Vancouver 2010 Symposium on Microgrids, 21-22 July, 2010

# More Microgrids Project

## Overview of demonstration objectives and highlight results

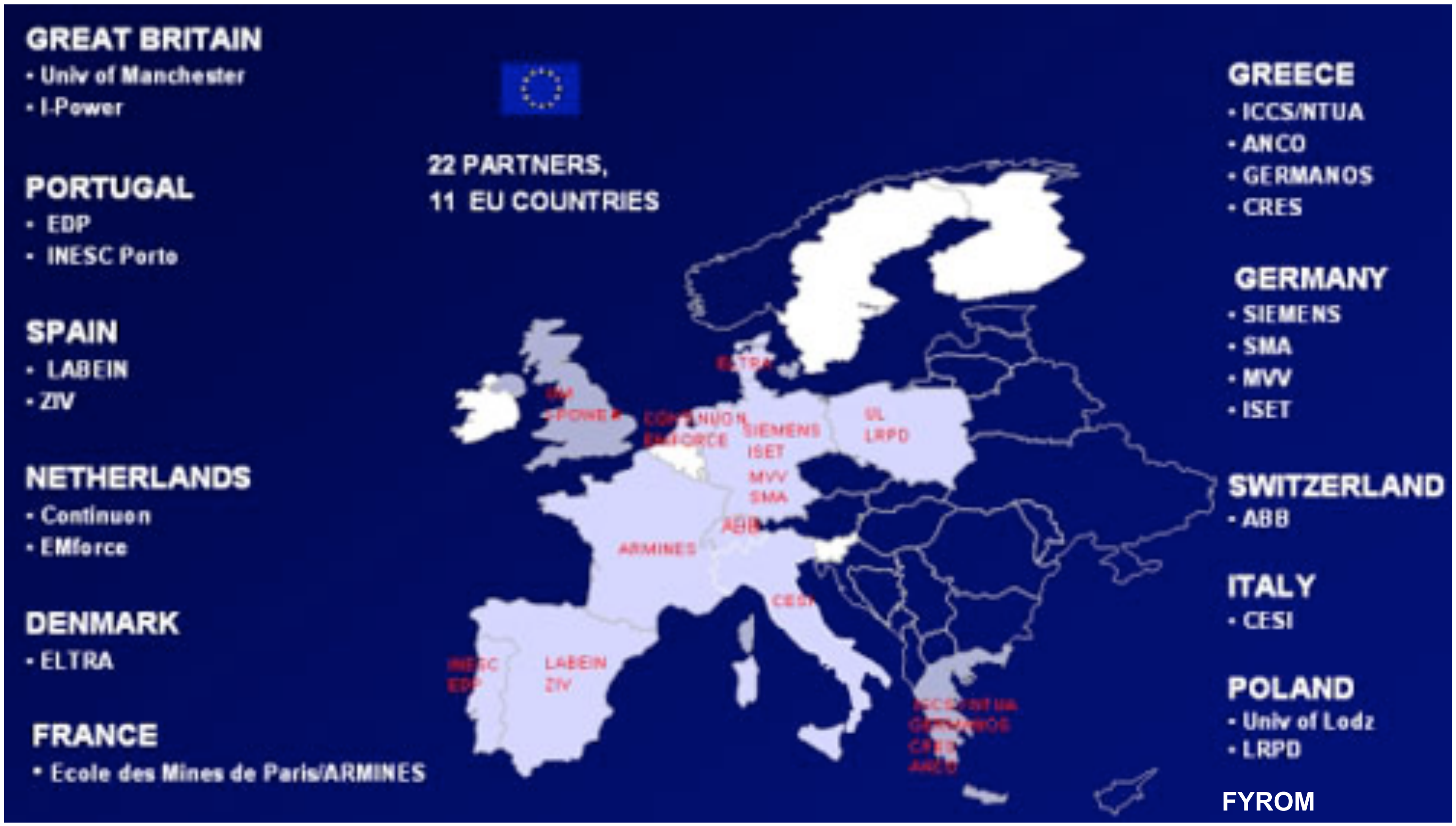
George Kariniotakis
Head of Renewable Energies & Smartgrids Group
Centre for Energy & Processes, MINES-ParisTech
georges.kariniotakis@mines-paritech.fr

