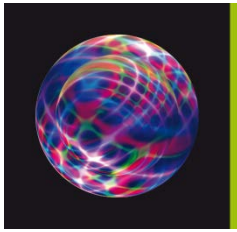
Dr. Enrique Kremers, *Competence Cluster Intelligent Energy Systems*
EIFER, EDF R&D & KIT

Multi-Scale Simulation of Energy System Focus on Power Grids



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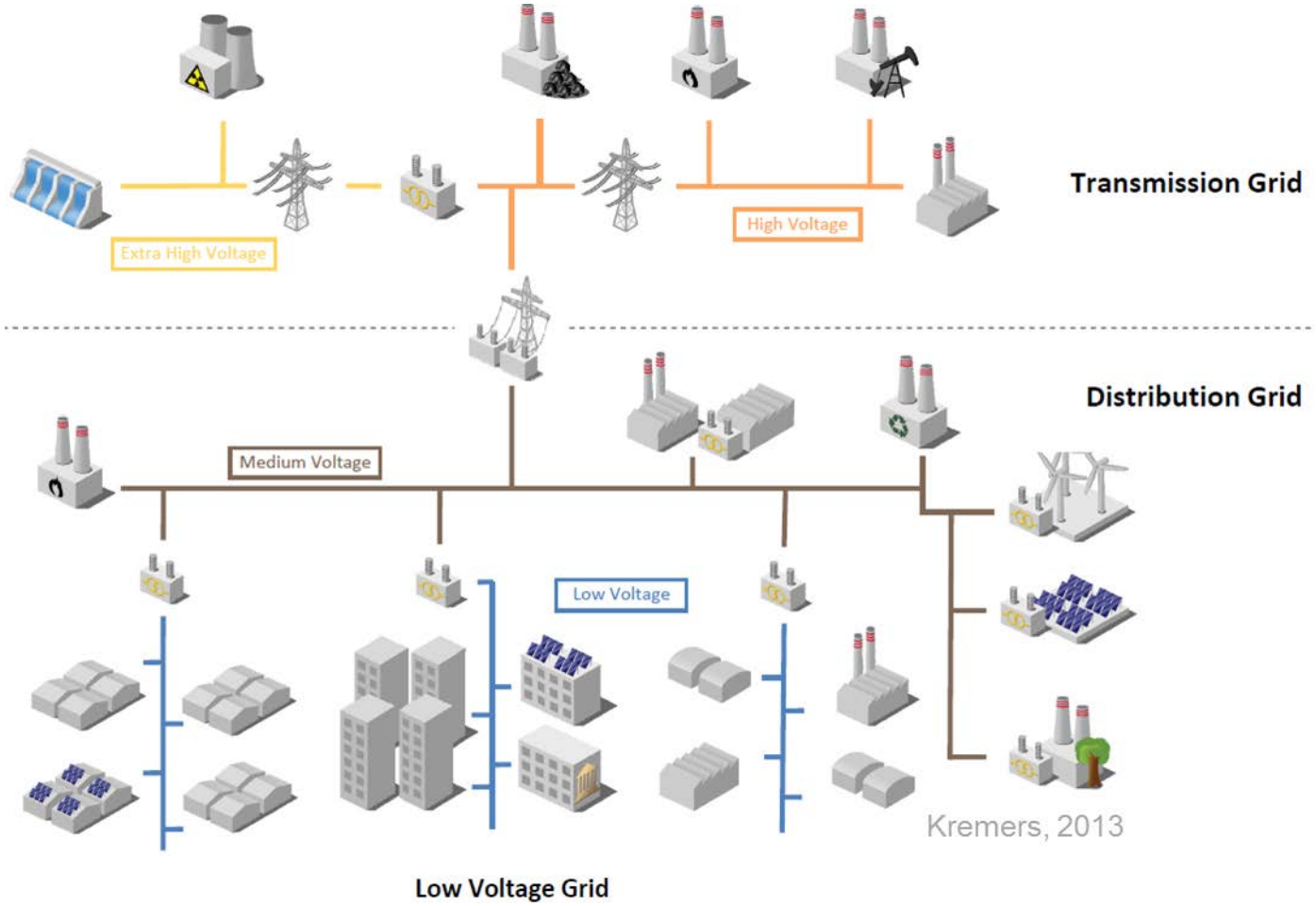
07.12.17, Karlsruhe
ADE Meeting

