Smart5Grid

Demonstration of **5G** solutions for
SMART energy **GRID**s of the future

5G PPP
The 5G Infrastructure Public Private Partnership

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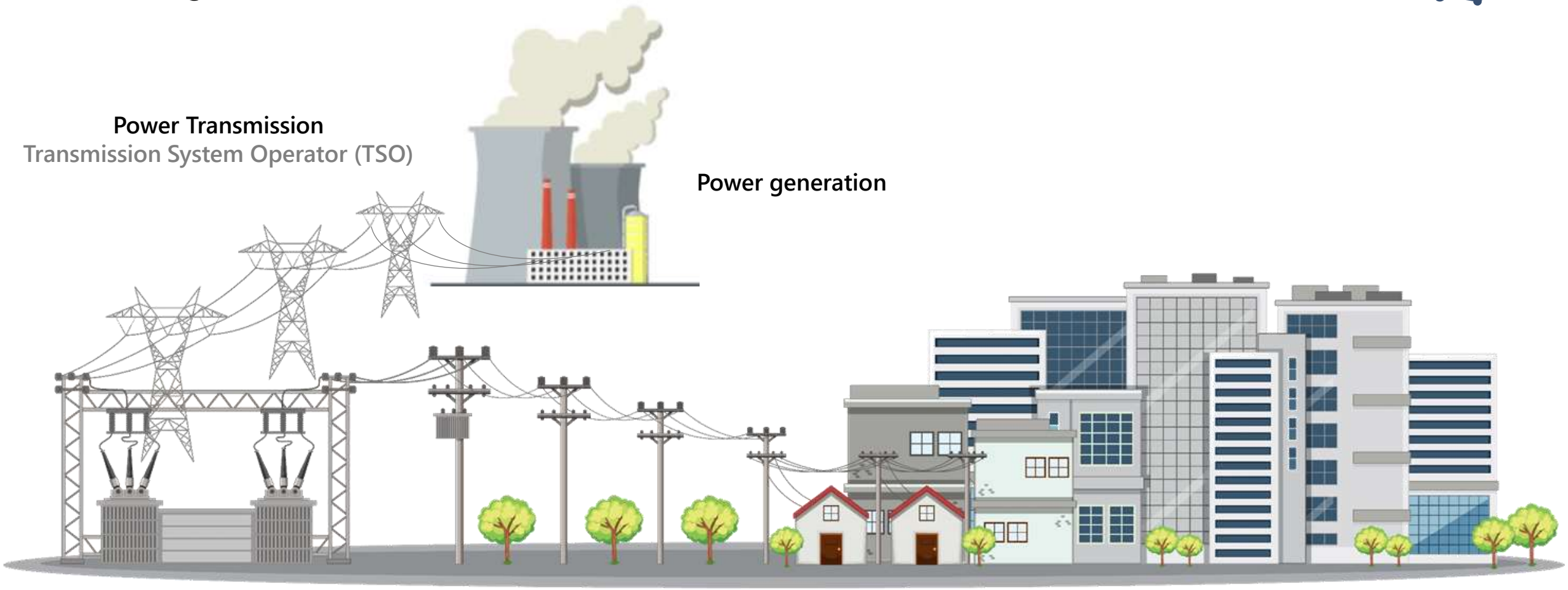
Energy Vertical

Traditional grid

Power Transmission
Transmission System Operator (TSO)

