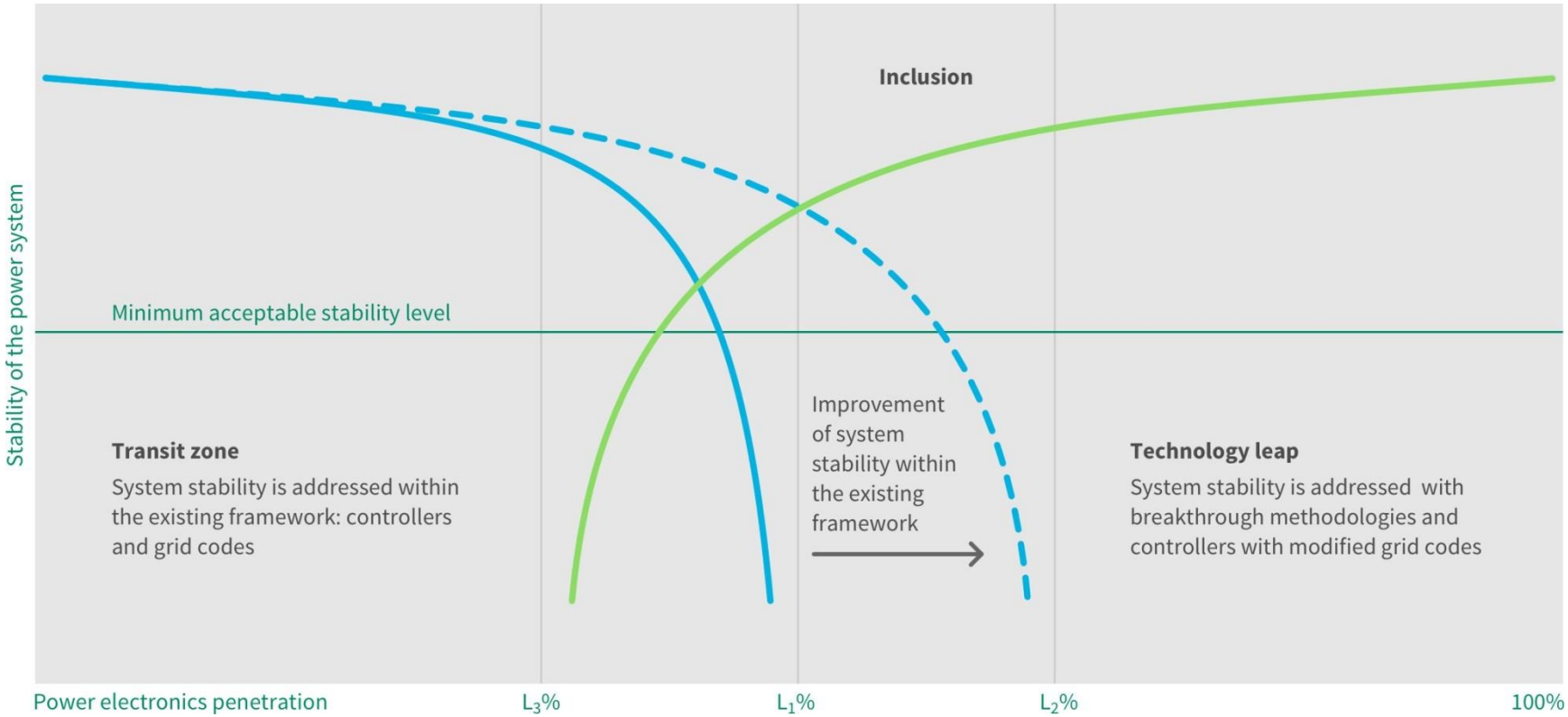
MIGRATE – MASSIVE INTEGRATION OF POWER ELECTRONIC DEVICES

IEA expert workshop:

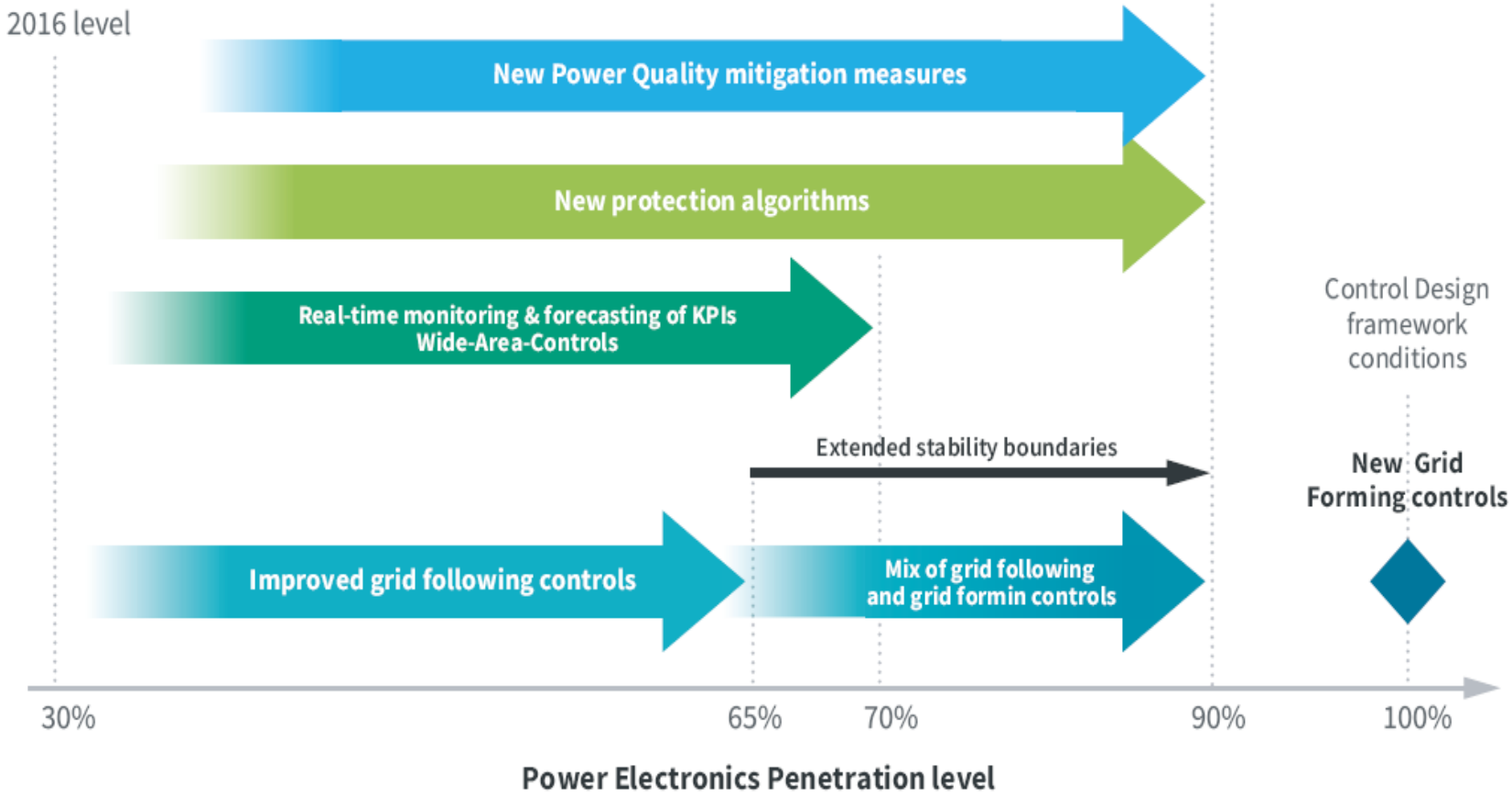
Technical secure integration of large shares of converter based power sources

March 25, 2020

OVERARCHING GOAL



STATUS OF PROGRESS



Diag. synthesizing MIGRATE contribution towards more RES into the grid

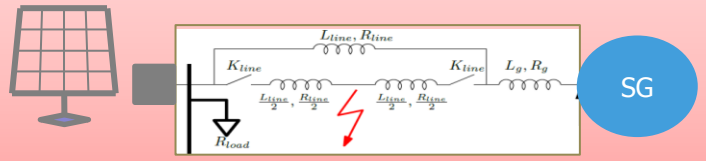
A necessary condition to operate a grid with extremely high PE penetration