www.microgrids.eu

# More Micrograids Project

*"Large Scale Integration of Micro-Generation to Low Voltage Grids*

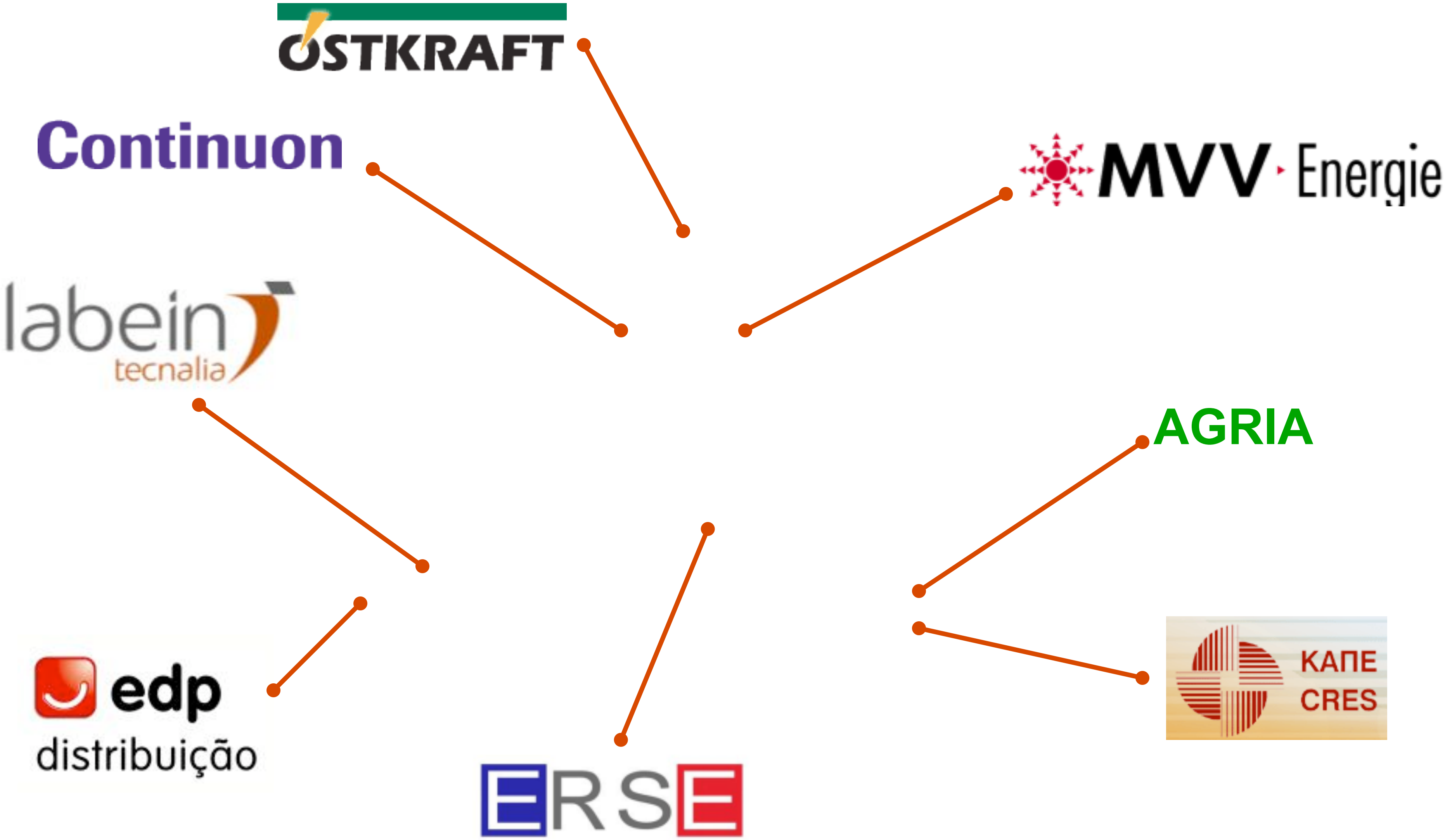
Contract : ENK5-CT-2002-00610, Budget 8 Mio€