Power generation

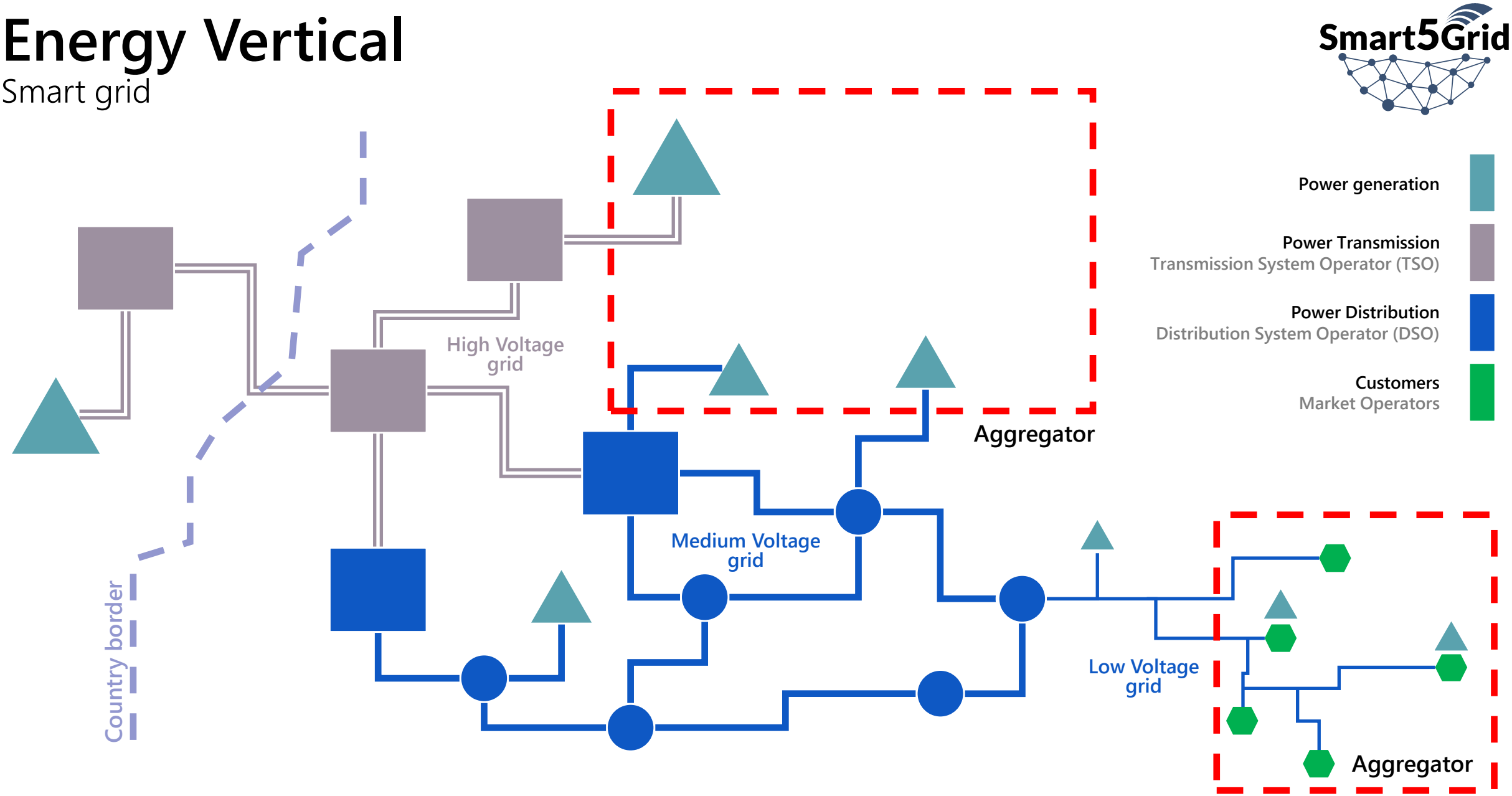


Power Distribution
Distribution System Operator (DSO)

