RESERVE

FUTURE GRIDS

fast, safe, sustainable

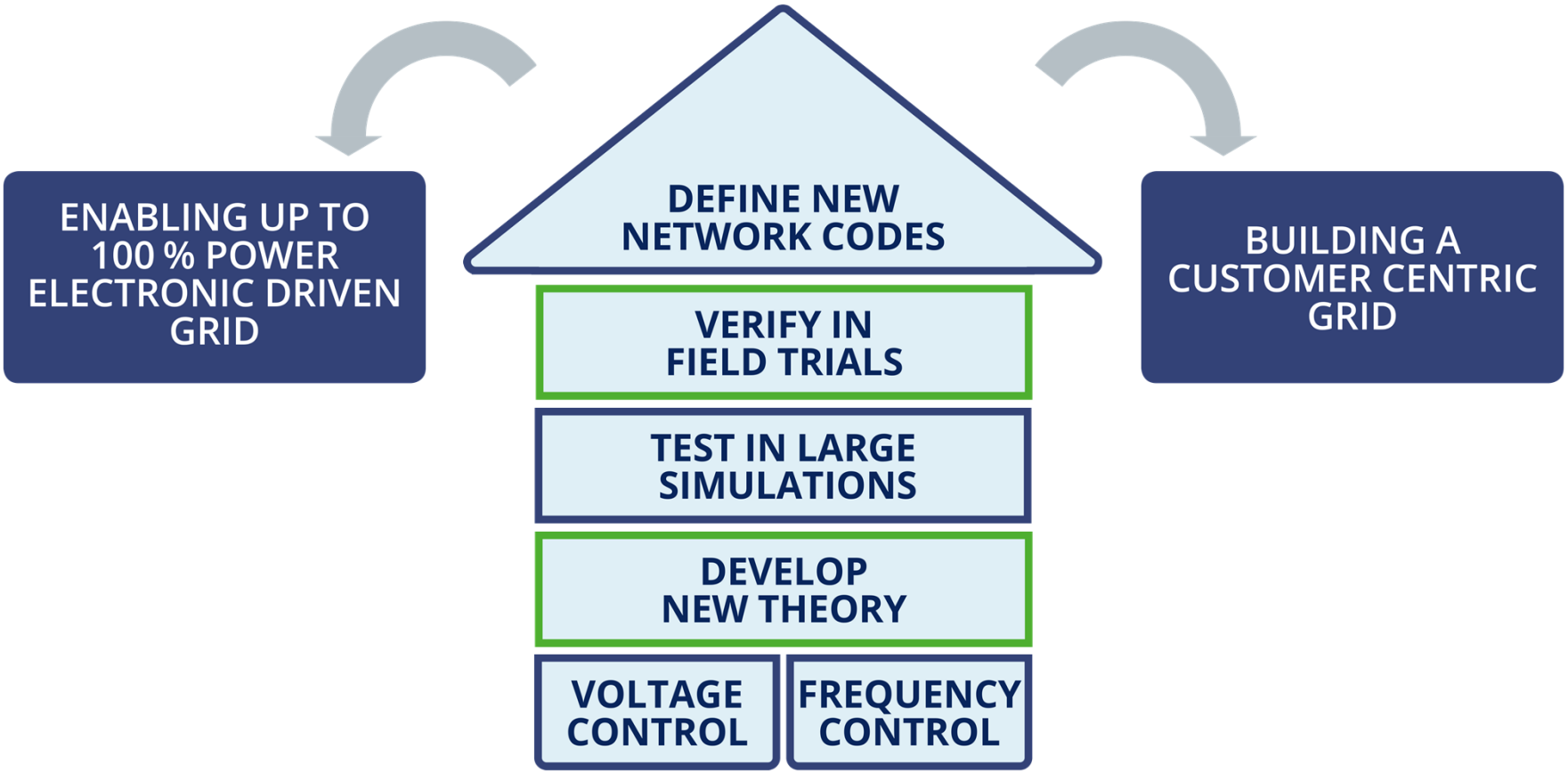
RESERVE Scenarios for up to 100% RES

19th June 2018

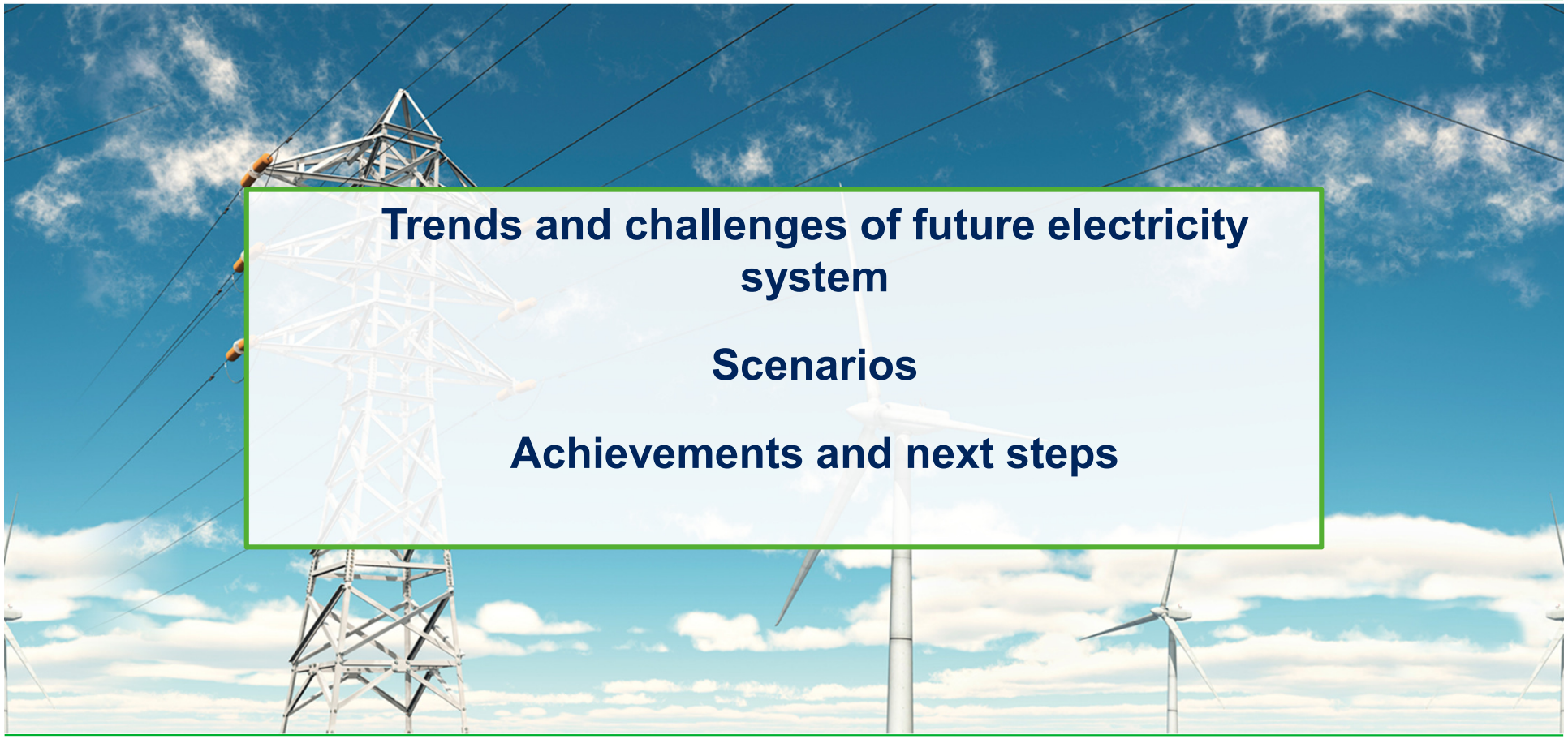
Aachen, Germany

Andrea Mazza
POLITO

PROJECT OVERVIEW DIAGRAM



OUTLINE



Trends and challenges of future electricity system

Scenarios

