



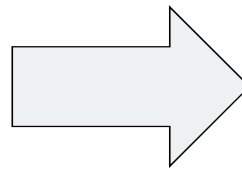
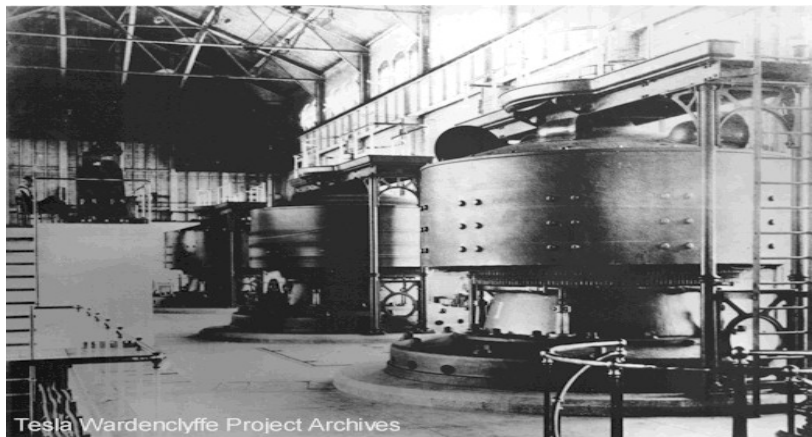
FUTURE GRIDS:

fast, safe, sustainable

RESERVE: THE CONTEXT



- The European Commission and the Member States are setting ambitious goals in terms of use of renewable energy sources (32% by 2030)
- As result, many Renewable Energy Sources driven by power electronics have been and will be installed in the grid
- This change is affecting the fundamentals of grid operation and it is the necessary to rethink the basics of control and automation

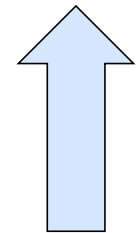
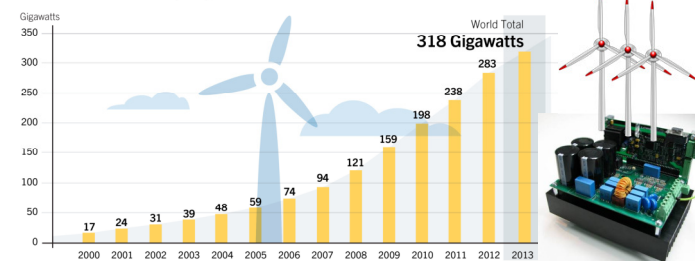


RESERVE: THE CONTEXT

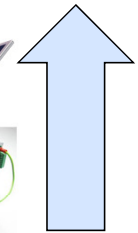
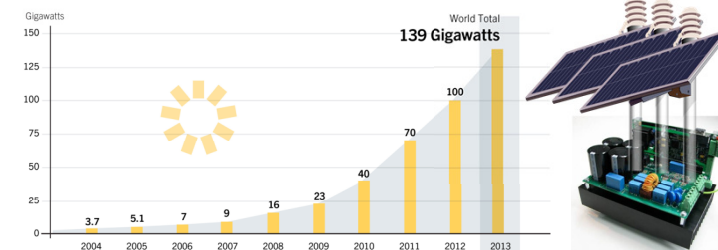


- Because the majority of the new Energy Sources are connected to the Distribution Grid, as also underlined by the Winter Package, the relation between DSO and TSO is going to change
- RESERVE focuses on the role of Distribution Grid and power electronic-driven sources inserted in this section of the network (in parallel the project MIGRATE is focusing on the Transmission level)

Wind Power Total World Capacity, 2000–2013



Solar PV Total Global Capacity, 2004–2013



Renewables 2014 Global Status Report

RISING QUESTIONS

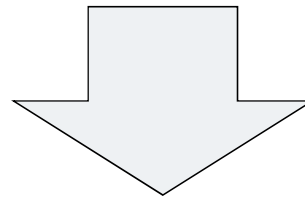


- How are we going to substitute the role of Synchronous Machines in future Power Systems?
 - How can power electronics play a new role and actually make the grid even better than before?
 - What is a good system level approach for future power systems?
 - Which role will Communication Infrastructures play?
 - How should we change operational logic to adapt to the new characteristics of the grid?
-

