# 6 Publishable Summary

## Objectives

Electrical network is at the core of the energy transition. The existing network and its current configuration are unable to efficiently support tomorrow's challenges: the renewable energy sources integration and the increase of the demand with new loads, such as electrical vehicles, to quote two of them. It requires flexibility, robustness, and adaptability: these qualities can be achieved with the development of MicroGrids, the new paradigm of electrical distribution structures. MicroGrids assume a cluster of loads and micro sources operating as a single controllable system that provides power to its local area. Today, they are deployed with the same logical architecture of the main electrical grid.

DC-µG aims to highly increase MicroGrid's energetic and economic efficiency taking into account two fundamental key factors: the direct current (DC) and the Cyber-Physical System (CPS). Indeed, a DC MicroGrid will allow for a better integration of essential elements in the distribution network which are intrinsically available in DC: renewable energy sources, storage systems and modern loads. This first element will improve efficiency, reliability and higher power quality. Then, the consideration of a DC MicroGrid as a CPS, i.e. an electrical system which tightly interacts with the physical system and its environment, brings flexibility, adaptability and capability to perform autonomous operations. CPS's ability to connect and interoperate within the MicroGrid thanks to communication protocols allows it to coordinate and optimize high-level functionalities while increasing its efficiency.

This project will focus on the development of a DC MicroGrid as a Cyber-Physical System since the design phase, combining dedicated mixed hardware and software developments in an integrated Smart Systems framework. Such aspects have been disregarded or underestimated and only marginally exploited until now, only using from-the-shelf results that are overlapped. The results are badly understood interactions and disturbances since systems grow in complexity, making impossible to assure any property of stability and performance in realistic situations of strong intermittency intrinsic to renewable energy sources (renewables) and plug-and-play loads as electric vehicles. Focus on crucial aspects as management and control aspects of such networks, smart power devices, dedicated telecommunication hardware and ad hoc data infrastructure will be put. The result will be a whole structure from low level controllers to high level management strategies that include telecommunication with a distributed and optimized system. The proposed grid must allow similar reliability and performance from today's distribution grid, but for a new environment composed of large shares of renewables and electric vehicles.

Our main target in the projects is to develop a Direct Current MicroGrid as a Cyber-Physical System, allowing for:

- a maximization of the energy efficiency, by creating a new generation of DC/DC converters, dedicated hierarchical control strategy and development of new monitoring technologies;
- a validation of safety and security, by providing conditions that increase the resilience of the grid and proposing different security methodologies and algorithm;
- an optimization of the economic value of the MicroGrid, by developing mechanism for ensuring economic competitiveness by reducing investment and operational costs, by identifying new business and market opportunities for the MicroGrids, providing suggestions for reducing the highly important infrastructure investment and validating methodologies for optimizing MicroGrid's performance, aging and maintenance.

## Description of the work

DC-µG project will design, develop, implement and evaluate DC MicroGrid architectures, providing energetic and financial efficiency. It includes a precise study of the optimal methodologies, processes and technologies that are needed for the implementation of the cyber-system work packages (WP2 and WP3) and the physical system one (WP4). The major difficulty is the interconnection among the WPs. They must take into account every requirement of technology characteristics, communication protocols, information security, digital infrastructure, data management and grid safety. Then, the WP5 will experiment, in real conditions,

the MicroGrid architecture. The task is to check the respect of all previous requirements and the achievement of the targets: energetic and economic efficiency for a reliable grid in the presence of large share of renewables and DC loads. Once the validation is achieved, a guideline composed by the optimal concepts, topology, architecture and models for the MicroGrid will be defined. It will propose the needed standards in order to deploy at the European scale this new electrical distribution network.

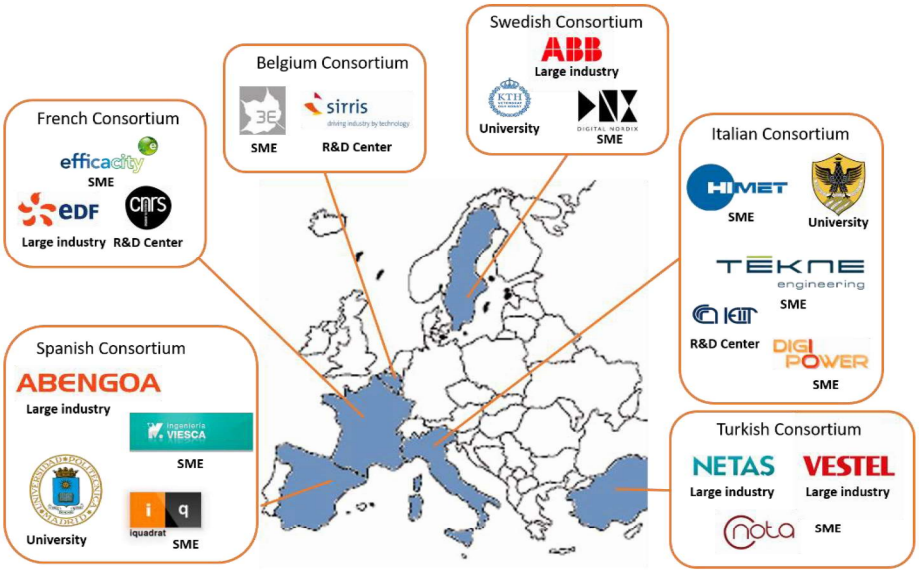
**Expected results**

The most ambitious expected result of the project is the deployment of the DC MicroGrid according to the CPS paradigm, with the purpose to guide energy transition across Europe. Several test-beds will be used to validate models, algorithms, devices, methodologies and requirements. Once the optimal MicroGrid control architecture will be defined, it will be implemented on a real case study provided by the consortium and will lead to a guideline proposal. This document will recommend a MicroGrid framework and the needed associated standards.

**Potential impact**

The deployment of DC MicroGrids as a CPS will create a new value chain. It impacts industry, with the designing and adaptation of DC equipment and grids, their sizing, and physical implementation modalities, including IT players addressing the cyber-system integration and security. End users are then Distribution System Operators, who will manage differently intermittent grids with an optimized and predictive control system. This new electrical architecture will reduce the stress inflicted to the main grid while allowing the integration of large shares of renewables and improving energy efficiency. The development of the DC MicroGrid as a CPS will then increase the progress of the European energy transition, which has fossil fuel utilization reduction and climate changes mitigation as core targets.

## Consortium




DC-µG
Direct Current MicroGrid