Achievements and next steps

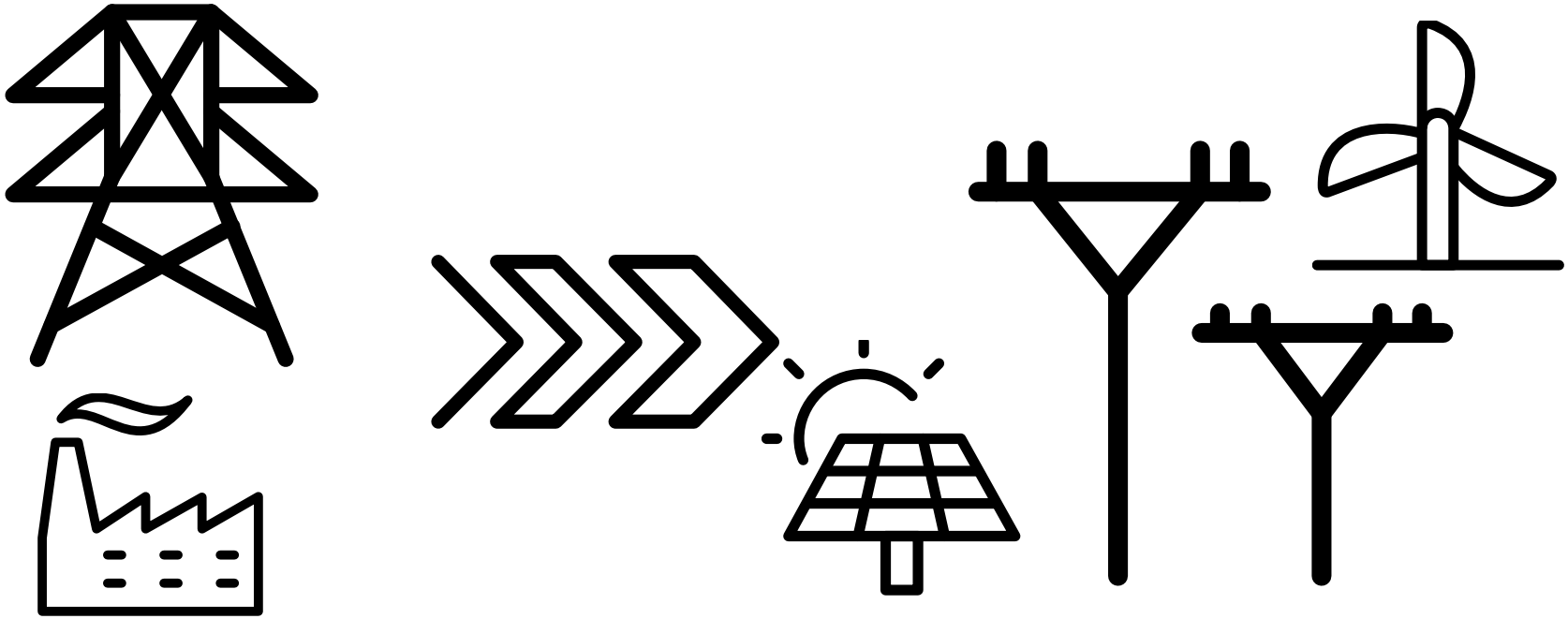
Trends and challenges of future electricity system

Scenarios

Achievements and next steps

TRENDS OF FUTURE ELECTRICITY SYSTEM

- Generation moving from *transmission domain* to *distribution domain*
- Increase of the share of RES, exploited by *inverter-based* generators



WHICH IS THE ACTUAL CHALLENGE?

- 100% RES vs 100% converter based power systems
- (Near) 100% RES already existing!!!

https://en.wikipedia.org/wiki/100%25_renewable_energy

WHICH IS THE ACTUAL CHALLENGE?

- 100% RES vs 100% converter based power systems
- (Near) 100% RES already existing!!!