EU CALL AND RESERVE VISION

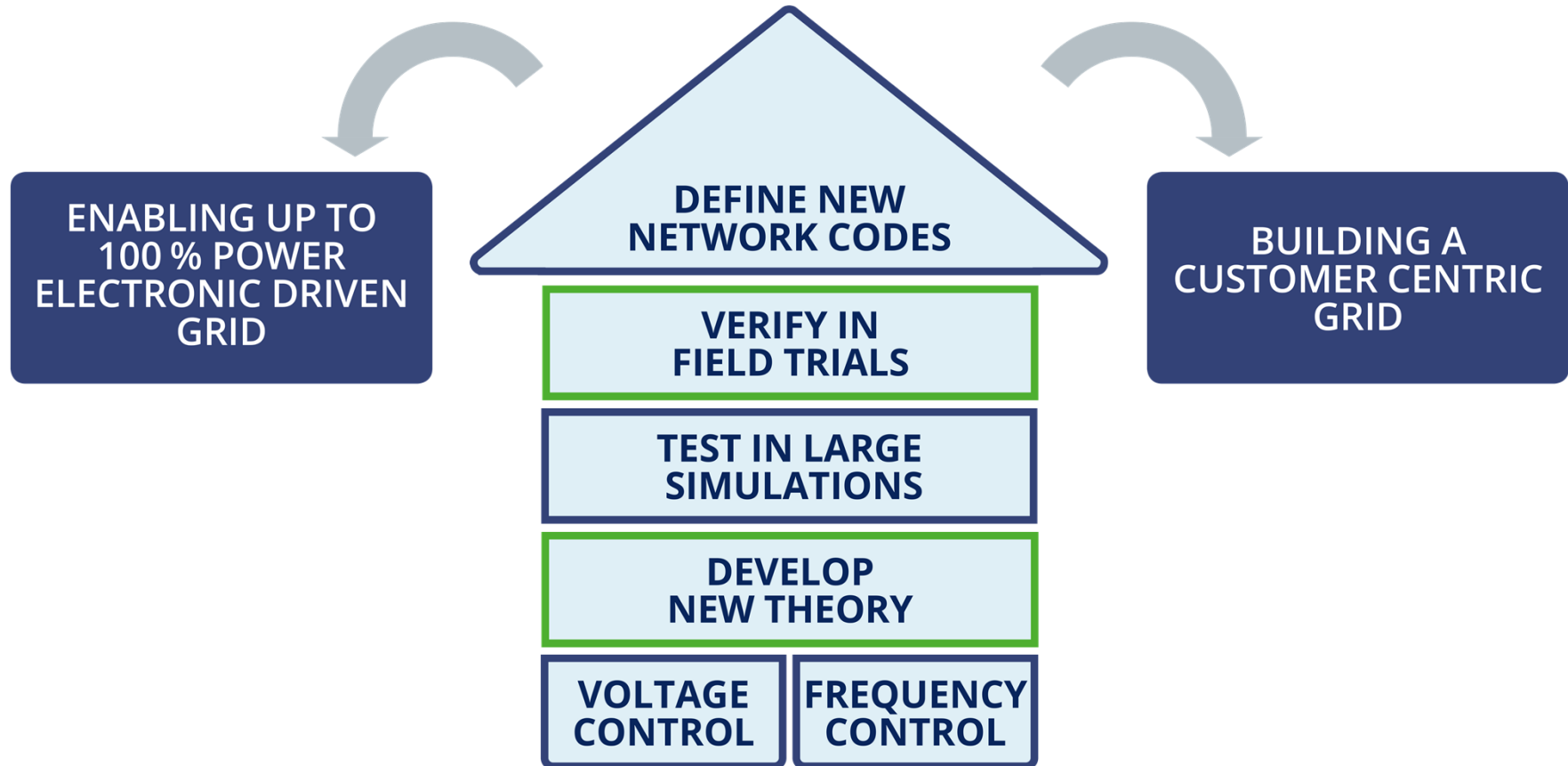


H2020 LCE-07: In a future European energy scenario with very high shares of renewables (up to 100%) in the energy mix, system support functions that are provided today by synchronous generation will need to be provided by renewable generation or procured from third parties



RESERVE Strategic Objective: To enable up to 100% penetration of renewable by developing innovative approaches to **system level automation** based on an innovative **ancillary service provision** to a close to market level of maturity, supporting them with validation of the concepts and policies using a **pan-European real time simulation Infrastructure** and **anchoring the approach** with the main sectors in Europe and beyond.