Stiff voltage source behavior

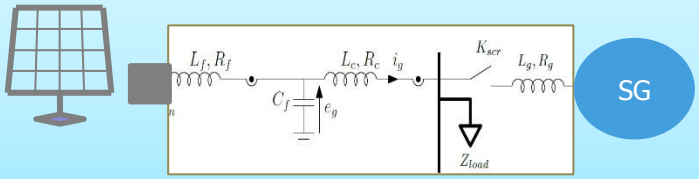
≈50 Hz

Synchronizes with other sources (RE, SM, GF)

Current-limiting strategy



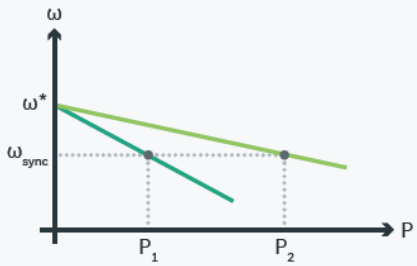
Islanding



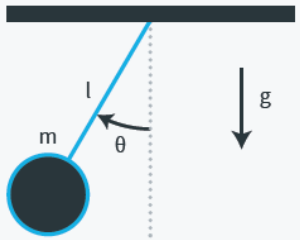
THE GF FUNCTION: MULTIPLE WAYS TO REALIZE

3 controls developed within WP3 (and made open source)

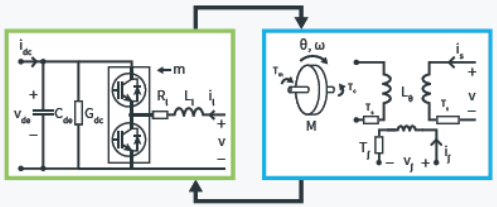
Filtered frequency droop



Dispatchable Virtual oscillator



Matching control



synchronous machine matching

Theoretical proof of stability can be achieved with basic grid assumptions.

Multiple other controls in the literature…

In MIGRATE, the controls were developed independently, on simple test cases

- They behave in a similar way (especially in small signal)
- They are interoperable
- A specific current limiting strategy can be applied to avoid costly oversizing.
- They release the stress on synchronous machine in a mixed system

MATURITY OF GF FUNCTION

Within Migrate;

The Grid forming function have been extensively tested in simulation:

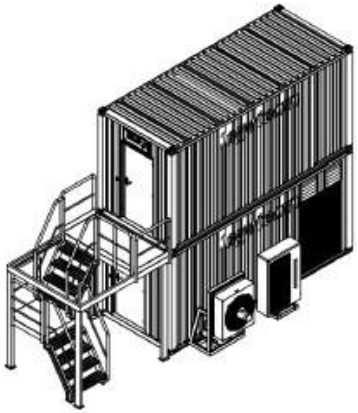
- on small test systems
- on reduced Irish system
- on reduced GB system

It has been tested in real time simulation.

Then tested on real lab scale Hardware.

One of the control will be tested in a follow-up EU Project (OSMOSE) with a 1MVA grid forming inverter connected on the transmission grid.