Customers
Market Operators

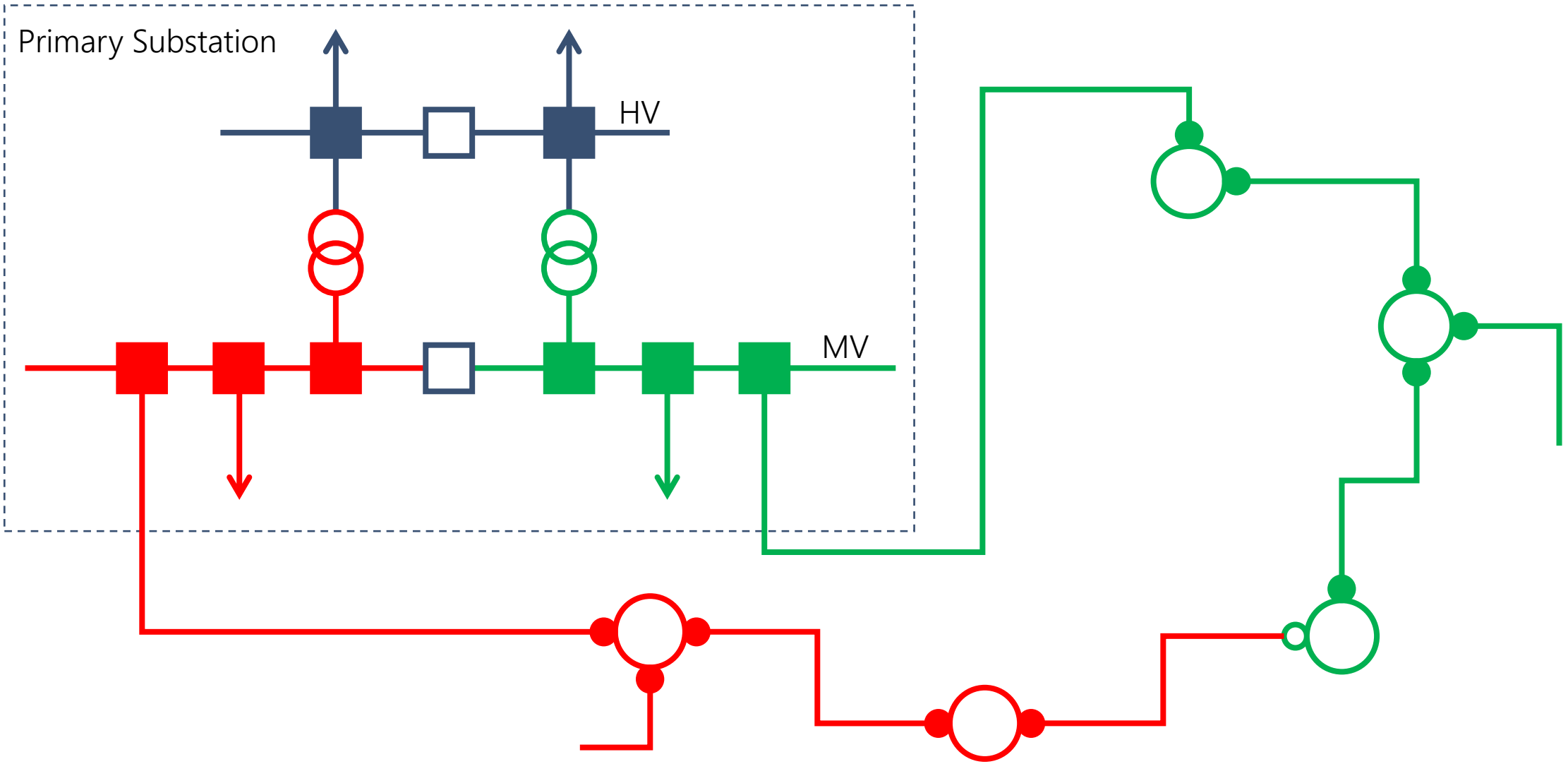
Energy Vertical

Smart grid



Energy Vertical

MV Distribution grid



Why 5G?

Advantages and opportunities for the industry

If compared to Optical Fiber

- Lower implementation costs
- Faster implementation
- Higher flexibility

If compared to 4G/LTE

- Lower latency (similar to Optical Fiber)
- Highest stability
- Virtually dedicated bandwidth (Slicing)