PROJECT OVERVIEW DIAGRAM



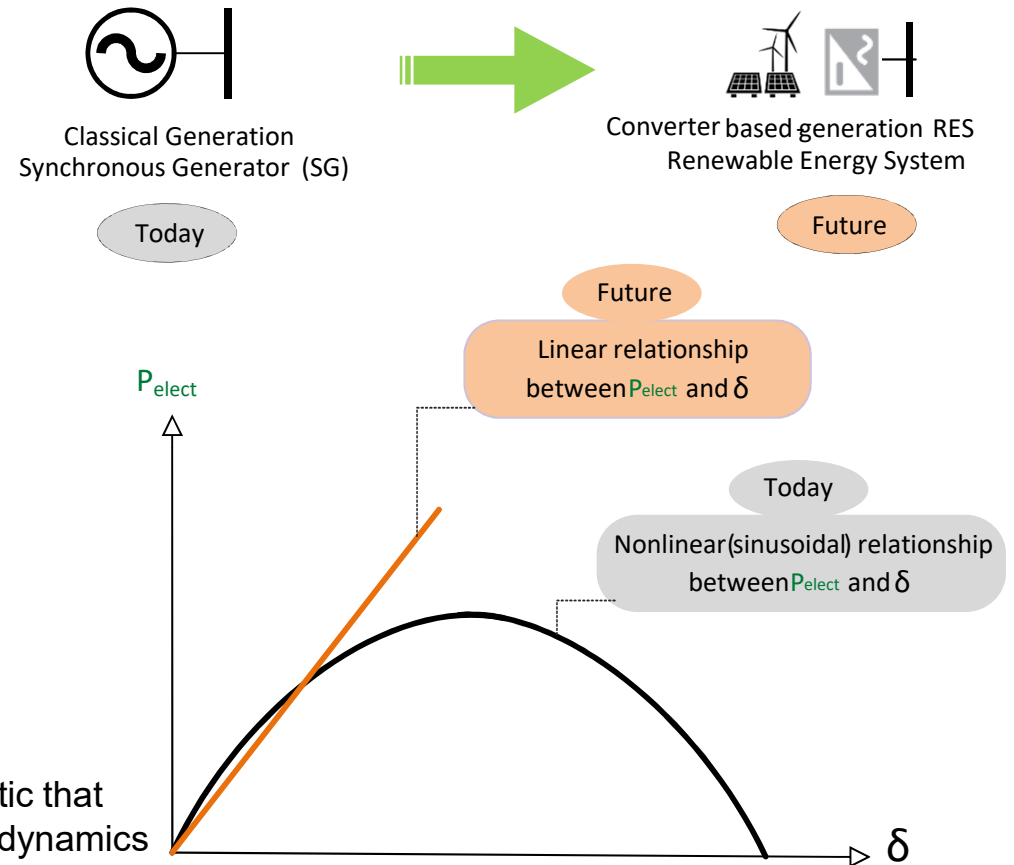
RESERVE: A NEW POWER SYSTEM THEORY



FREQUENCY STABILITY



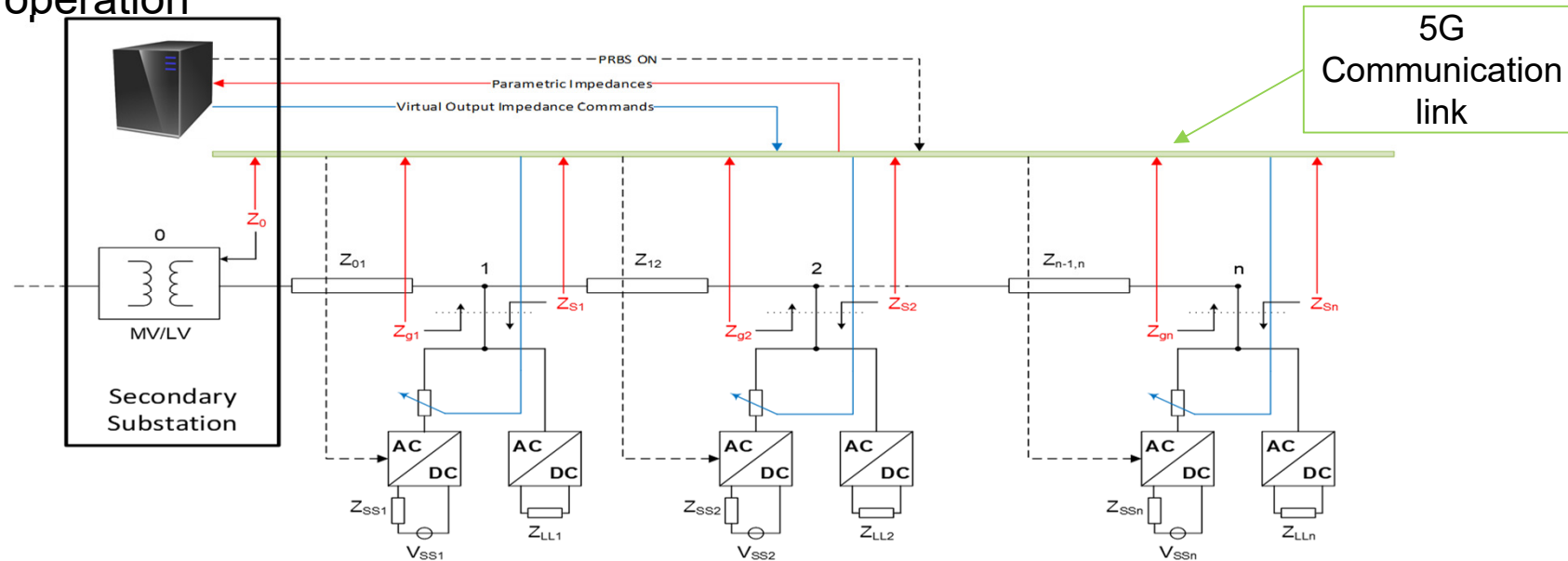
- Reconsider the concept of frequency and its measurement process
- Define the correct architecture of coordination of all the energy sources (centralized vs distributed)
- Redefine the behavior of the power converter to avoid unstable behavior and frequency oscillation (Linear Swing Dynamics)



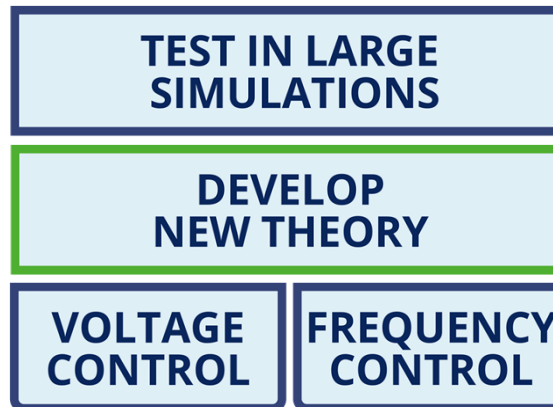
VOLTAGE STABILITY



- Review impedance concept to span over a large frequency region
- Control shapes the impedances and not only passive components
- On-line estimation of the frequency response as a key tool to ensure stability of operation



