressed.

3. **Example of pilot projects and use cases**. In this last part, lessons learned and key findings about pilot projects and use cases will be shared.
    - a professional with extensive experience as a community manager in Belgium (more particularly in Brussels and Wallonia) will share lessons learned and key findings from selected use cases.

- New ideas about a tariff structure including congestion risk will be discussed by the DSO, and illustrated on some use-cases, which cover: industrial communities, social communities, inclusion of storage in communities as well as communities with a larger mix of energy e.g. biomethane and heat communities. The importance of real time communication and how to realize it will be shown.

Expected benefits

At the end of the tutorial, participants will have acquired a structured vision of the growing Energy Communities sector, in terms of the mechanisms and regulations envisioned for managing and establishing communities, with their pros and cons, but also in terms of research questions that remain still open. Participants will also obtain a basic knowledge of the methods and tools necessary to efficiently manage a community technically (e.g., optimization, data analytics, etc.). They will be advised on further readings to deepen their knowledge.

Who should attend

The tutorial is suited for

- new researchers/students in the field of energy communities, as well as experienced researchers aiming to structure and enlarge their knowledge
- community managers, system operators (distribution, transmission)
- anyone interested in joining/forming an energy community in a near-future

Support material

A copy of all the presentation material used in the tutorial will be supplied to delegates (electronic version).

About the presenters

Zacharie De Grève (University of Mons, Electrical Power Engineering Unit, Power Systems and Markets Research Group)

Zacharie De Grève (M'12) received the Electrical and Electronics Engineering degree from the Faculty of Engineering, University of Mons, Mons, Belgium, in 2007. He was a Research Fellow of the Belgian Fund for Research (F.R.S/FNRS) until 2012, when he got the Ph.D. degree in electrical engineering from the University of Mons, where he is currently an Associate Professor with the Electrical Power Engineering Unit. He is the general coordinator of the Erasmus Mundus Joint Master Degree in Smart Cities and Communities (SMACCs, www.smaccs.eu). His main research interests concern the application of Machine Learning and Operations Research to electric power systems and energy systems, and focus on energy economics. He also develops an expertise in computational electromagnetics.

Bertrand Cornélusse (University of Liège, Montefiore Institute, Microgrids and local energy communities group)

Bertrand Cornélusse received an M.S. in electrical engineering and Ph.D. in engineering sciences from the University of Liège, Belgium, in 2006 and 2010, respectively. His interests lie in applying optimization and machine learning to energy management applications, such as microgrids, distribution systems, and electricity markets. He is now an associate professor in the Electrical engineering and Computer Science department of the University of Liège. Before this, he led the development of the European day-ahead market coupling algorithm Euphemia together with European exchanges and contributed to several European research projects and research projects funded by the Walloon region of Belgium, such as the GREDOR project that studied the application of optimization and machine learning techniques to improve the planning and operation of electrical distribution systems.

Simone Paoletti (University of Siena, Department of Information Engineering and Mathematics, Smart Grids Research Group)

Simone Paoletti received the Laurea degree in Information Engineering (cum laude) from the University of Rome Tor Vergata, Italy, in 2000, and the Ph.D. degree in Information Engineering from the University of Siena, Italy, in 2004. Since March 2021, he holds an Associate Professor position at the Department of Information Engineering and Mathematics of the University of Siena. His current research interests include identification and stability analysis of piecewise affine and switched systems, and forecasting, control, and optimization techniques for smart grid management. From 2008 to 2013 he participated in the EU project "ADDRESS: Active distribution network with full integration of demand and distributed energy resources," having the role of responsible for Task 3.5 "New operational planning applications for the MV control center." From 2011 to 2014 he led the activities of a research contract with Siemens S.p.A. on the development of algorithms for renewable power generation forecasting in medium and low voltage grids. He is currently involved

in several renewable energy community projects in Siena and its surroundings, where his group contributes with mathematical models for optimal planning and operation.

David Vangulick (ORES, innovation strategy and long term planification – PHD candidate University of Liege)

Engineer within ORES (one of the main distribution company in Belgium (http://www.ores.be)) since 2011 but 15 years 'experience in energy distribution (Engie Group).
He is in charge of the service "Prospective Network and Market" . This function mainly covers planning of electricity grids (MV) including gas (MP), long term investment plan and innovation.
This also involves the analysis of the major trends of the energy needs and their impacts on the distribution network. Besides his duties in ORES, he is currently pursuing a PHD thesis on deployment peer to peer energy exchange using the Blockchain technology (in University of Liege (ULiège) (http://www.uliege.be).

François Bordes (WeSmart, CEO)

Accomplished entrepreneur and independent director, with a strong expertise in managing teams for delivering solutions in various sectors and industries.
François has many years of experience in management (in sectors going from energy consulting to big data and data science), and has built a deep knowledge through its involvement in numerous companies, as well as strong leadership abilities.
François has created in 2016 the company WeSmart, where he is currently CEO. WeSmart started its activities in the field of monitoring energy data, and develops an expertise since 2018 in the management of Renewable Energy Communities.
