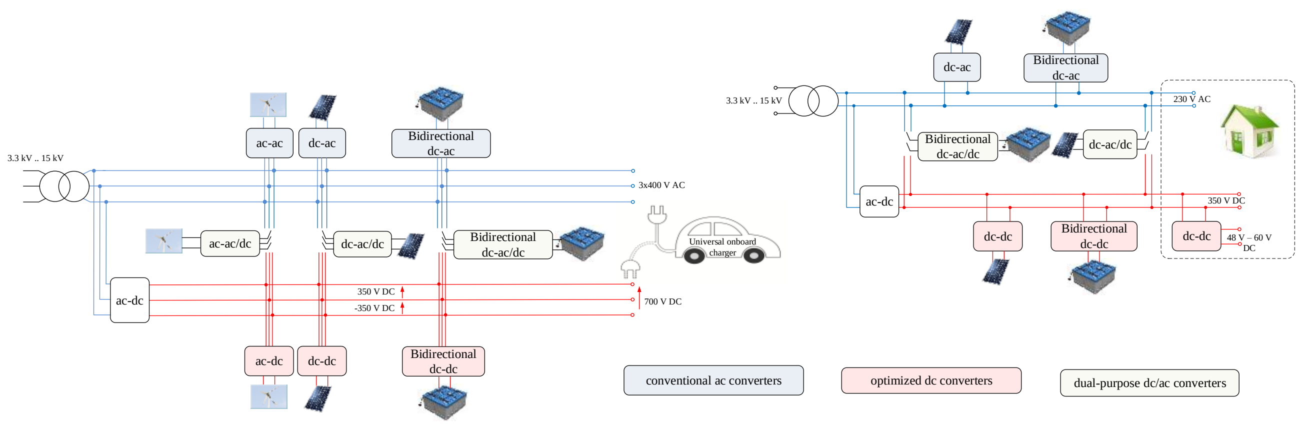
NEW HIGH POWER DENSITY POWER ELECTRONICS SUBSYSTEMS AS THE FUNDAMENTAL FOR FUTURE HYBRID MICROGRIDS

The current ac grid infrastructure is not very compatible to renewable energy integration due to its inherent unpredictable generation capability and its inertia-less nature. The Low Voltage dc (LVdc) is naturally applicable in a scenario with a high penetration level of renewable energy systems, battery-based energy storage systems, home appliances, and electric vehicles. It may lead to reduced power electronics stages, higher efficiency and resilience, cost reduction in energy distribution, space and weight savings, with a flexible placement of electrical equipment. Furthermore, this modern system will no longer operate at a specific frequency, facilitating its control and definition of standards. The **LVdc grid can solve problems with a further increase in renewable energy generation, vehicle electrification and reduction of environmental pollution**. Despite on well awareness of the LVdc there are several main problems towards this concept realization that consist of **non-mature level of power electronics** and**"chicken and egg problem"** where there is no evident business model for investors because they do not see real dc appliances.



Vision of the future low-voltage distribution system with dc and ac grids coexisting (*O. Husev, et al, " Dual-Purpose Converters for DC or AC Grid as Energy Transition Solution," IEEE Industrial Electronics*

In this context, **the goal** of this project is **to speed up the energy transition** by developing and promoting the breakthrough of the advanced high power density power electronics converters that can be considered as a fundamental for future hybrid microgrids. The goal is going to be achieved based on several hypotheses.

T**he concept of dual-purpose (or universal) converters** that are proposed to solve "chicken and egg problem" consists of using the same internal terminals to connect the ac or dc grid or a load. These devices provide installing the renewable energy generation facilities (or storage batteries) to the ac grid and reconnecting to the dc grid when the time comes without power electronics upgrading. Also **new circuits along with new approaches** in design based on **artificial intelligence** will help to achieve high power density and mature level of power electronics converters. Particular attention will be paid to the exclusion of the presence and contribution of its losses at high frequencies of magnetic elements.

Among new approaches, capacitively isolated solutions can be a superior replacement of traditionally transformer based isolated solutions. Also, isolated solutions with resonance circuit with primary and secondary compensation capacitors are proposed which along with WBG transistor utilization allow to realize very high switching frequency which in turn means very low inductance that can be realized without ferrite core. Control approach is an integral component of the proposed solution where the cycle skipping approach is considered the most suitable for this case. All these solutions along with some novel based on switched and flying capacitors with minimized inductors will approach the concept of **on-chip power converter design**.

Apart from PI, 2 Postdoctoral researchers and 2 Ph.D. students will be involved. The work will be distributed in 5 work packages. The primary research outcome will be delivered in at least 4 journal papers (Q1) on average annually. At least 3 patent applications, including 1 European, are expected under the project.