Electrical Energy Systems



- Different networks & levels
- Interconnected
- Large scale
- Dynamic behaviour (time, space)

Motivation

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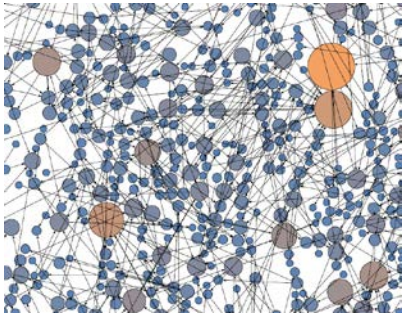
Why a complex systems approach for the modelling and simulation of territorial energy systems?

- Energy systems can be seen as a **system-of-systems**
- Increase of **decentralised decision processes**
- Increase of **communications** and **interactions**
- **Large** numbers of **heterogeneous entities**



→ Modern energy systems are complex system:

- Current tools mainly specialised on **one scale** only
- Behaviours at **different scales** at the system
- **Disaggregated** and **transversal** models
- **Interactions** among the components
- Dependencies, **causes** and **effects**
- **Systemic** perspective

Multi- and Cross-scale Modelling

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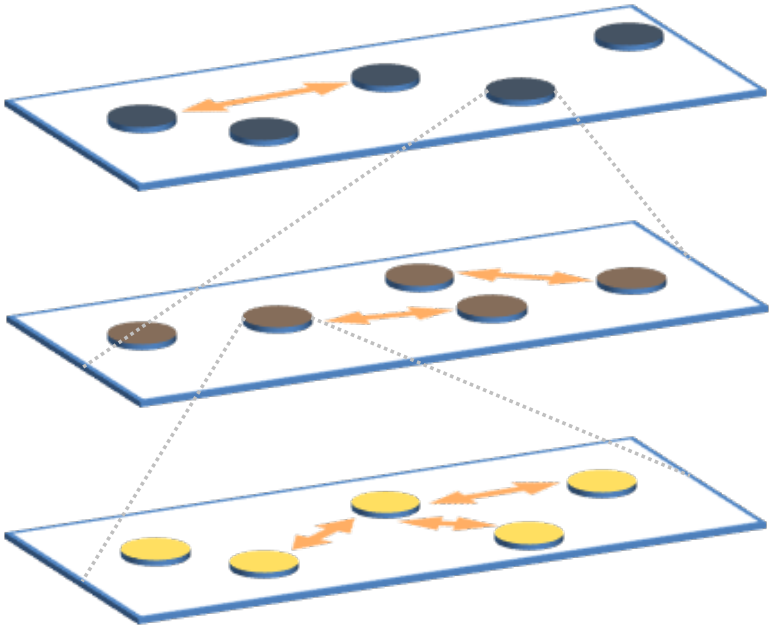
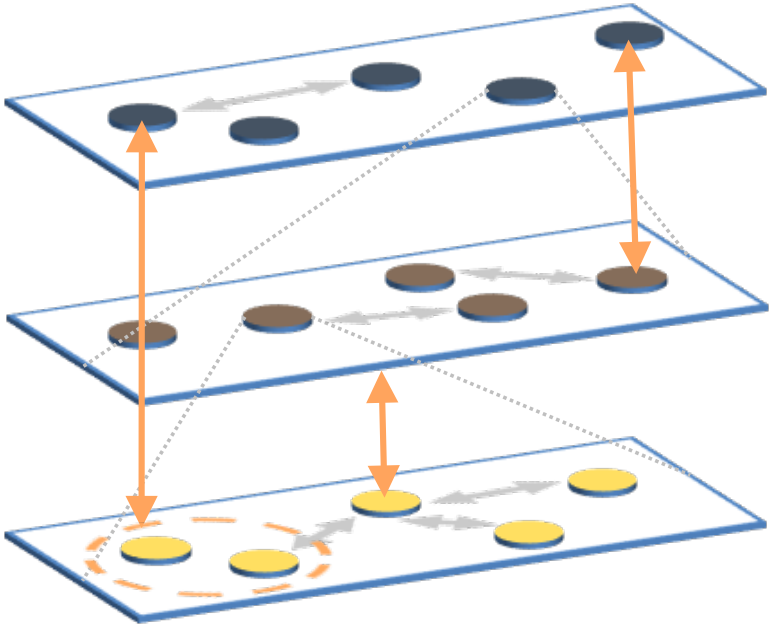
State-of-the-Art