Major peculiarities

- Virtual Edge computing, strengthening the system resiliency

What we test in the project

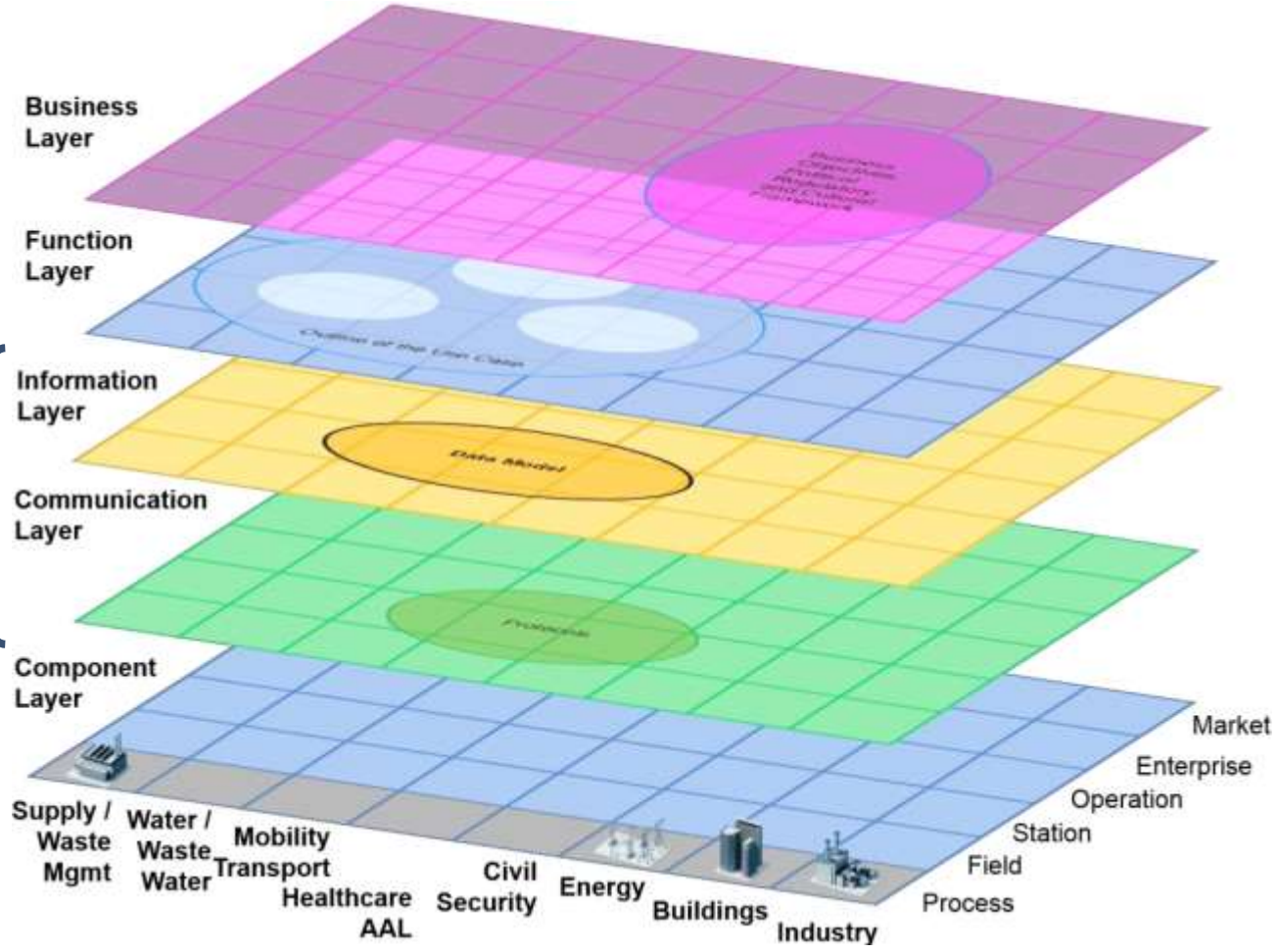
- **NetApp**: an extension of the Network Virtualization Functionality that provides an **abstraction of the 5G complexity** to allow the development of data-network functionalities to a broader group of people. EC aims to create a market segment for NetApps, to support the penetration of 5G technology and foster the digitalization

SGAM

Smart grid architecture model

To successfully cope with the new challenges, all intermediate layers needs to be optimized: in other words, a full digitalization is the key!

