new assets, reactive power, intelligent curtailment and batteries

CONGESTION MANAGEMENT IN DISTRIBUTION GRIDS WITH PHOTOVOLTAICS

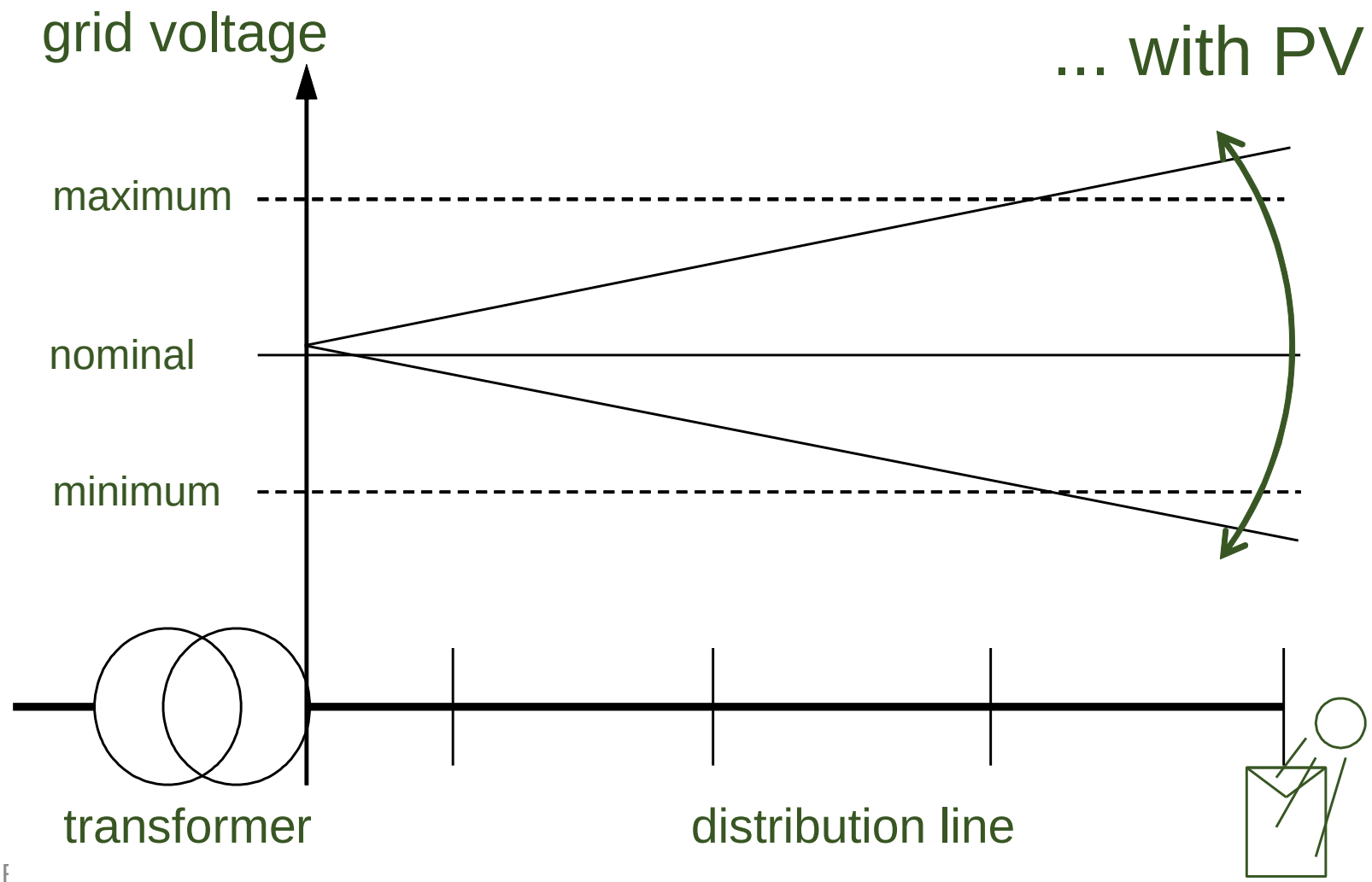
Outline

- Congestion in distribution grids
- The MetaPV project
- Recommendations from real-world testing
- Questions for discussion