Multi-scale model



Interactions **within** the different scales

Cross-scale model



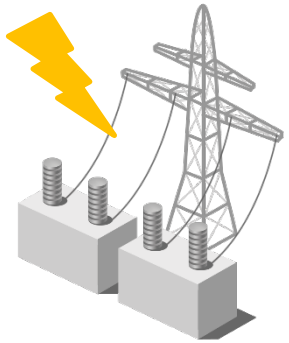
Interactions **between** the different scales

Island Energy Systems

- Islands are autarkic systems
- Costly generation, still relying heavily on diesel generators
- Subsidised electricty price
- Renewable Energies can reduce fuel dependency

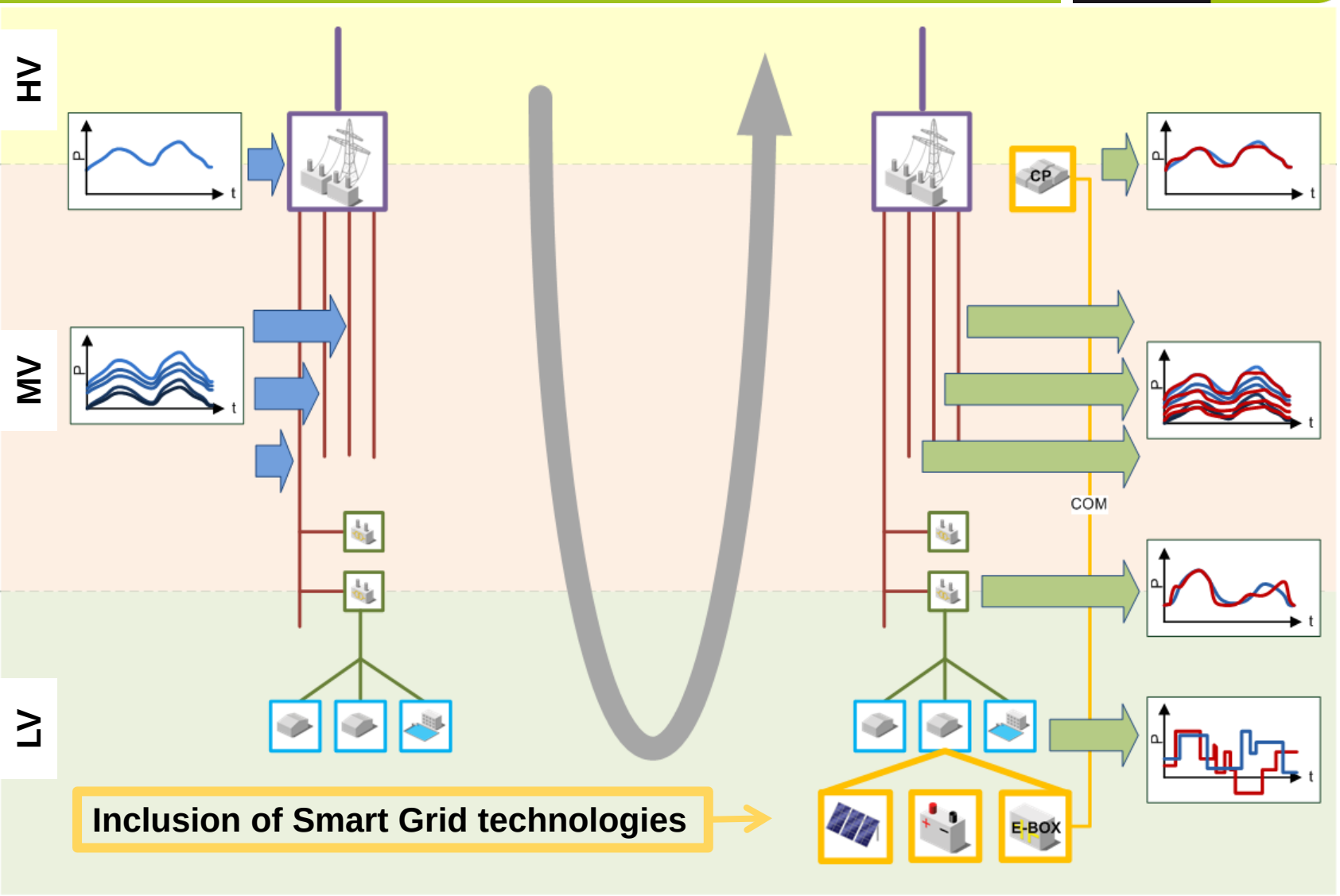
But:

- Fragility of island grids
- Renewables fluctuation provides penetration limits



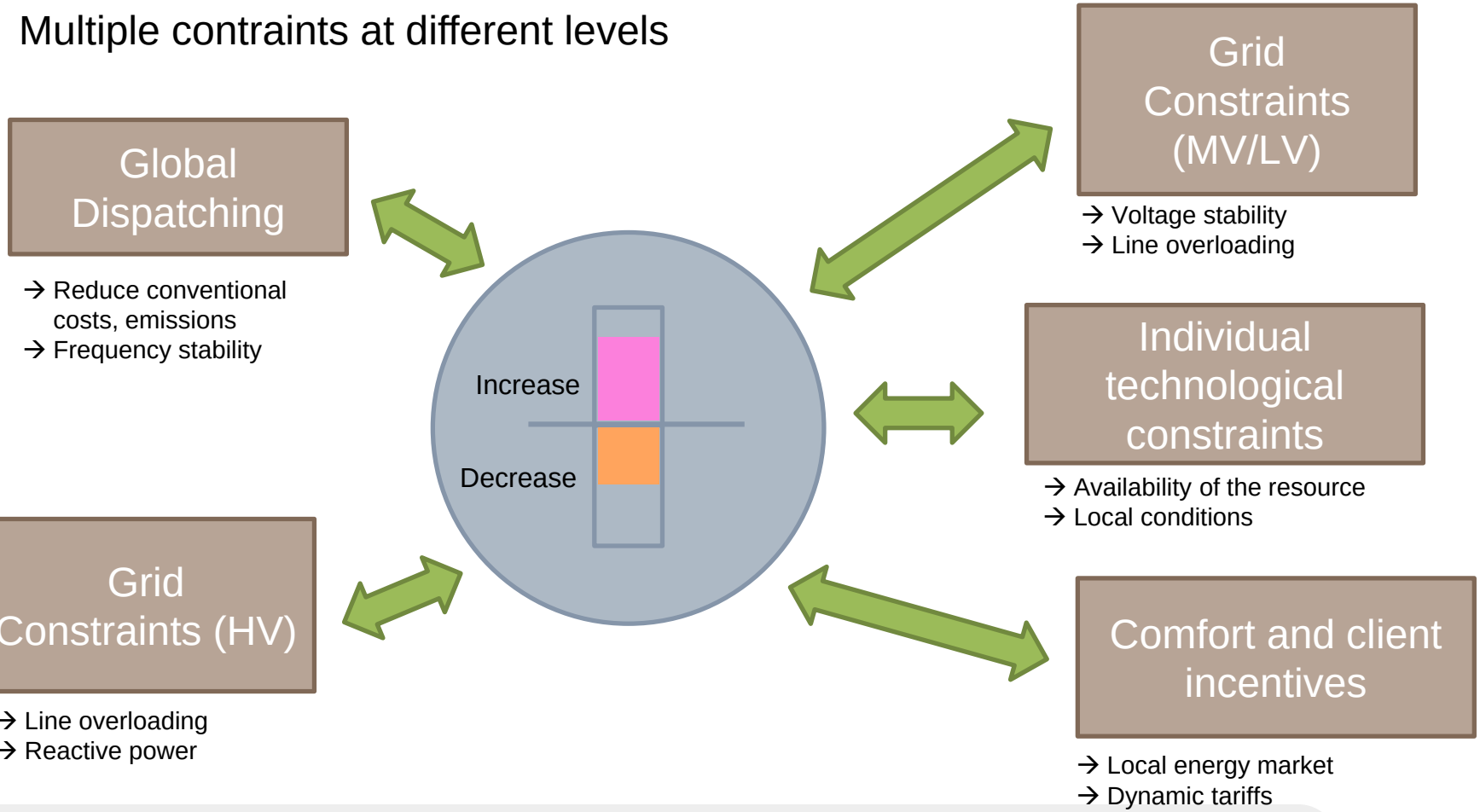
How to increase the share of renewable energies while maintaining (or even increasing) system stability and quality of service?