# More Microgrids Project

**Highlights :**

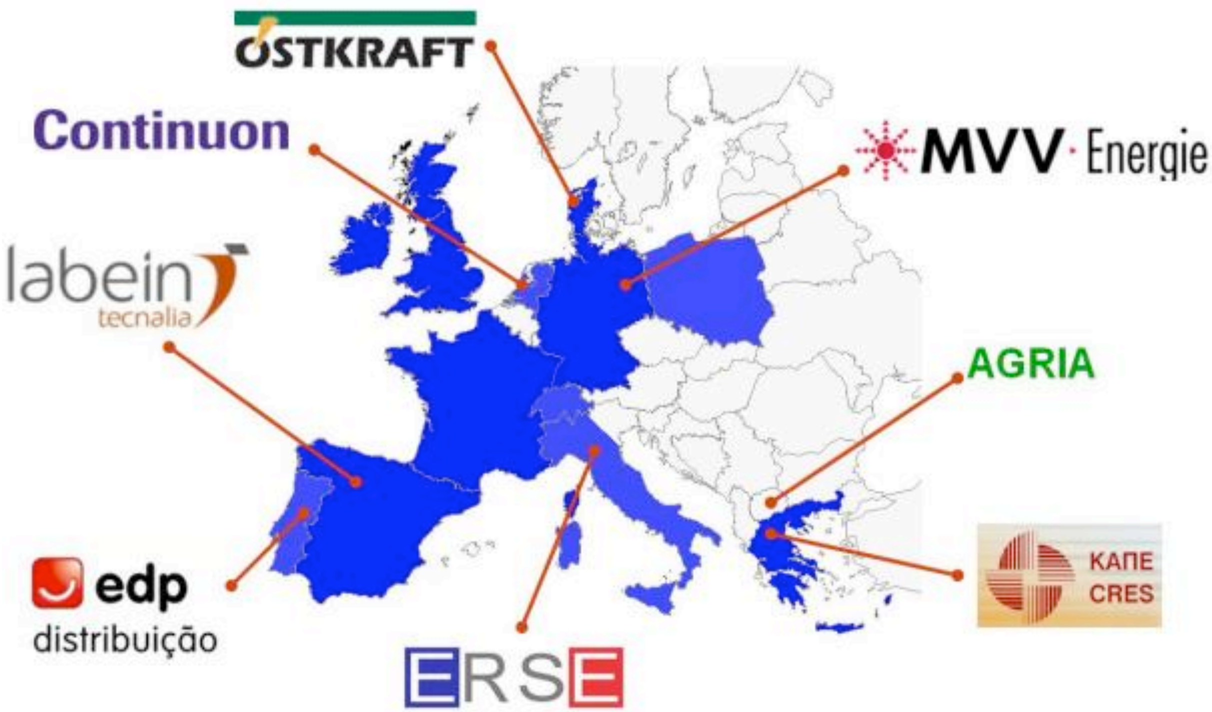
- Implementation of sophisticated control techniques for Distributed Generators and Load Controllers
- Integration of several microgrids into operation and development of the power system. Interaction with DMS.
- Field trials to test control strategies on actual microgrids
- Quantification of microgrids effects on power system operation and planning


ÖSTKRAFT
Continuon
MVV Energie
labein
tecnalia
AGRIA
edp
distribuição
ERSE
ΚΑΠΕ
CRES

# Field demonstration cases

Types of microgrids :

- 3 urban/commercial
- 1 rural
- 2 islands
- 2 labos



# Field demonstration cases

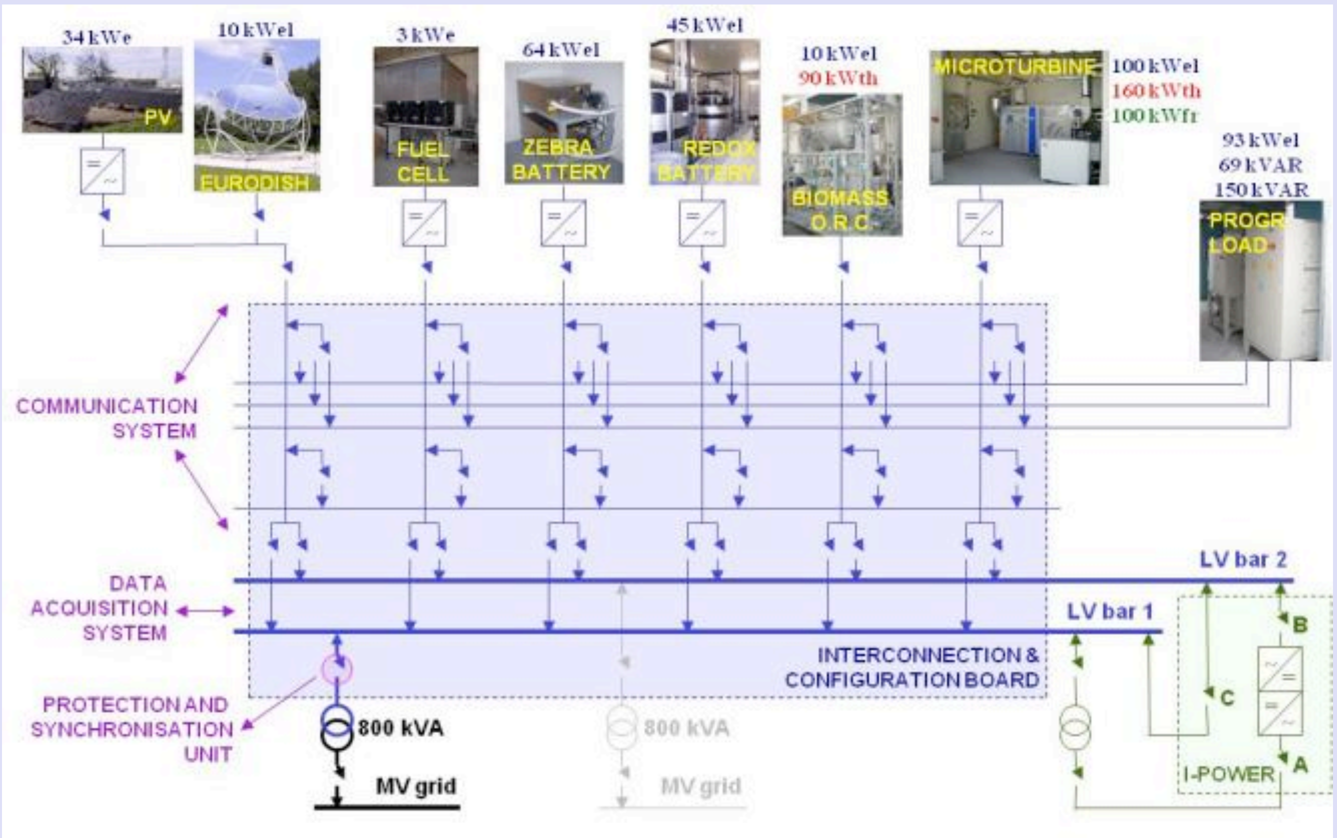
## 2 large laboratories considered for "risky" tests