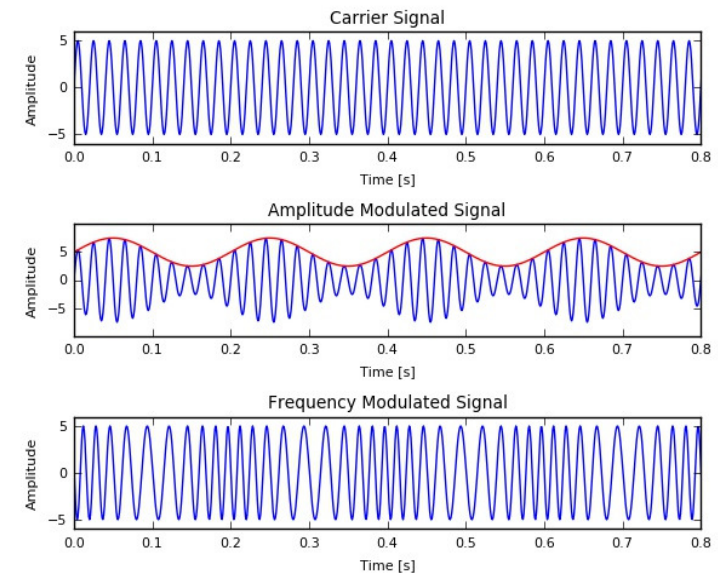
RESERVE: ENABLING LARGE TESTING



A NEW CONCEPT OF TESTING



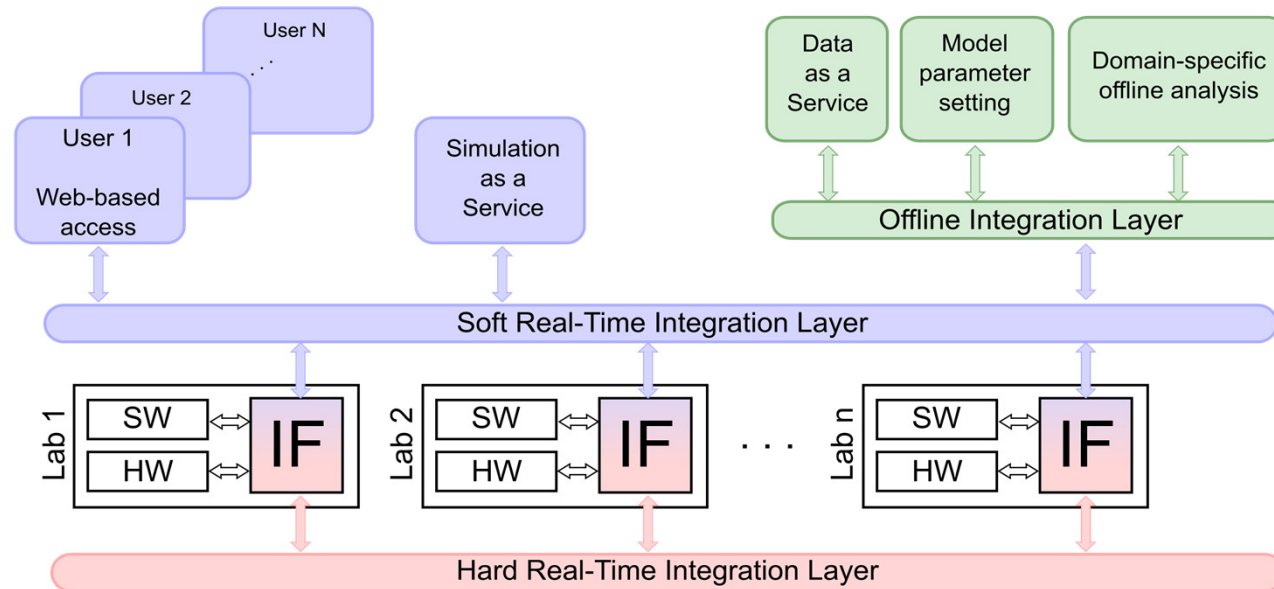
- New concepts can not be tested in the real grid
- Real-Time simulation as intermediate verification before real deployment
- Development of a new open source real-time simulator to support the creation of a continental-wide set-up able to check interactions among infrastructures
- Applying dynamic phasors as a tool to support the new real time solver able to run in standard computer
- Providing tools to link laboratories in real time creating a unique computing infrastructure