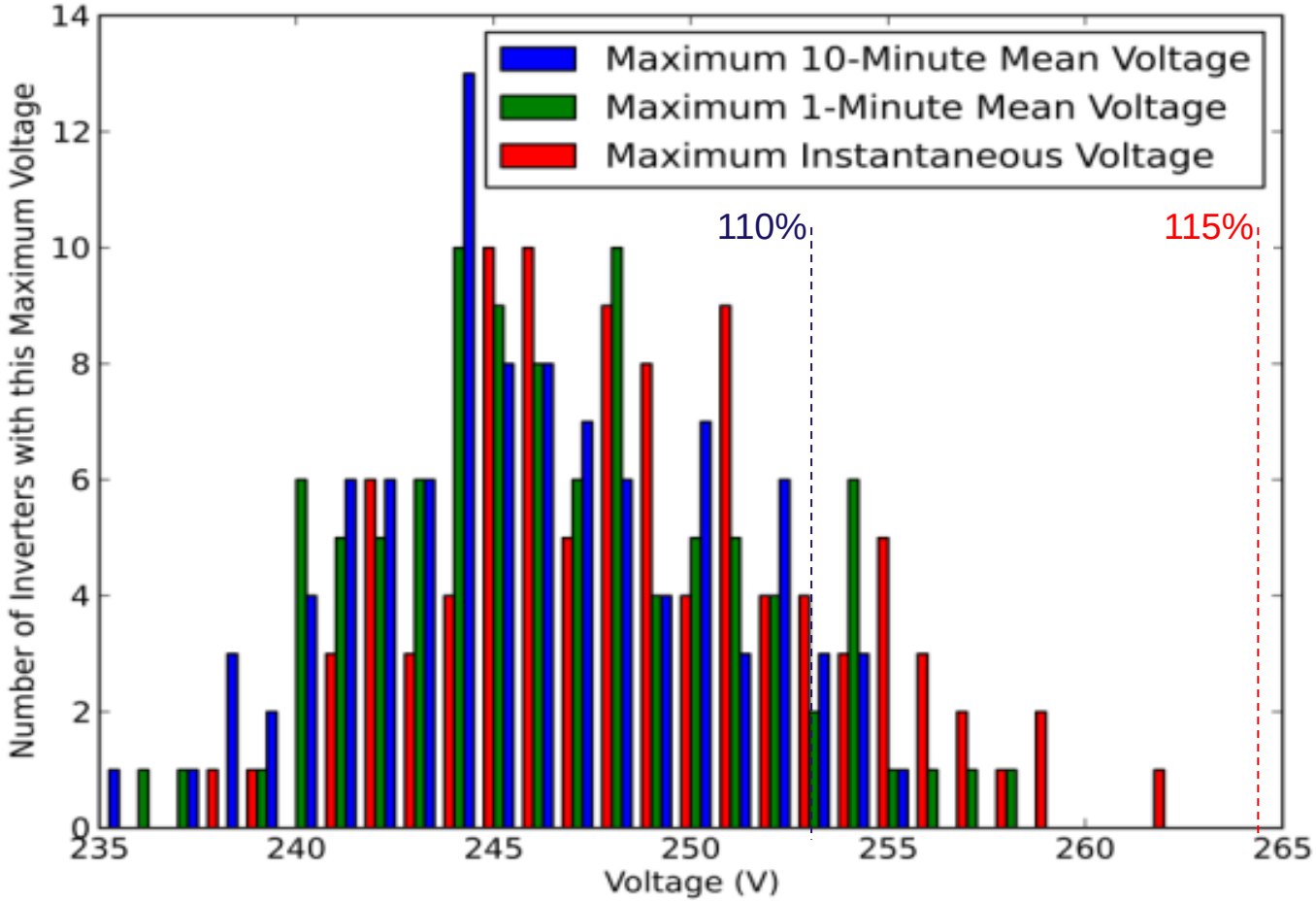
Bottlenecks are Local

CONGESTION IN DISTRIBUTION GRIDS

Overvoltage in Distribution Grids



In Many Distribution Grids Congestion Occurs Rarely



The MetaPV Project

GRID SUPPORT FROM DISTRIBUTED PHOTOVOLTAICS

MetaPV at a Glance

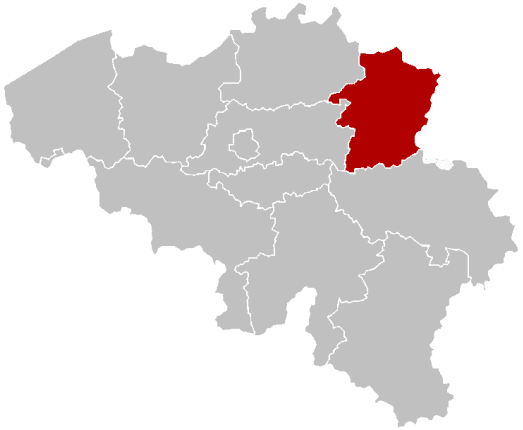
- FP7 grant agreement 239511 with DG Energy
- October 2009 - March 2015
- Large-scale demonstration
  - Residential (LV): 85 plants with 430 kW
  - Industrial (MV): 9 plants with 2.4 MW

- Results at www.metapv.eu

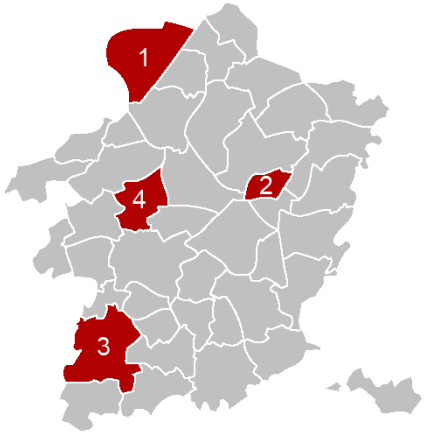
Strategic Objectives

- Distribution grid hosting capacity: + 50%
- For ~10% of the costs of grid reinforcements
- Maintaining quality, safety & security of supply

Large-scale demonstration in the real world !



(a) Province of Limburg (red) in Belgium



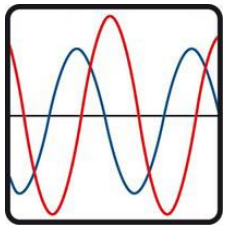
(b) Municipalities in Limburg

The Citizen as Guinea Pig

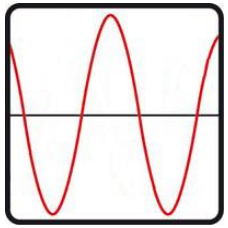
A distribution grid in Opglabbeek

Source: Infrax

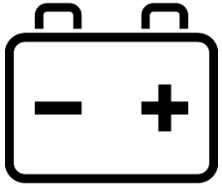
Three Solutions for Smart Control of Inverters