Paraguay

Norway

Iceland

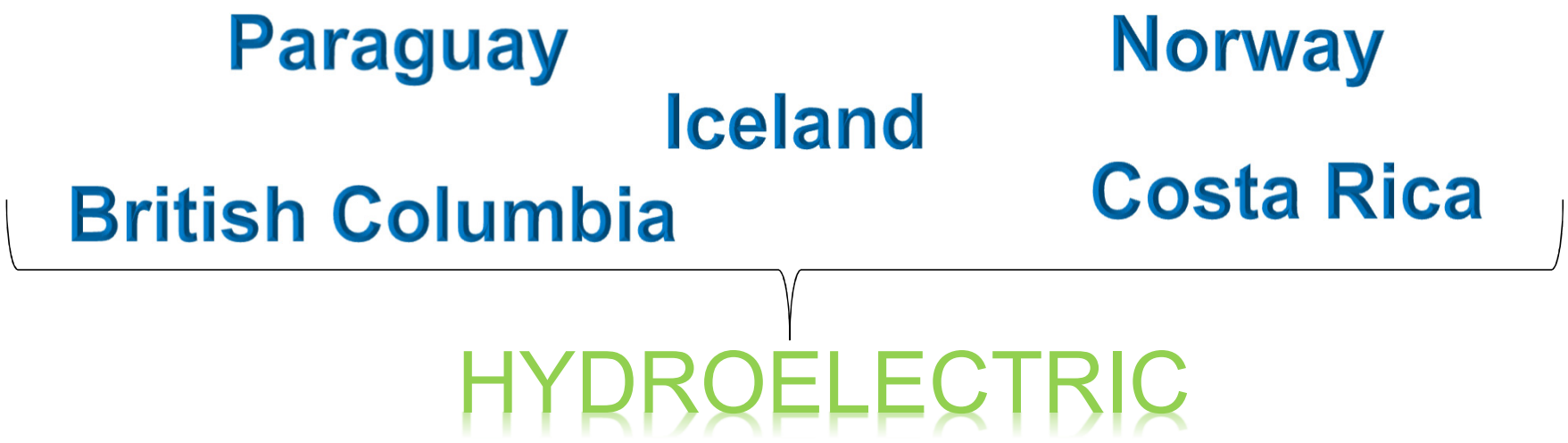
British Columbia

Costa Rica

https://en.wikipedia.org/wiki/100%25_renewable_energy

WHICH IS THE ACTUAL CHALLENGE?

- 100% RES vs 100% converter based power systems
- (Near) 100% RES already existing!!!



https://en.wikipedia.org/wiki/100%25_renewable_energy

WHICH IS THE ACTUAL CHALLENGE?

- 100% RES vs 100% converter based power systems
- (Near) 100% RES already existing!!!

Paraguay

Norway

Iceland

British Columbia

Costa Rica

HYDROELECTRIC

HIGH INERTIA SYSTEM

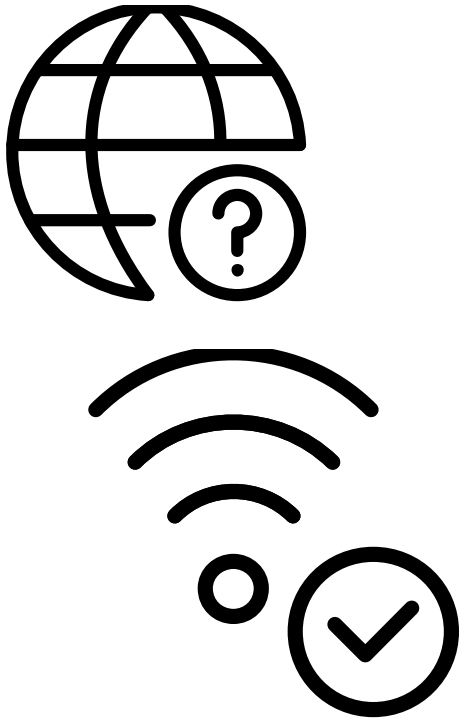
https://en.wikipedia.org/wiki/100%25_renewable_energy

WHICH IS THE ACTUAL CHALLENGE?

- Why we consider 100% of non-synchronous generators?
  - **most challenging condition**
  - leads to think **alternative solutions** for properly **operating the electricity system**

WHICH IS THE ACTUAL CHALLENGE?