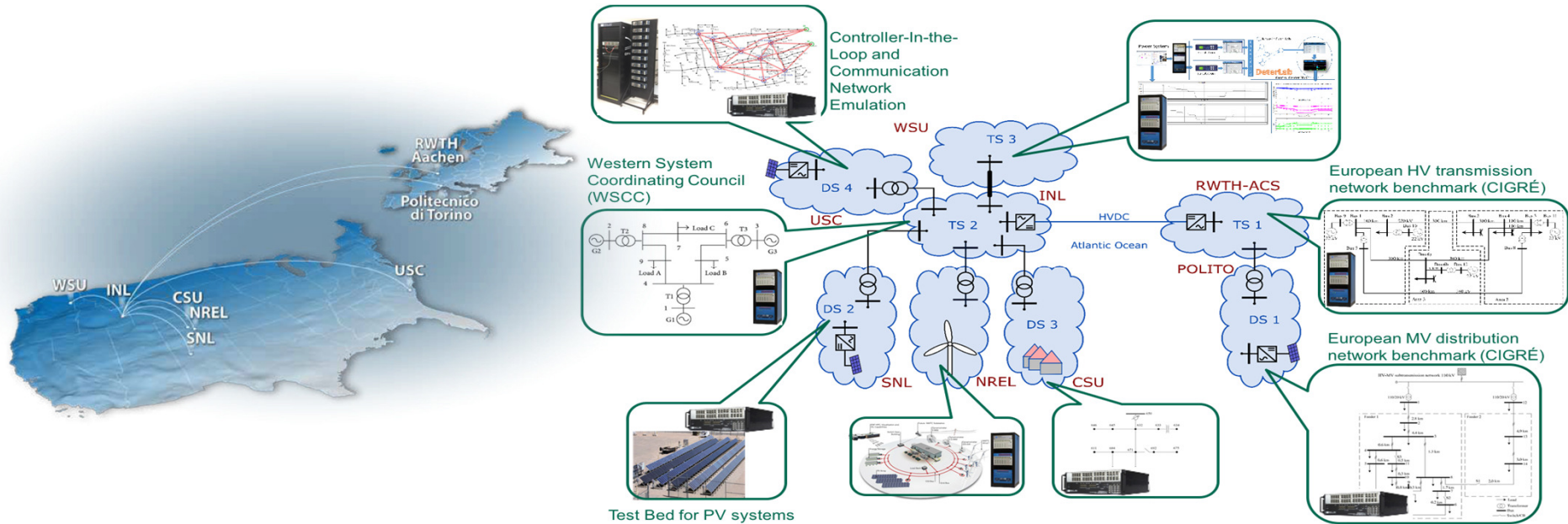
VILLAS FRAMEWORK



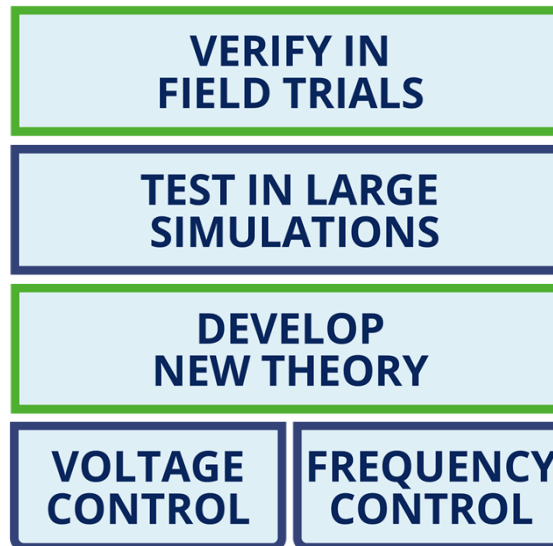
- VILLAS stands for Virtually Integrated Laboratory for Large System Simulation
- VILLAS offers a set of tools to integrate real-time simulation across the network
- VILLAS enables creation of very large simulation scenarios integrating the resources available in different laboratories