Multi-Scale Modelling of an island system



Use of distributed load flexibilities

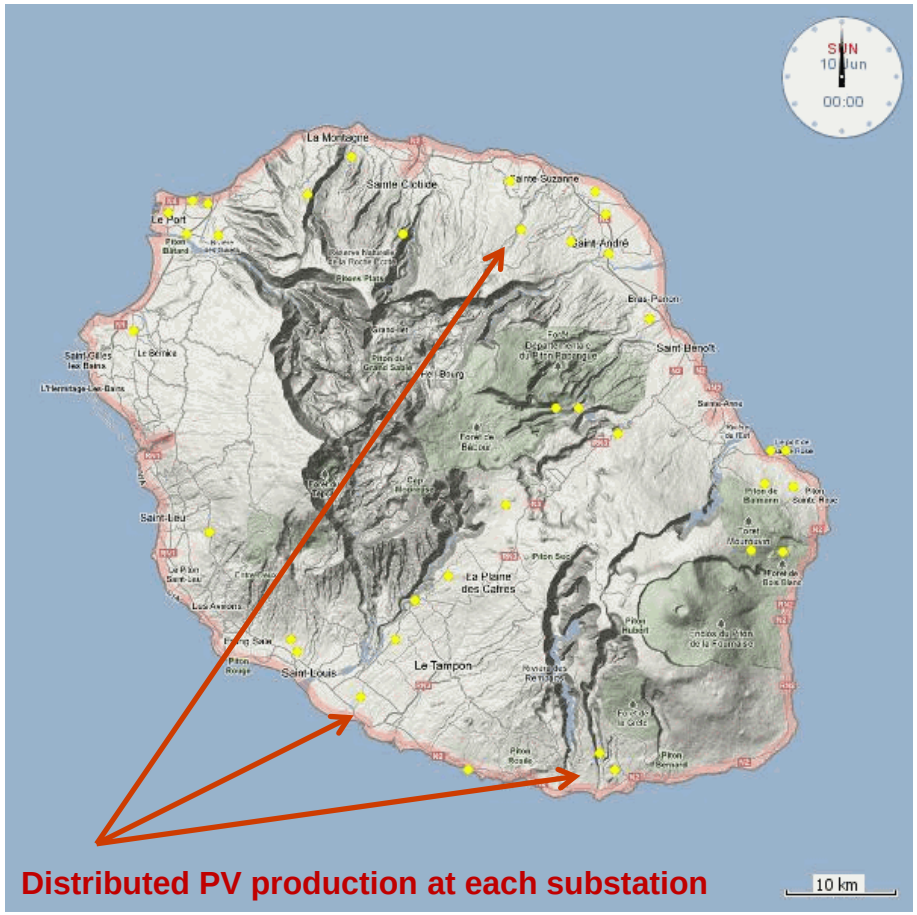
- Flexibility potential can be positive or negative
- Time dependant and causally dependant
- Multiple contraints at different levels



