

#### Supervisory Control of Microgrids in Grid-Connected and Islanding Mode – Investigations Using a Real-Time Digital Simulation Platform

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#### **Future power grid**









Whole Europa is hit by a Blackout.

Whole Europa? Nope! One smart village is able to fight the darkness...

And there will be more!







### **Criterias for the control structure**

- Recognition of faults to initialize the islanding process
- Recognition of recovery to initialize the reconnection process
- Short detection time.
- Transients to be minimized.
- Quickly each steady-state
  - In Islanded Mode, frequency and voltage is kept constant.





### Benchmark grid







# **Superisory control**

#### Islanding

- Detection
- Command for circuit breaker
- Command to local control
- Reconnection
  - Detection
  - Synchronisation
- Coordination of local controllers
  - Selection of master device





### Local control

- Grid connected mode:
  - Real and reactive power (PQ) to grid is controlled
  - by current mode control
- Islanding mode (only "master" device):
  - Voltage and frequency (VF) is controlled
  - By voltage mode control







#### Simulation setup





# Simulation types

- Offline simulation
  - Full setup
  - More time consuming
- Real-time simulation
  - Reduced setup: One DER4 and one load L7
  - More realistic:
    - Can be linked to hardware





## Schematic of the current controlled VSC







# Islanding detection and

#### grid reconnection control













### **Simulation scenarios**







### Scenario1: Intentional Islanding

#### **Offline Simulation**



#### **Real-Time Simulation**



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# **Scenario 1: Intentional islanding**

**Real-Time Simulation** 







# Scenario 2: 3-phase short to ground

**Offline Simulation** 







# Scenario 3: 1-phase short to ground

**Real-Time Simulation** 







### Summary

Control for islanding and re-connect of microgrid:

To do

- Converter control
- Supervisory control
  - Detection for islanding
  - Re-connection
  - Power control



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