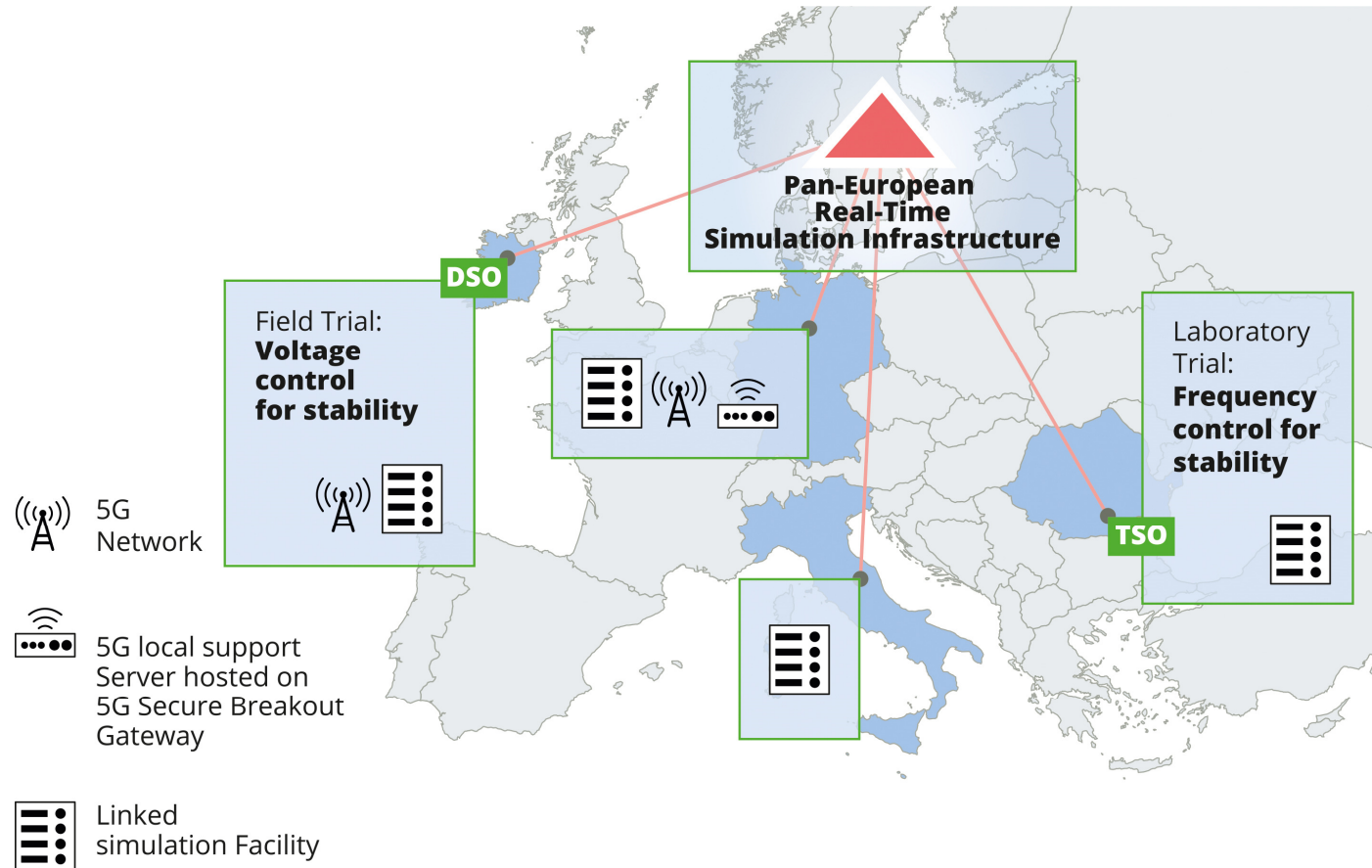
THE SUPER-LAB SCENARIO



RESERVE: IN FIELD VERIFICATION



RESERVE TRIALS



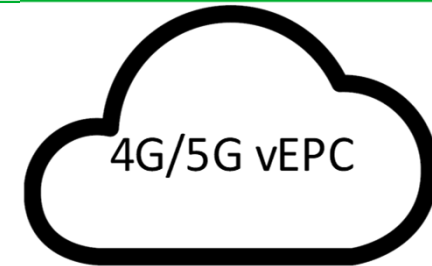
UNIQUE HIL EXPERIMENTS

- Together with Field Test advanced testing will be performed in the RWTH lab
- Joined Power and Communication test thanks to real-time simulation and a real base-station
- Unique testing of 5G networks before the deployment