- Why we consider 100% of non-synchronous generators?
  - **most challenging condition**
  - leads to think **alternative solutions** for properly **operating the electricity system**
  - **communication** systems play a **fundamental** role



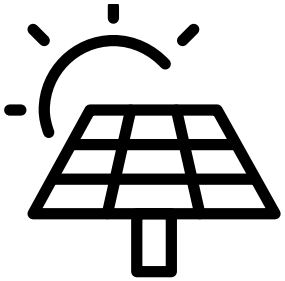
Trends and challenges of future electricity system

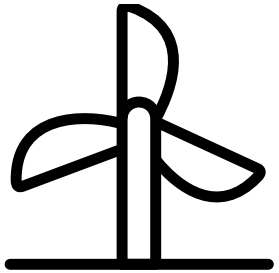
Scenarios

Achievements and next steps

FEATURE OF THE SCENARIOS

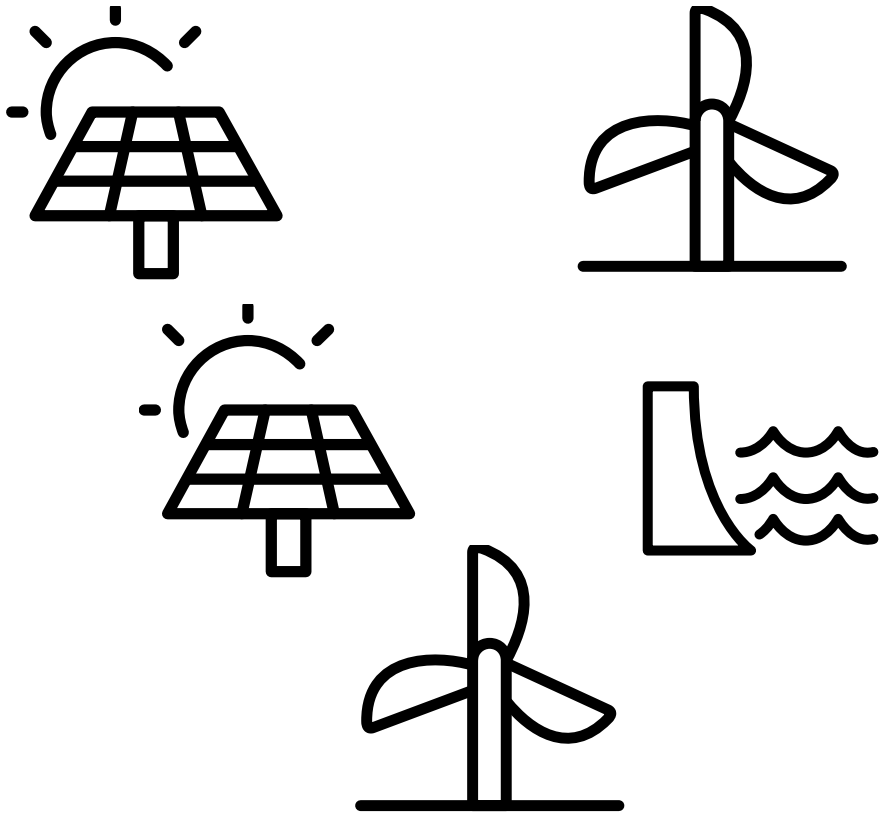
- Type of GENERATION
  - totally converter based





FEATURE OF THE SCENARIOS

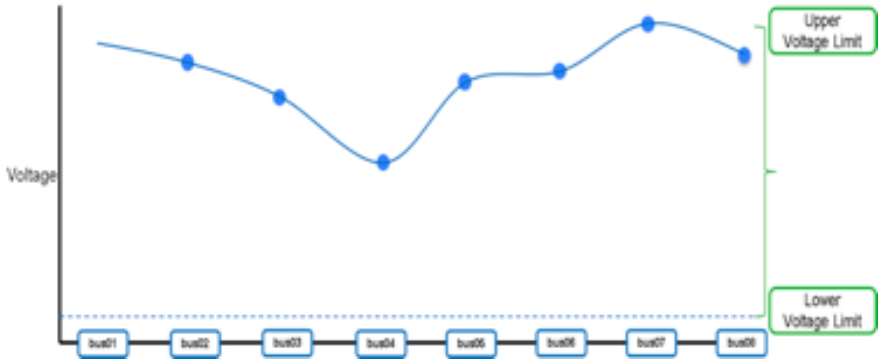
- Type of GENERATION
  - totally converter based
  - mixed mechanical/synthetic inertia