Reactive power

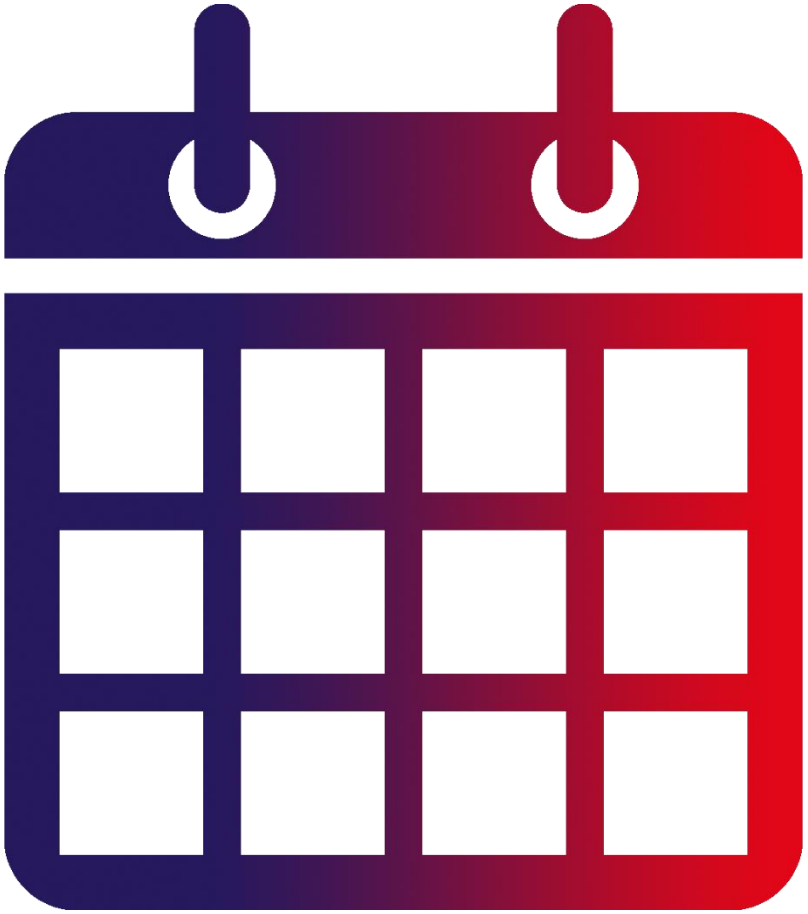


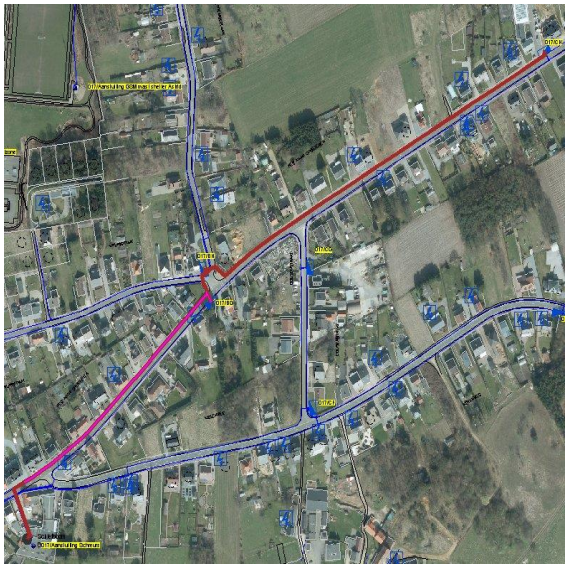
Limit active power



Battery storage

Alternating Tests with Different Control Methods

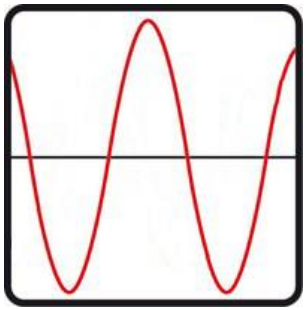


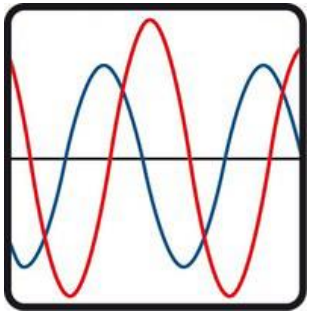


Real-life Testing and Evaluation

RESULTS & RECOMMENDATIONS

It Works





- Inverter-based voltage control works in practice
- By controlling reactive and active power, the voltage is kept within the limits
- … hence more PV can be connected to the existing grid.