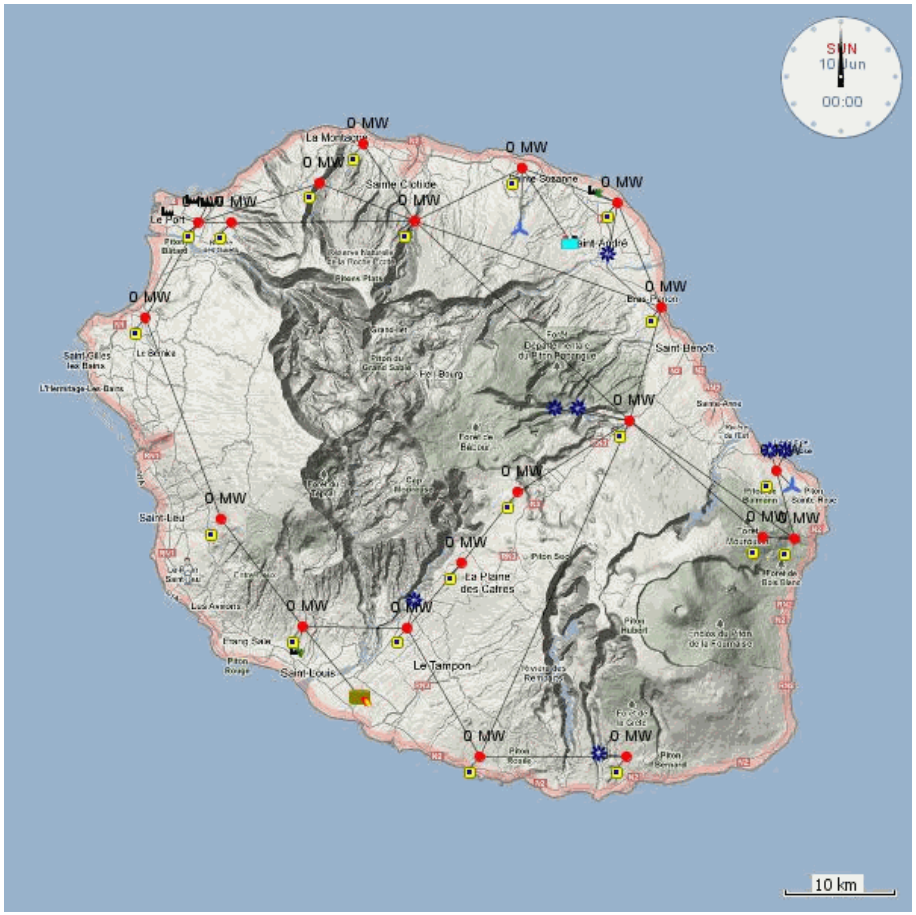
PV Panel study for largely distributed systems – Base scenario / no clouds