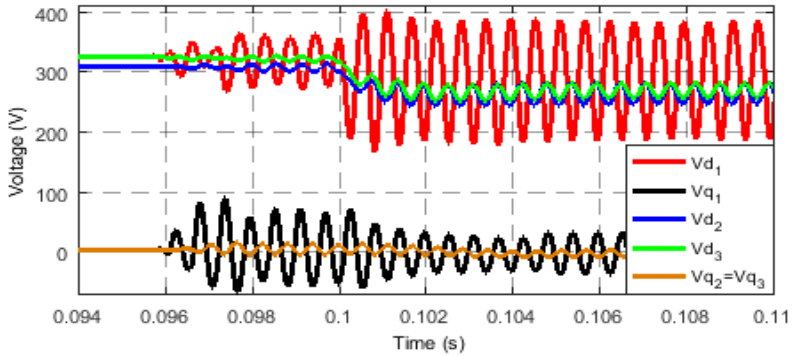
FEATURE OF THE SCENARIOS

- Large share of converters -> Voltage problems at distribution system level

  - Voltage profile along the line

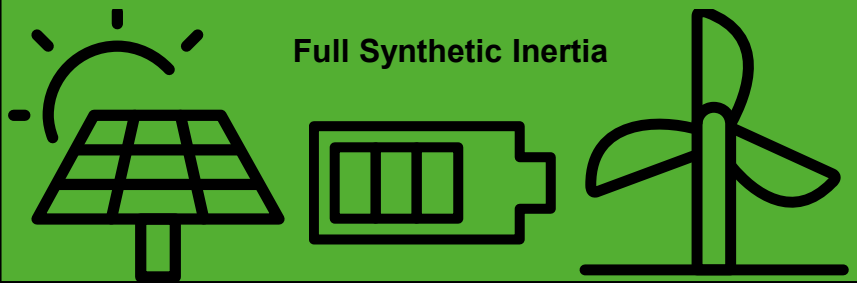


  - Dynamic problems



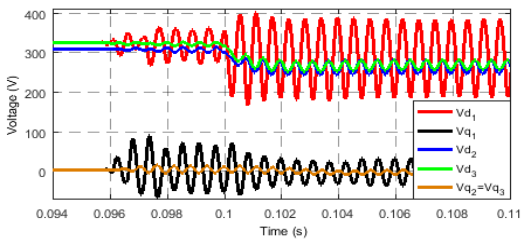
OVERVIEW OF THE SCENARIOS

Scenarios for addressing the challenges of future power systems:

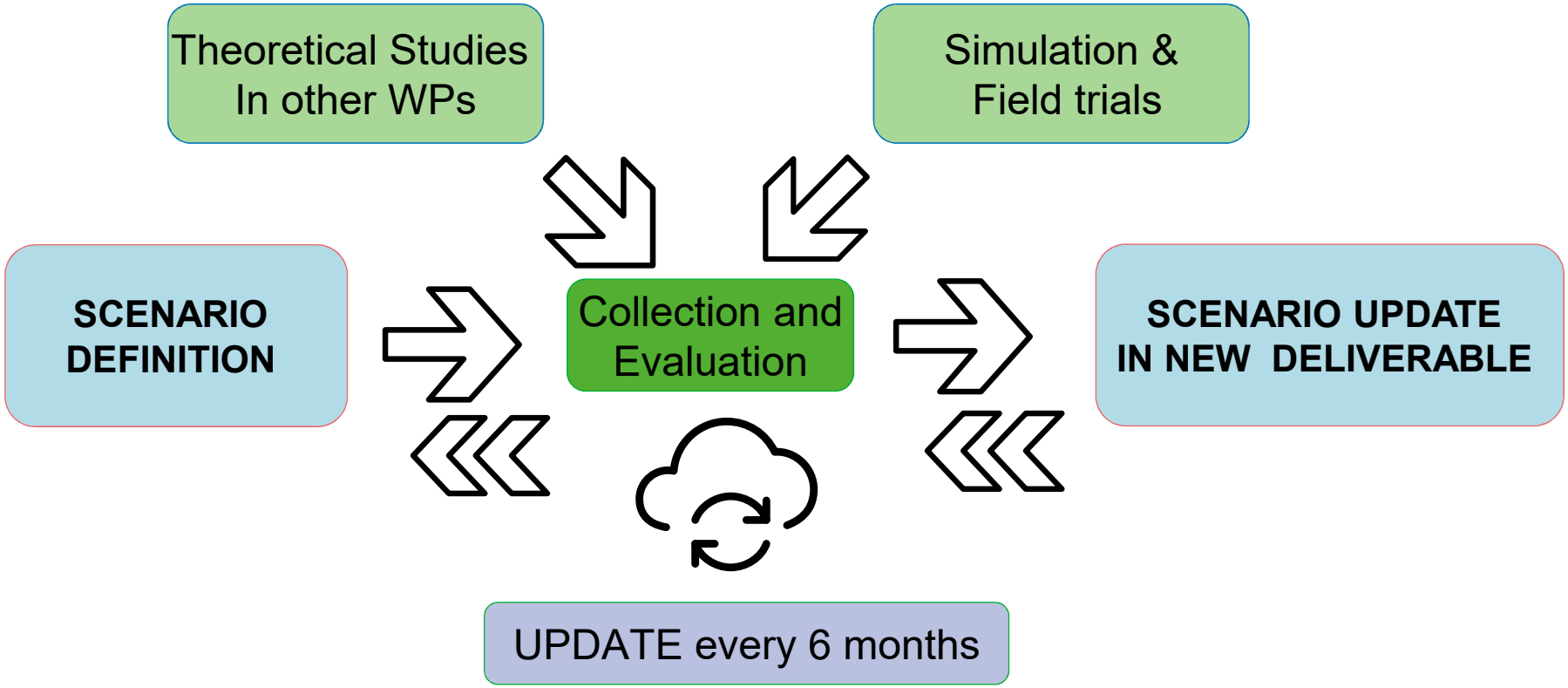
	Scenario	Short term	Long term
Frequency Scenarios	**Mixed Mechanical-Synthetic Inertia** 	provide **synthetic inertia** Fully AC network	**100% RES** power system Control of the **frequency dynamic** Participation of **VPP** in the **secondary frequency regulation**
	Full Synthetic Inertia 	Hybrid AC/DC (with use of HVDC**)** Converters **participating at the frequency control**	**No mechanical inertia** Frequency control by linear swing dynamics (**LSD**) Hybrid AC/DC

OVERVIEW OF THE SCENARIOS

Scenarios for addressing the challenges of future power systems:

	Scenario	Short term	Long term
Voltage Scenarios	**Dynamic Voltage Stability** 	Investigation of the **voltage transient** voltage **harmonics and stability**	**Implementation of virtual Output Impedance (VOI)** control **high number** of controllable power **converters**
	Active Voltage Management 	**steady-state** voltage management	**steady-state** voltage control **high number** of controllable power **converters**

UPDATES OF THE SCENARIOS



Trends and challenges of future electricity system

Scenarios

Achievements and next steps

ACHIEVEMENTS AND NEXT STEPS

Done	Definition the relevant scenarios for both frequency and voltage control, considering massive deployment of RES sources until year 2050 Creation of the ICT scenarios, and delivering of specific input on relevant parameters of future 5G mobile networks.
In Progress	Collection of the information for the next updates
To be done	Delivering of the final version of the scenario (including all the collected updates) at the end of the project

OBJECTIVES AND ACHIEVEMENTS

Objectives	Summary of achievements
To **define** the system level **requirements** which allows the **transition to up to 100% RES** will generate	Creation of **four different scenarios** (two for frequency and two for voltage control)
To define the **architectural** and **functional implications** of the requirements	**Initial definition of the ICT requirements**, by putting them in **relation with the needs of the electrical system**. This definition led to a draft the implications in terms of characteristics of the ICT system (including aspects such as delay, latency and availability)
To define the **starting points** of work on the **technical solutions** to maintaining **stability of voltage and frequency**	Share of the knowledge and listing of the **potentiality of ICT based techniques for electricity sector**, by ensuring a **common understanding and language between ICT experts and energy engineers**
To **relate our research** and architecture **to the test beds** to be implemented by the project **for voltage control**	Taking into account the potential of physical devices being deployed, the **voltage scenarios were developed in such a way so for challenging the test beds to consider future communication technologies** (such as **5G**) and information data exchange over that communication medium based on a **large share of inverter-based generation systems**.

Thank you!!

RESERVE

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.