labein tecnalia

# Field demonstration cases

## 2 large laboratories considered for "risky" tests

ERSE



# Objectives of field demonstrations (1/2)

Experimental validation of various actual Microgrids in different operating modes. In particular the following objectives were set :

- Evaluation of different operating modes :
  - interconnected
  - islanded – evaluation of long term operation, (i.e. fault level, parallel operation of inverters, harmonics etc)
  - transitions from interconnected to islanded mode and vice versa.
  - automatic isolation and reconnection
  - zero energy flow with main grid
  - black start capability

# Objectives of field demonstrations (2/2)

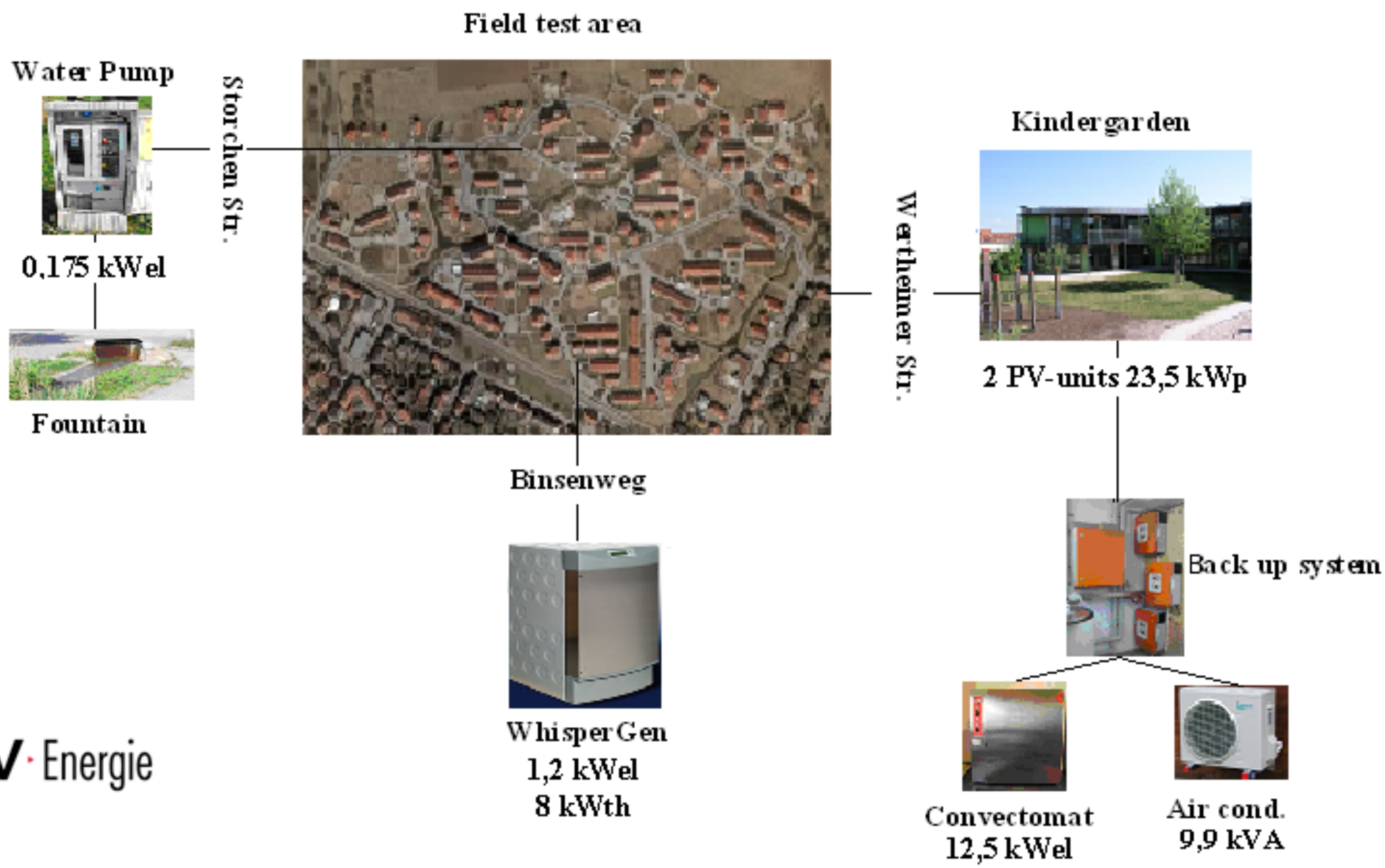
- Evaluate different control strategies :
  - Centralized
  - Decentralized (agents)
- Assess of power quality aspects from the integration of DG & RES units.
- Study issues related to awareness and acceptability of customers