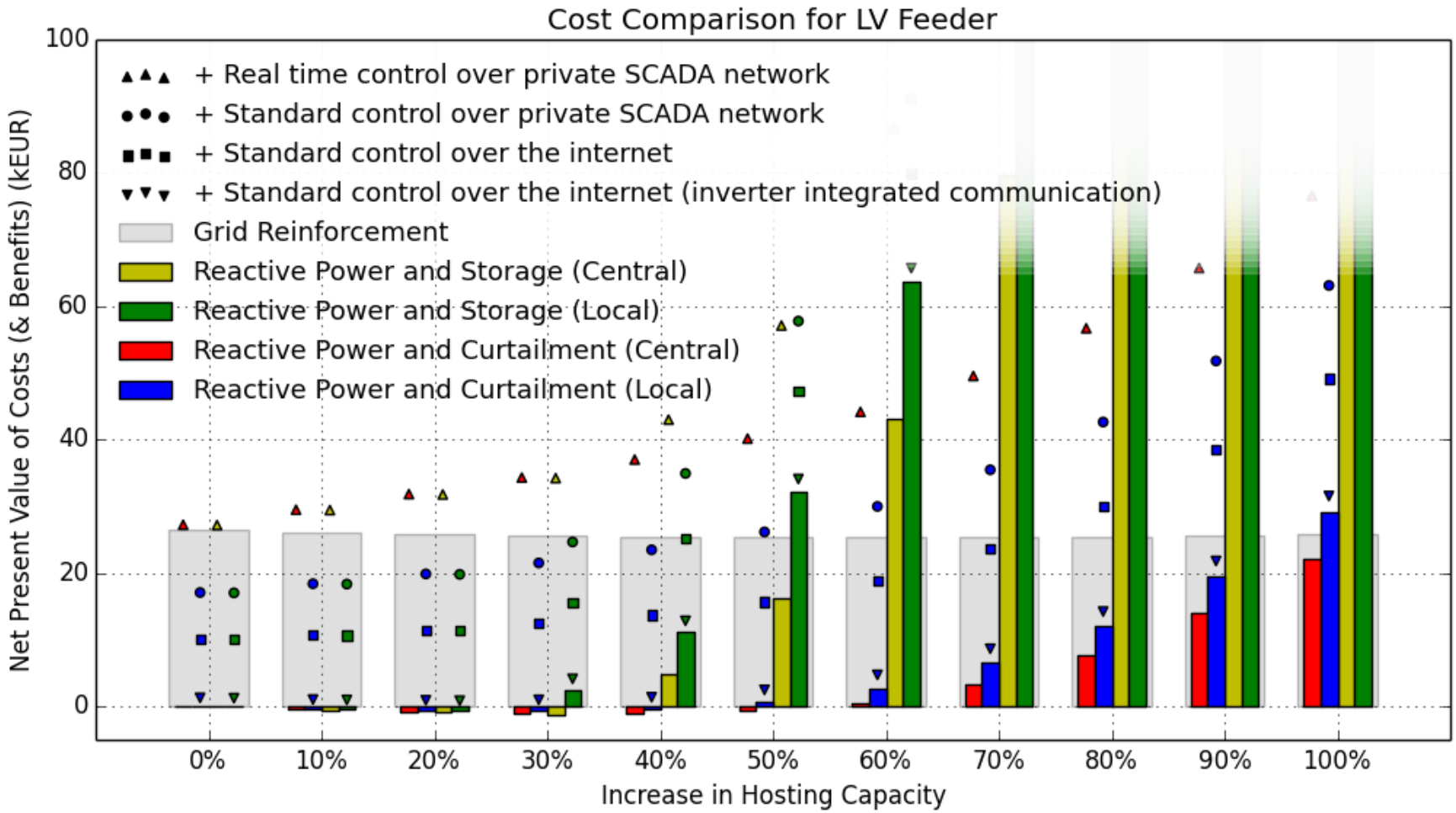
Pro's and Con's of Different Solutions

Criteria

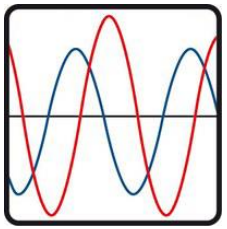
- effectiveness
- efficiency
- fairness
- simplicity

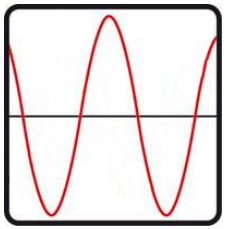
	Effectiveness	Efficiency	Fairness	Simplicity
Q(*V*) with small/no deadband	++	-	-	++
Q(*V*) with medium deadband	+	+	-	++
Q(*V*) with large deadband	-	++	-	++
Q(*V*) with location-based deadband	+	++	+	+
PF(*P*) without deadband	+	+	++	++
PF(*P*) with deadband	+	++	++	++
Coordinated control with uniform *Q*	++	+	+	-
Coordinated control with uniform *PF*	++	+	++	-
Coordinated control (hierarchical)	++	++	-	-

Costs and Benefits



Combining Reactive and Active Power



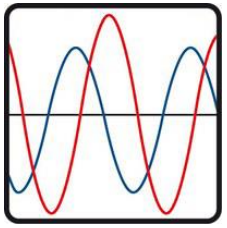


Small limitations do not significantly affect the annual energy yield. However, this requires a clear legal and regulatory framework.

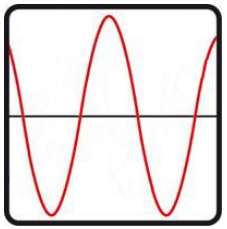
Political questions:

- Should power from renewables be wasted?
- How much is acceptable?
- Who decides to control?
- Should there be financial compensation?