Scenario: 2010

Installed PV peak power (distributed): 85 MW



Distributed PV production at each substation



Balance: **SUPPLY**– **DEMAND**

Load flow

S < 100% S < 110%
S < 120% S > 120%

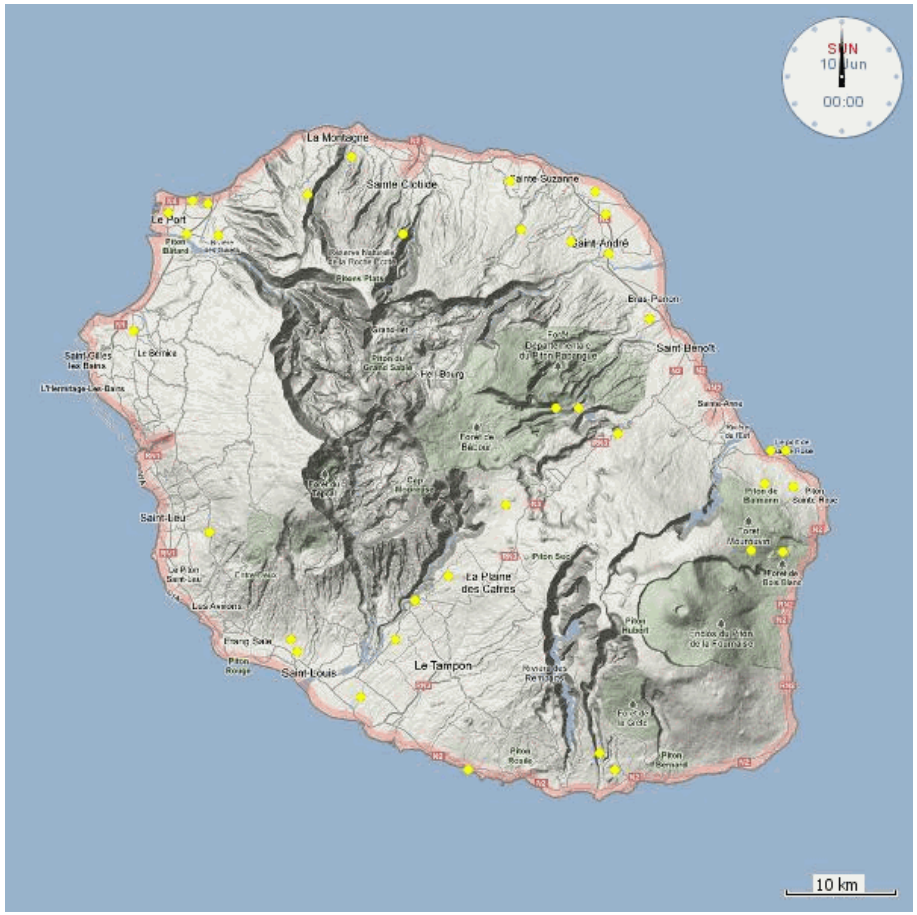
In relation to base scene with no wind

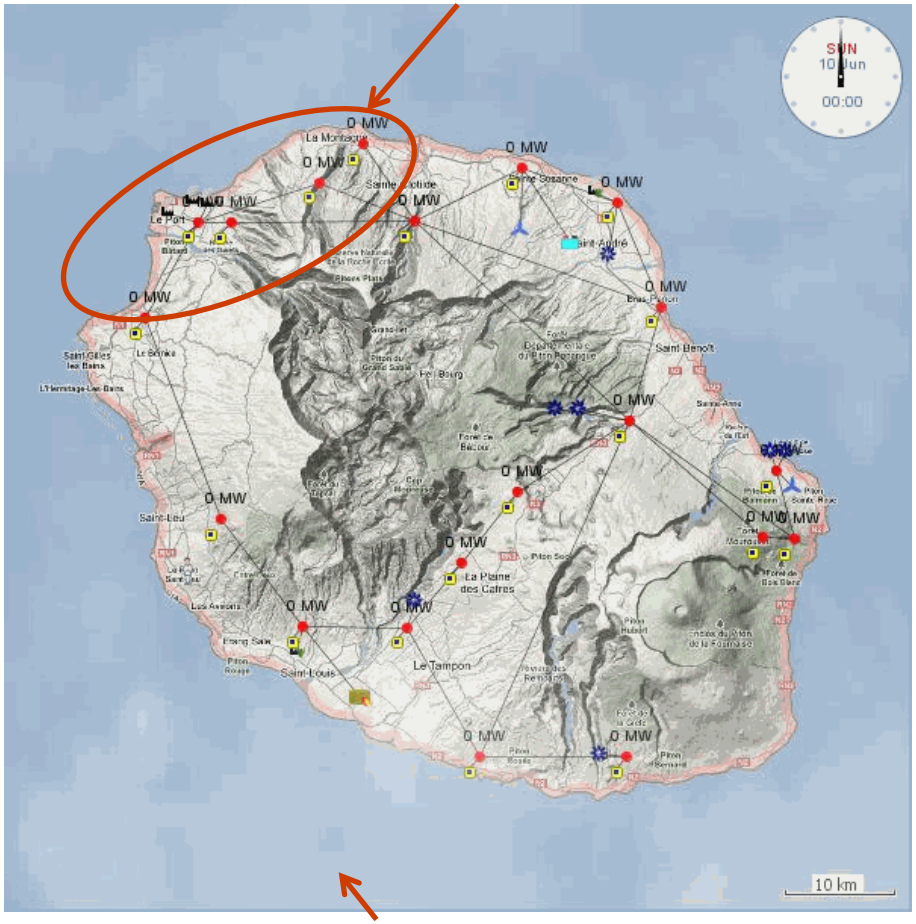
PV Panel study for largely distributed systems – Cloudy day