Further, in a complementary project (INCO) :

- Evaluate the integration of new RES technologies like biogas.

# HIGHLIGHTS: The Manheim case

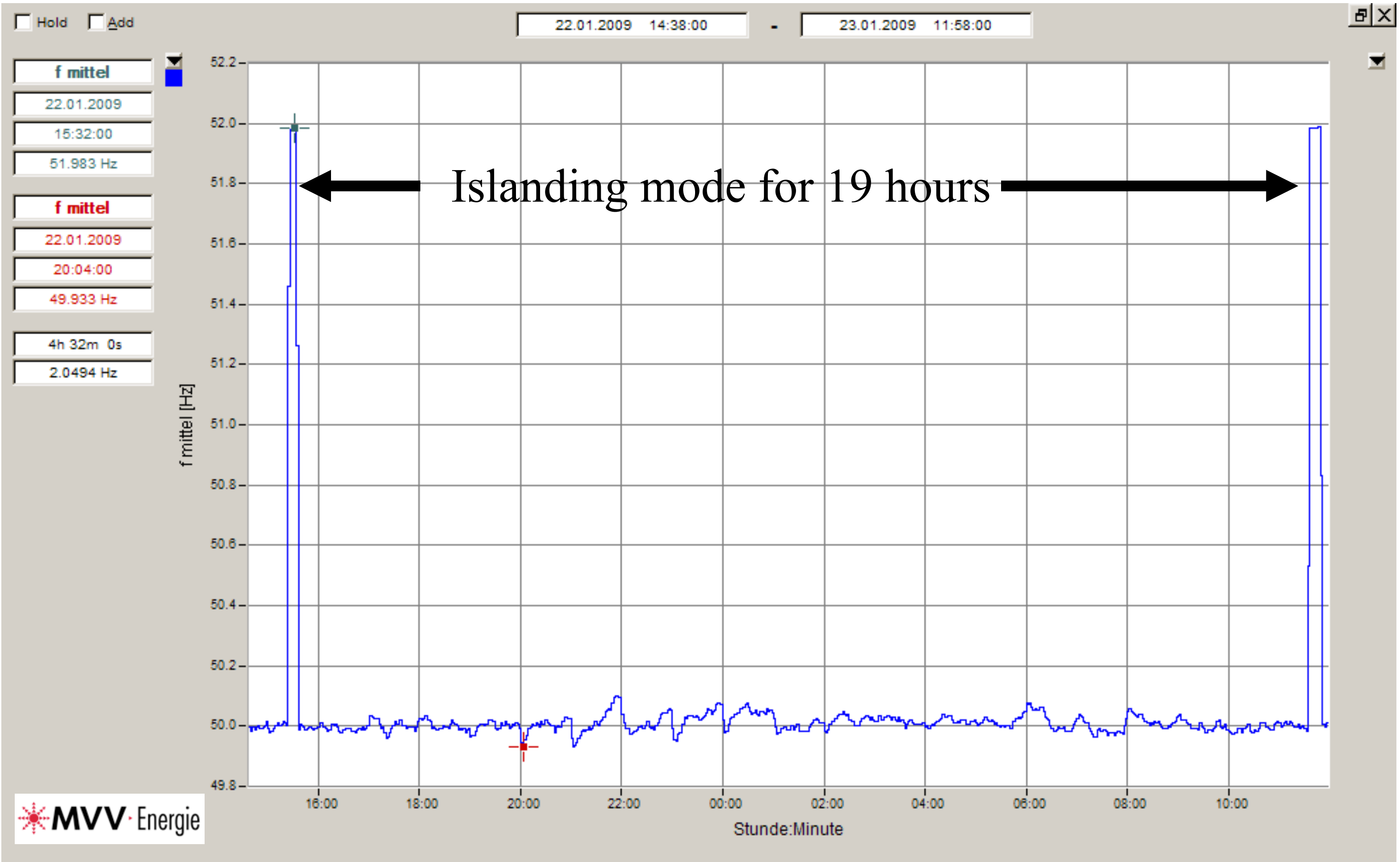
## Field test area and installed units




MVV Energie

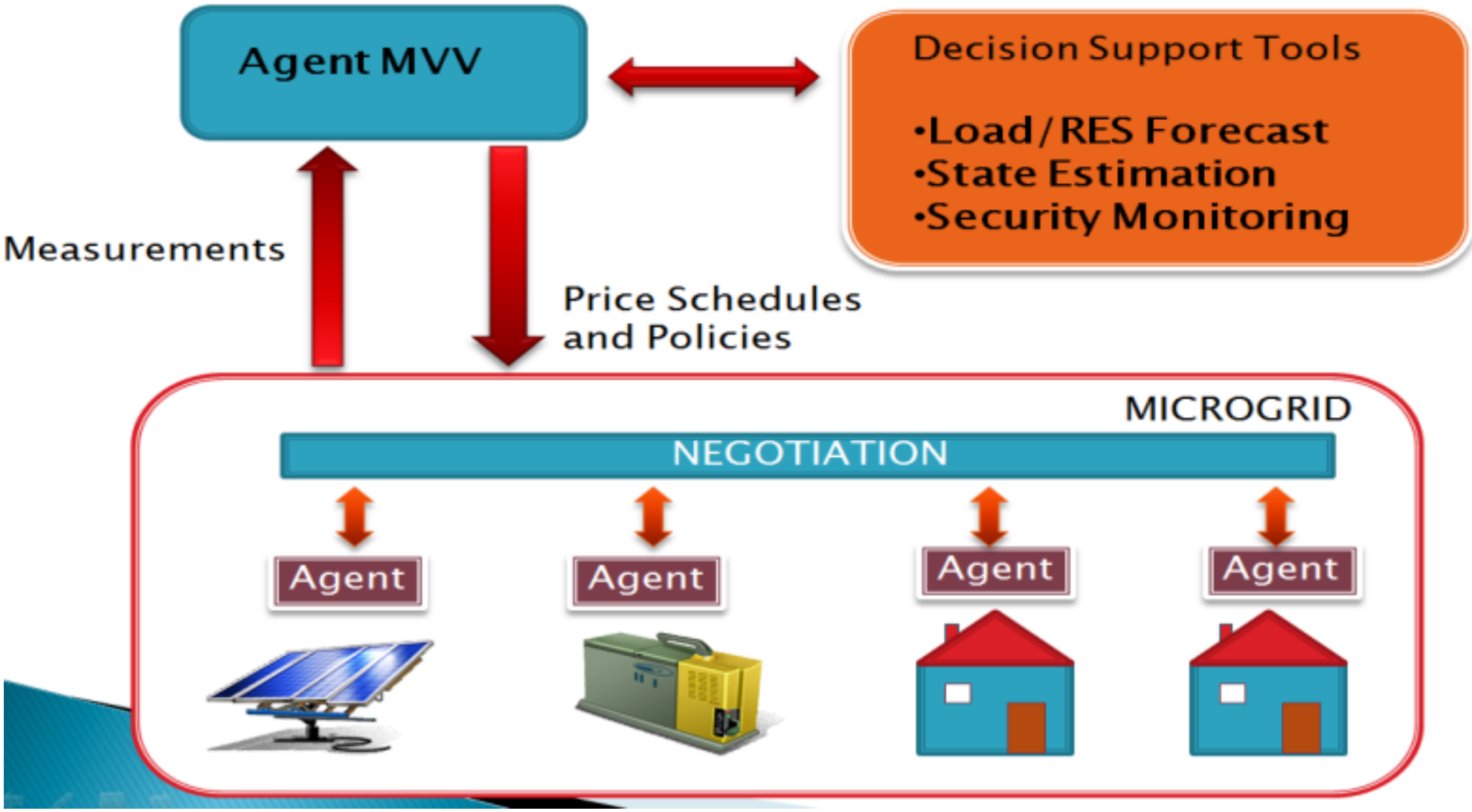
# HIGHLIGHTS: The Mannheim case

## Proof of seamless transition Grid - Island - Grid



# HIGHLIGHTS: The Manheim case

## Proof of functionality of multi agent system



# HIGHLIGHTS: The Manheim case

## Role of social acceptance


# HIGHLIGHTS: The Bronsbergen holiday resort case

## Description of case & objectives

Holiday park, Zutphen, NL
108 cottages with PV roofs
Installed solar power 315 kWp
Peak load 150 kW