Virtualization simplifies the Component layer, offering a more dynamic and flexible approach



ENGINEERING

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Summary

Content overview

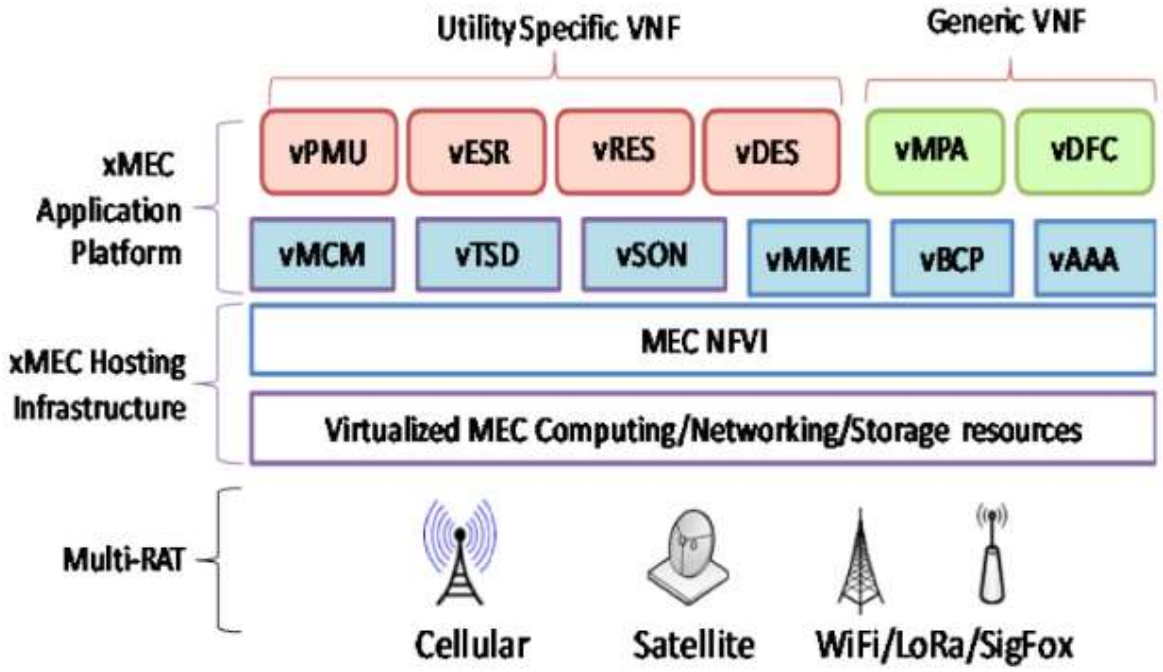
- NRG-5 in a nutshell
- Virtualization and digitalization
- vPMU Conceptual Work IN NRG-5
- NRG-5 test bed
- Results (5G-Like, 4G, Ethernet)
- Smart5Grid Handover

NRG-5 in a nutshell

Targeting the Smart Energy vertical domain, NRG-5 defines use cases covering all three groups of Machine Type Communications (MTC) while also investigating how already defined 5G radio features could be used in Energy use cases.

1. Smart Meter identification and autoconfiguration
2. Predictive Maintenance for utility infrastructures
3. Low Phasor Measurement Unit (PMU), enabling precise state measurements to be made across an entire gird, support fast monitoring of distribution feeders, with data refresh of 10 to 50 times per second.