Scenario: 2010

Installed PV peak power (distributed): 85 MW

Due to cloud coverage, there is a higher production in the thermal plant





Balance: **SUPPLY– DEMAND**

Load flow

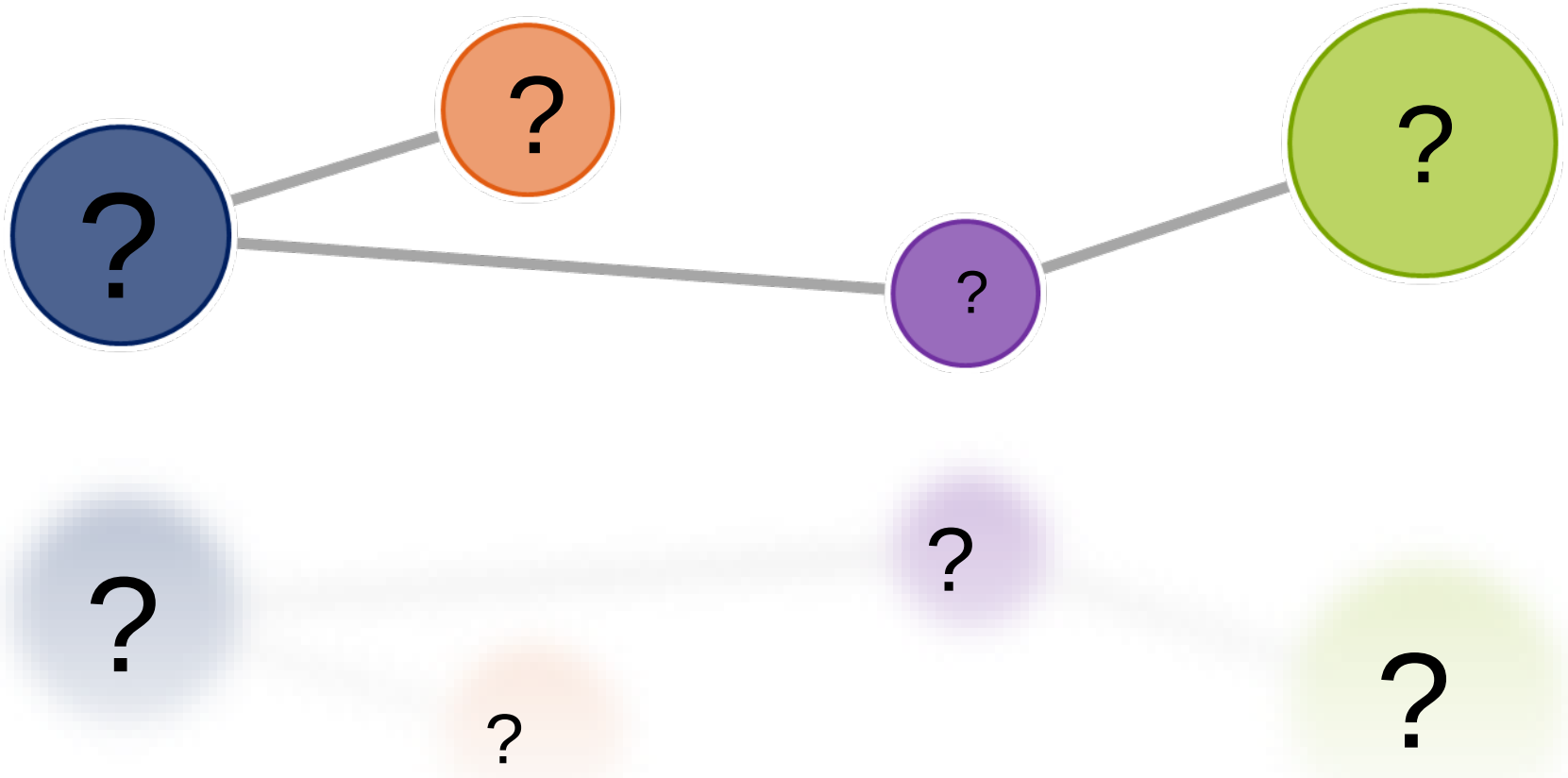
Cloud coverage

S < 100% S < 110%

S < 120% S > 120%

In relation to base scene with no wind

Thank you for your attention…



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