RTDS

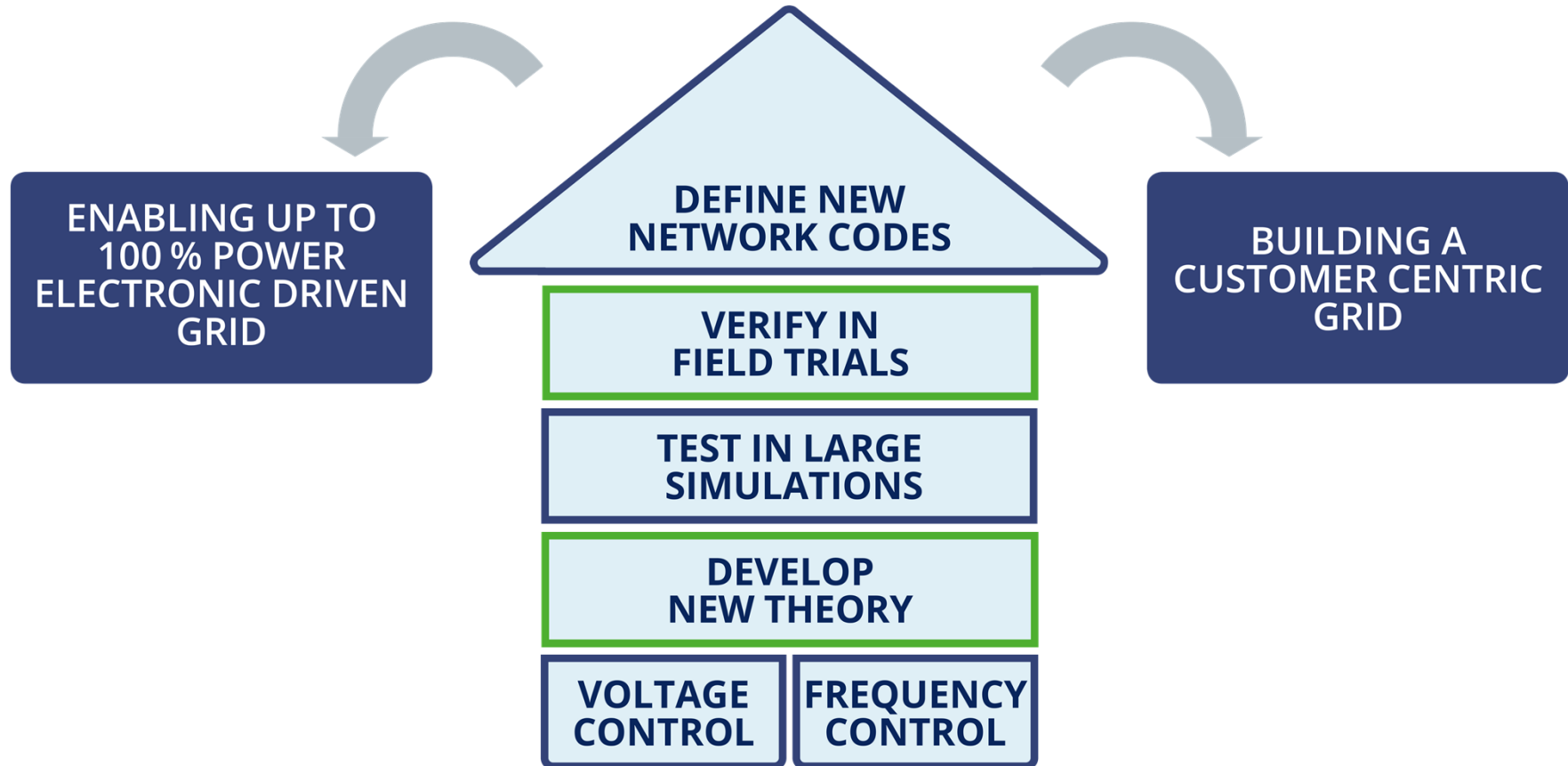


eNodeB



Ericsson Distributed Cloud

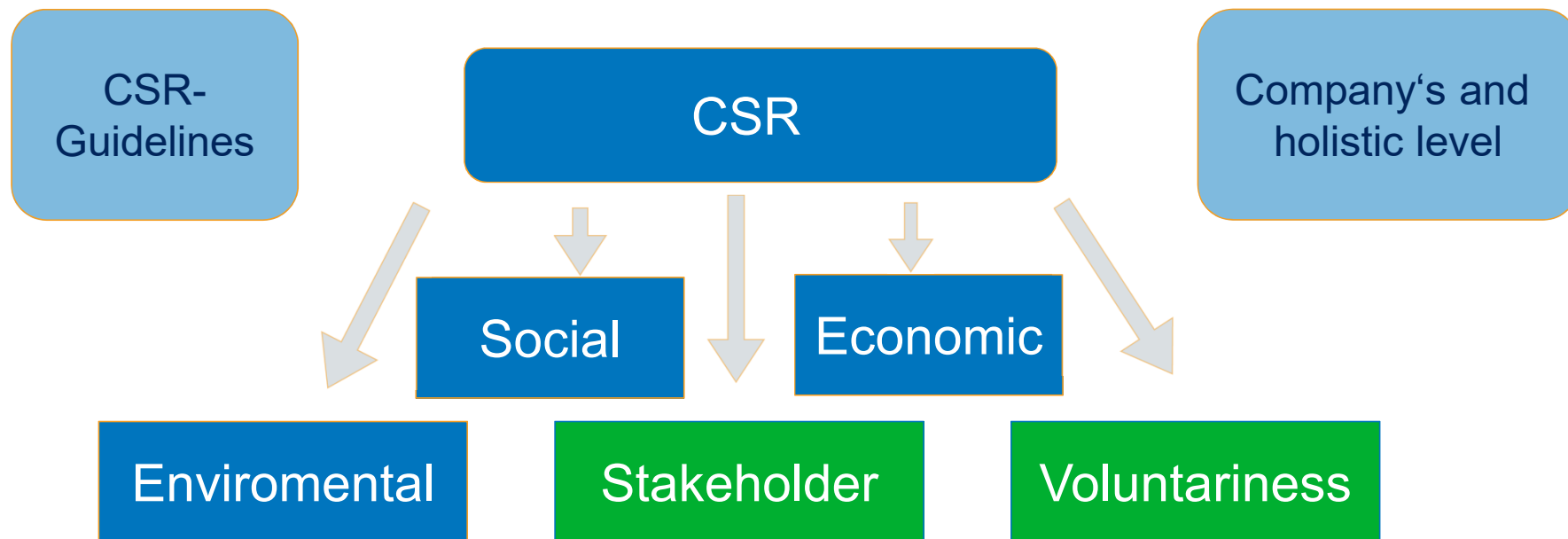
RESERVE: CREATING IMPACT



NEW BUSINESS MODELS BASED ON CSR

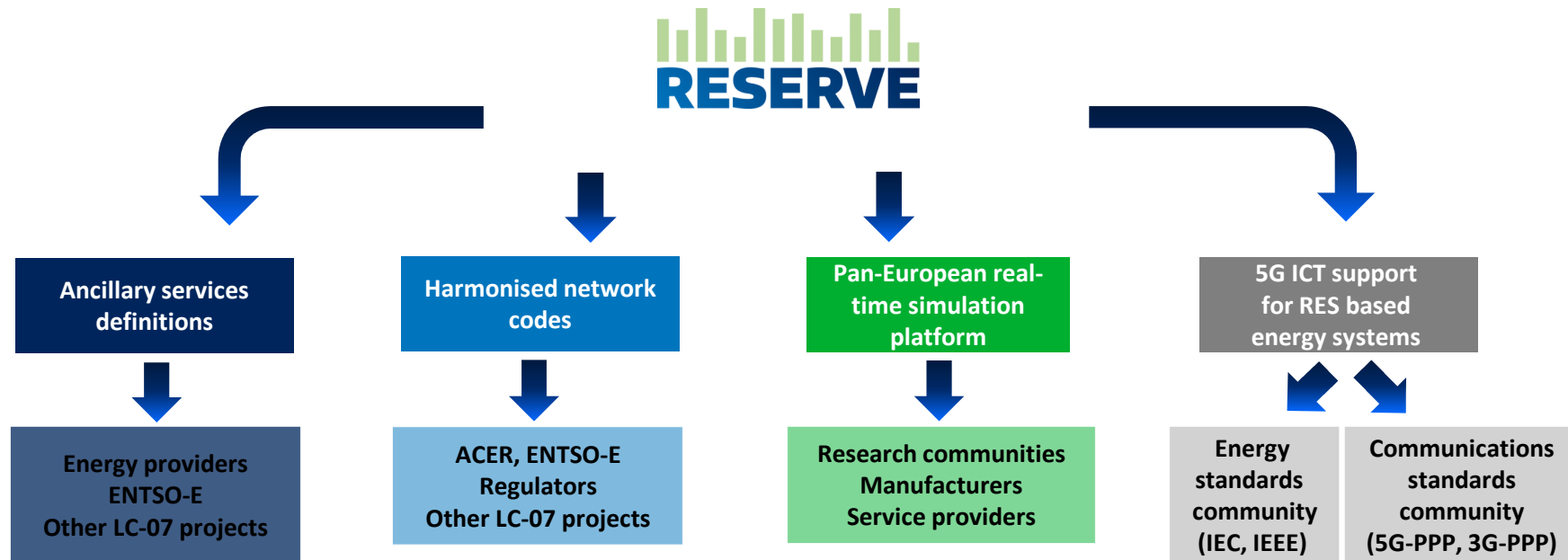


Brundtland Commission (1987): Sustainable Development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

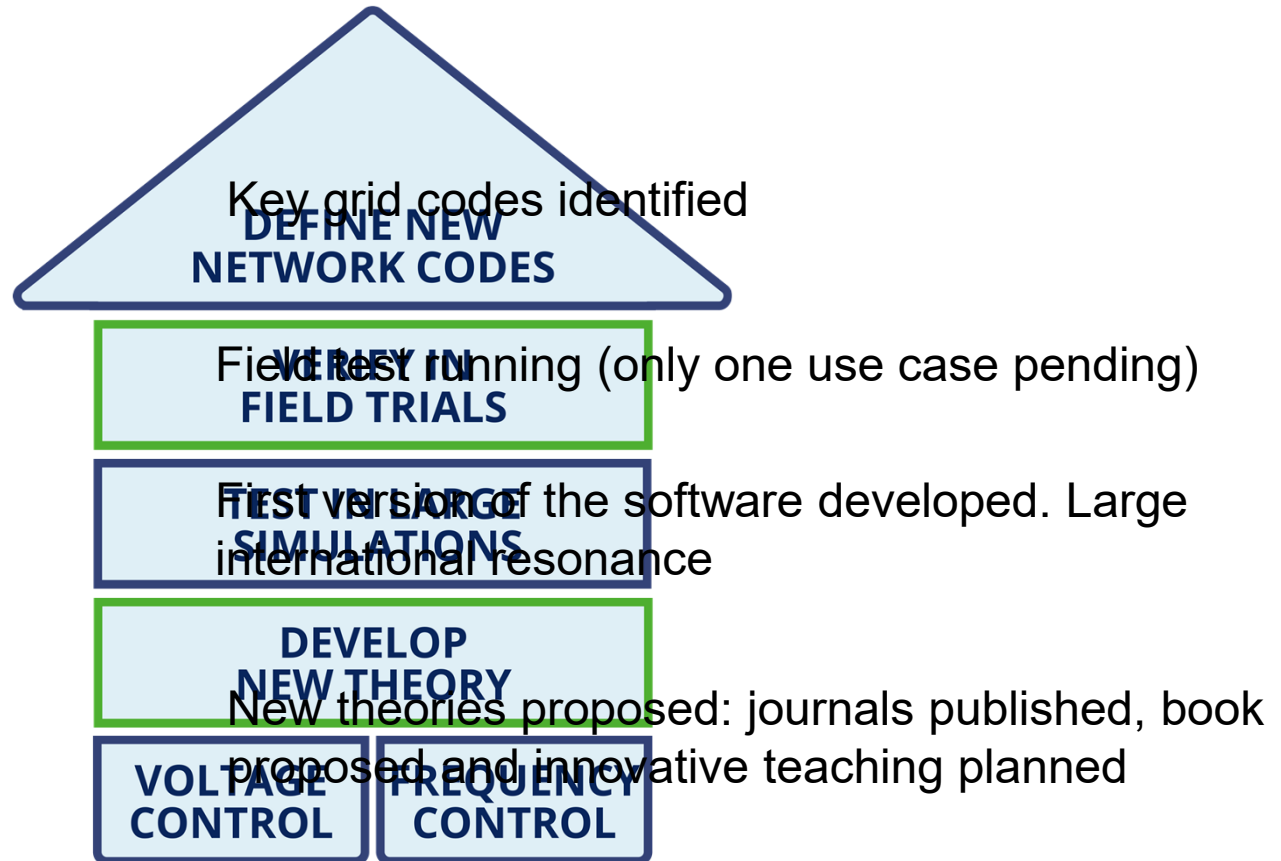


Source: Dahlsund (2006)

RESERVE RESULTS



RESERVE: KEY ACHIEVEMENT



SUMMARY



- RESERVE considers very forward looking scenario
- Main idea is to look at the future to be better prepared in the present
- Focus on future Ancillary Services: review fundamentals of frequency and voltage control
- Concept proven an innovative laboratory infrastructure and in field tests
- Attention on the social aspect with a CSR approach



www.re-serve.eu



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727481.