NRG-5 in a nutshell

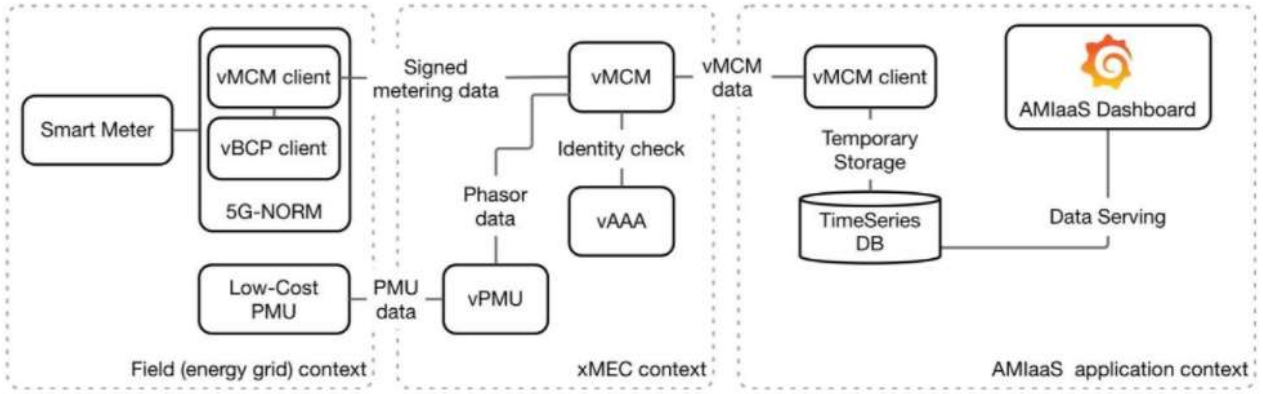


- Utility Specific VNFs Address specific industry challenges for the T&L sector
- Generic VNFs :Core primitives for data processing at application layer
- Multiple VNFs will be "chained" together for an energy service

Virtualization and digitalization

- Network Virtualization (NV) releases the network from its anchor in hardware and runs a virtual network on top of the physical network. The result is a more dynamic system that can be controlled from a central plane, removing the need for humans to manually configure pieces of hardware.
- 5G network virtualization will permit the division of hardware resources into functions that can be controlled by software: network functions virtualization (NFV). In network management, NFV seeks to directly optimize network services.
- On the same approach is it possible to investigate how “Energy functions can be controlled and managed by software”.

Main objectives of the vPMU demo

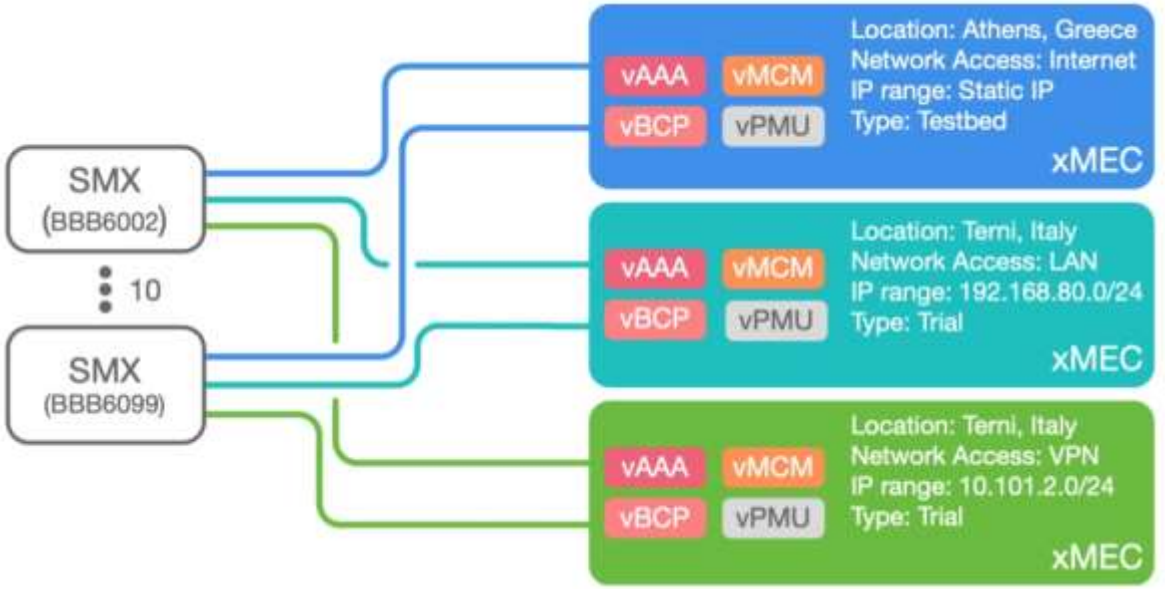


- NRG-5 considers the deployment of
  - i) sub-minute updates for smart meters (at the level of second) and
  - ii) the mass deployment of low-cost PMUs reporting at least 20 samples per second, without calculating the phasors locally but on the edge assisted by vPMU.