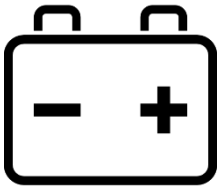
Active Power Curtailment and Storage



- Curtailment is not the preferred option
- Combination of reactive power with curtailment is very effective



- Small amounts of curtailment do not alter the yearly energy yield



- Larger amounts of energy can be buffered with storage
- Most expensive option
- Consider combining different objectives

Overall Conclusion

- Inverter control can increase hosting capacity significantly
- Allows to deploy grid reinforcement more strategically
- Keeps grid fees affordable

➢ **Requires voltage control capabilities as a standardized feature for all plants, even though these may never be activated in many grids**

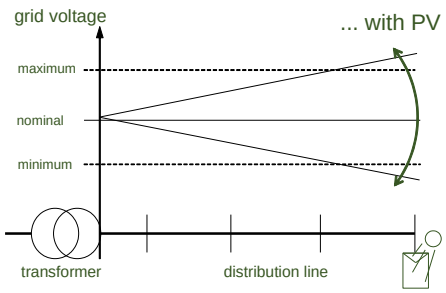
We encourage all stakeholders to build further on the results for improving, replicating and upscaling the solutions presented here.

Broader Context of RES Integration

STATEMENTS FOR DISCUSSION

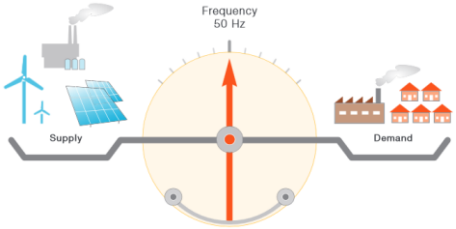
Differentiation in the Smart Grid Context

Local congestion management:



- MetaPV solutions
- **Reactive & active power** control for local congestion management
- **Optimizing** the use of infrastructure **locally**
- More strategic grid reinforcement
- Probably regulated

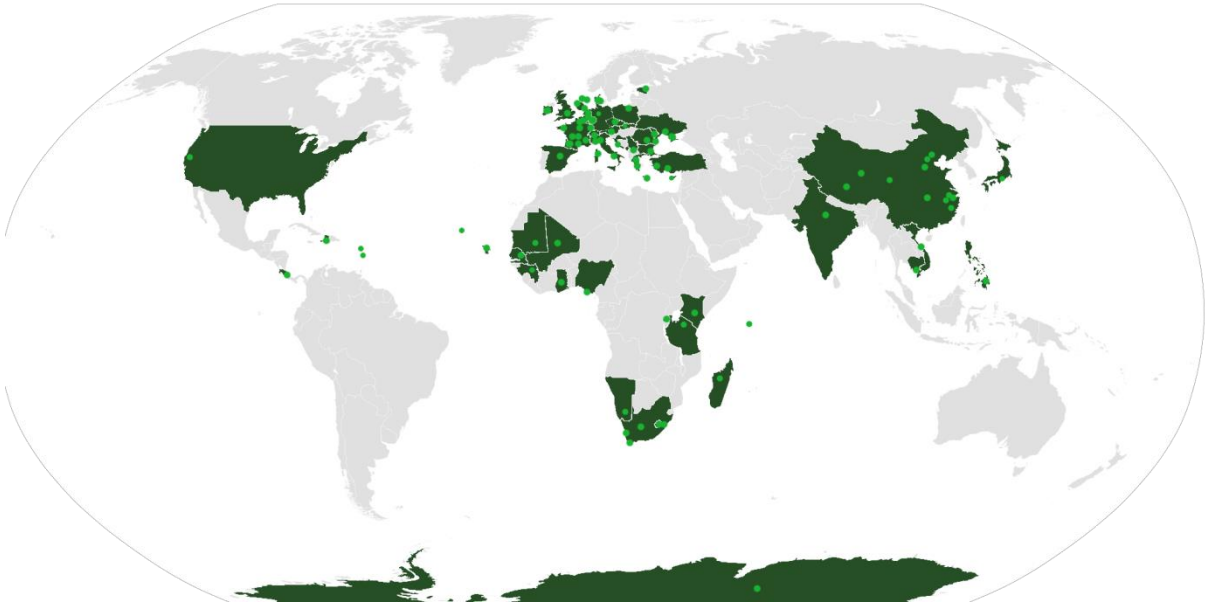
System level challenges:



Source: EPIA 2012

- Require **active power** control towards a **global optimum**
- Possible with energy management or storage
- With distributed or centralized resources
- With **central control** or **adequate aggregation** & disaggregation
- Probably market-based

Thank you



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