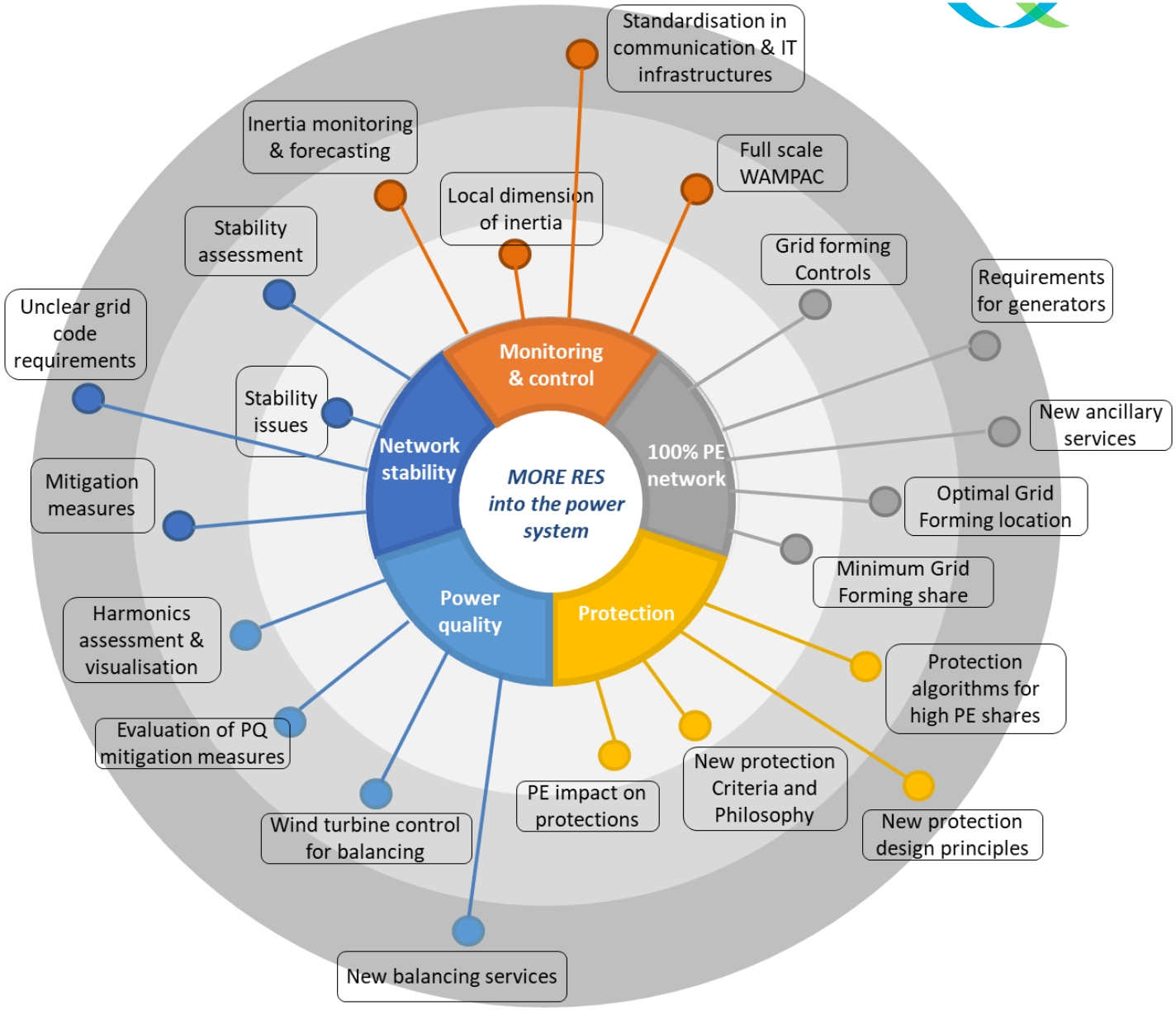
AC/DC	1000 kVA
Battery Li-ion	500 kW – 60 min
Supercapacitors	1000 kW – 10 s
Transformer	600 V – 20 kV



OSMOSE

OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

OVERVIEW OF KEY PROJECT RESULTS



Colour code:

- Knowledge about …
- Tools for …
- Recommendations on …

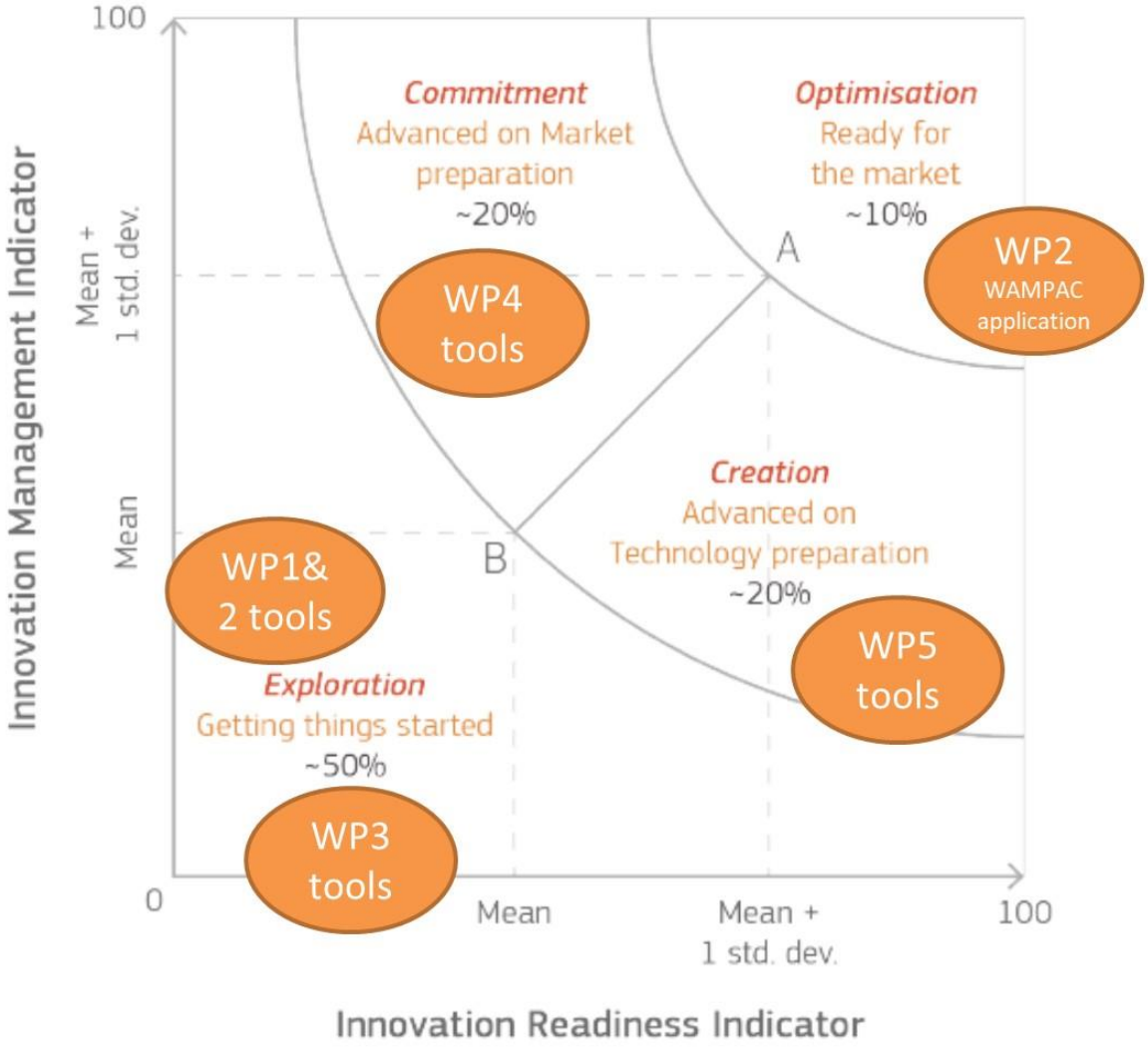
EXAMPLE: STATUS NEXT STEPS

100% PE GRID

MIGRATE results	Recommendations for implementation	Next R&D required
Feasibility of a stable 100% PE grid	Prefer "technology agnostic" requirements for grid forming (i.e. also applicable to synchronous condensers/ loads/ generation)	Optimal location and sizing of grid forming capabilities on very large transmission system
Interoperable grid-forming controls	Include grid forming requirements in grid codes, with limited constraints at first in order to foster manufacturers developments	Regulation of synchronous generators in systems dominated by Grid-forming inverters dynamics
Min. 30% share of grid-forming required in a 100% PE grid	Perform cost/benefit analysis of grid forming controls at RES plants vs at TSO substations	Testing methods to validate GF capabilities of voltage sources
Current limitation strategy to protect converters from over-currents		New system dynamics indicators for PE-based systems
Optimal location of grid-forming controls for new ancillary services		Black-start in inverter-led systems
Economic feasibility of grid-forming approach		

Example of Roadmap diagram (WP3) included in deliverable D6.4- D6.5

RESULTS MAPPING ON THE INNOVATION RADAR



- ***Innovation readiness*** relates to the technical maturity of evolving innovations.
- ***Innovation management*** addresses the consortium's capacity and commitment to bring innovations to the market

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691800.

The information, documentation and figures in this presentation are written by the MIGRATE project consortium under EC grant agreement No 691800 and do not necessarily reflect the views of the European Commission.
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