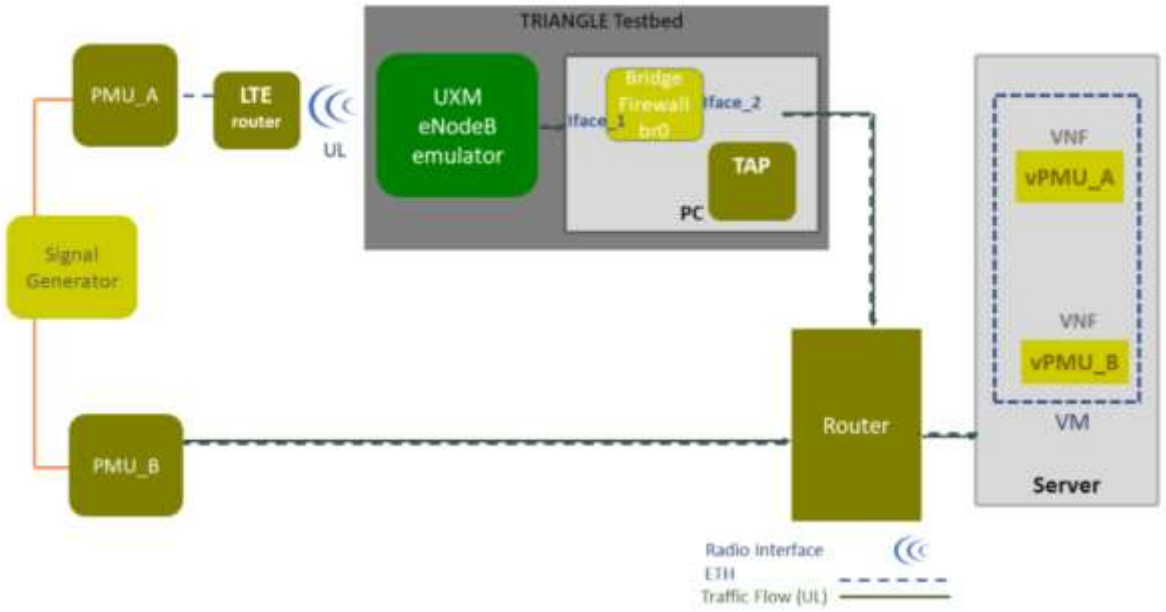
VPMU Conceptual Approach

In NRG-5 traditional PMU is divided into:

- a data acquisition unit responsible for sampling the electricity grid and
- a virtual network function (VNF) responsible for calculating the corresponding phasors. This VNF sits on the edge cloud



NRG-5 Test Bed



TRIANGLE testbed is an End-2-End (E2E) testbed which allows flexibility and reconfiguration for realistic testing scenarios:

- extensive testing of services against different scenarios.
- configurations in realistic controllable environment for testing and validation purposes.

Results

Min.diversion	Voltage [v]		Phase [rad]		Freq. [Hz]		Latency [ms]		Reordered pcks	
	4G_div	5G_div	4G_div	5G_div	4G_div	5G_div	4G_div	5G_div	4G_div	5G_div
	0,12	0,12	5,58	5,41	1,53	0,30	0,006	0,000	0,00	4,00
Avg. Diversion	0,19	0,04	0,19	0,35	5,21	1,39	0,165	0,010	1602	541
Max.diversion	1,28	1,18	5,86	5,93	10,52	5,12	0,184	0,030	3040	899

The diversion of the main measurements between 4G and 5G-like mobile networks with respect to the reference case (Ethernet connection) are summarized in the table

Smart5Grid handover

- Add complexity to the echosystems as well as create new tools for experimenter to build their VNF and also NetApp
- To use 5G-API for providing new capabilities for develpers
- Energy services full virtualization
- Orchestration of the different NetApp.

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Thank you!

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