# HIGHLIGHTS: The Bronsbergen holiday resort case

## Description of case & objectives

Holiday park, Zutphen, NL
108 cottages with PV roofs
Installed solar power 315 kWp
Peak load 150 kW

### Technical objectives

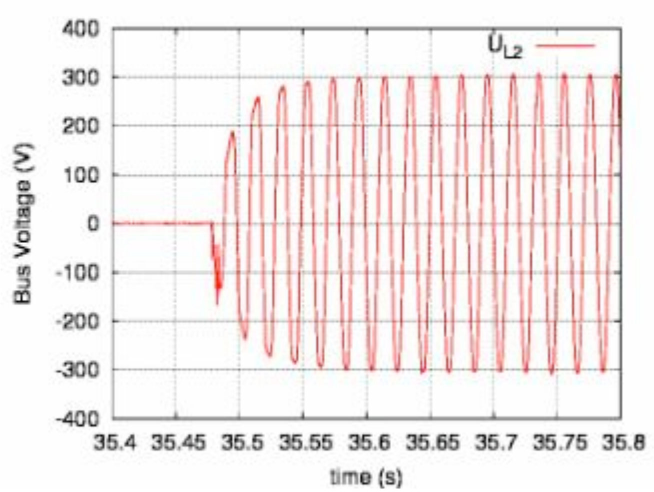
- Demonstrate stable parallel operation of inverters and load sharing in islanded mode √
- Demonstrate fault level in islanded mode √
- Demonstrate cap. to manage battery energy and lifetime √
- Demonstrate reduction of harmonics √
- Demonstrate black start capability of microgrid √
- Demonstrate automatic isolation and reconnection √
- Demonstrate long-term islanded operation principle demonstrated, but 24h not permitted – load during the nights too high for batteries

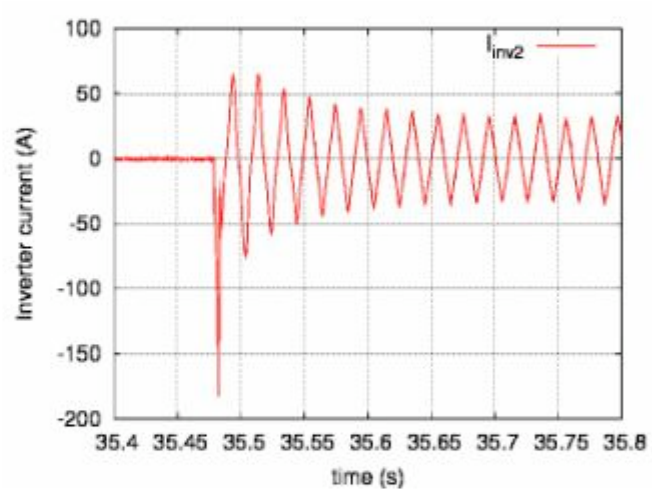
# HIGHLIGHTS: The Bronsbergen holiday resort case

## Test of black start

Objective:
Show that a single inverter is capable to black-start a de-energised distribution network.

Methodology:
Run the microgrid in islanded operation, then switch both inverters off. Restart one inverter.

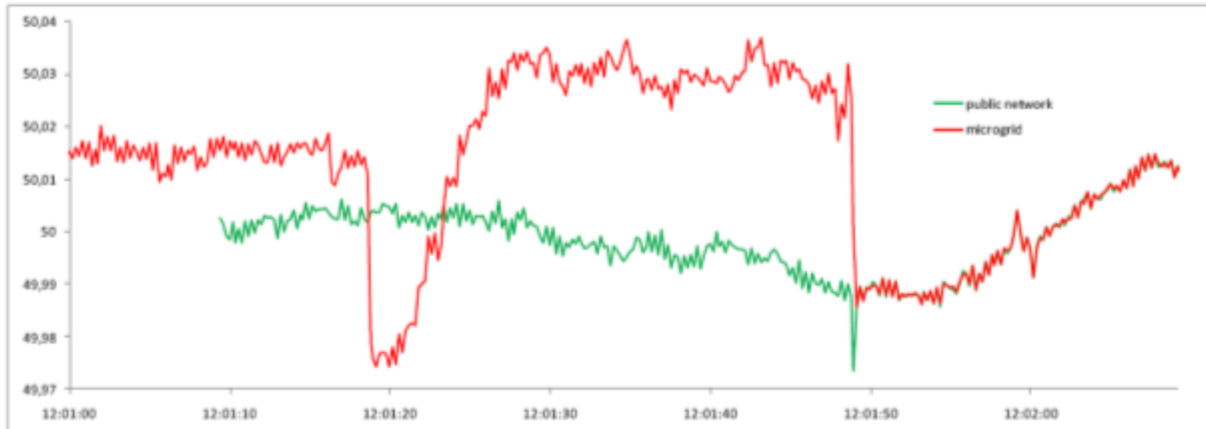


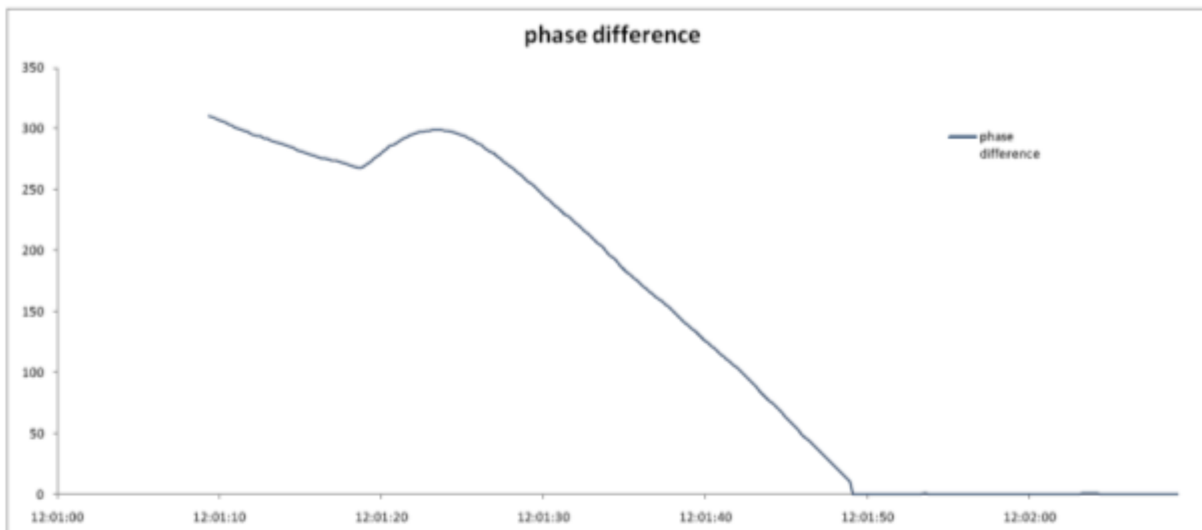
# HIGHLIGHTS: The Bronsbergen holiday resort case

## Test of automatic microgrid reconnection

Measured frequencies of the microgrid (red) and the public network (green).




Measured phase difference between the microgrid and the public network.



# HIGHLIGHTS: The Bronsbergen holiday resort case

## Lessons learnt

- Additional hard- and software => need for instruction and education of all who has to work with the equipment
- Additional safety issues
- Cooperation with customers is required
- Battery inverters with proposed control system , SC rating and black start capability very suitable for  microgrids that must swap between grid-connected and islanded mode → being commercialized right now
- Very powerful capability to improve harmonic behaviour of the network → being commercialized right now
- Island detection on microgrid level remains an issue: Is possible but not as simple as for a single inverter. Standardization of concept would be helpful
- Batteries must be dimensioned generously to avoid operating too close to reliability limit; synchronization may fail if SOC close to 100%
- Adherence to grid codes by all components must be certified (i.e. PV inverters failed to switch off when f>52 Hz)

# Overview & perspectives

- The relative small size of the demonstrations permits to draw mainly qualitative conclusions => main lessons learnt concern the "**how to**" :
  - Proof of concepts (i.e. decentralised control) in real systems
  - Technical feasibility (i.e. islanding)
  - Monitoring/observation of microgrid operation
  - Assessment of cooperation with customers (i.e. acceptability)
  - Knowledge about costs, deployement, operation of microgrids

- The next step could be "large-scale" demonstrations to assess effects of scale (i.e. load shaving, $CO_2$ savings etc).

# Overview & perspectives

- The EC launched a call for demonstration projects within FP7 *(March 2010, ENERGY.2010.7.1-1: "Large scale demonstration of smart distribution networks with distributed generation and active customer participation", financing 35 Mio€)*

- Several projects were proposed. Currently they are at negotiation phase. Successful ones are expected to start by beginning of 2011.

# Thank you for your attention!