

Field Tests on Actual Microgrids

Test case of AGRIA

INCO Partners:

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BIG



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More Microgrids project work package F

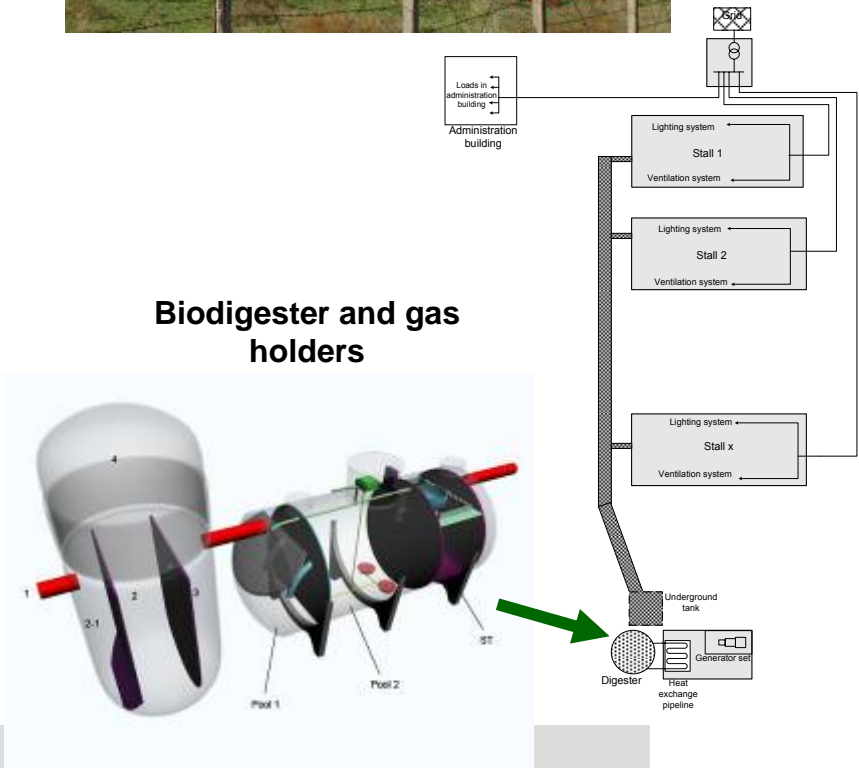


www.microgrids.eu

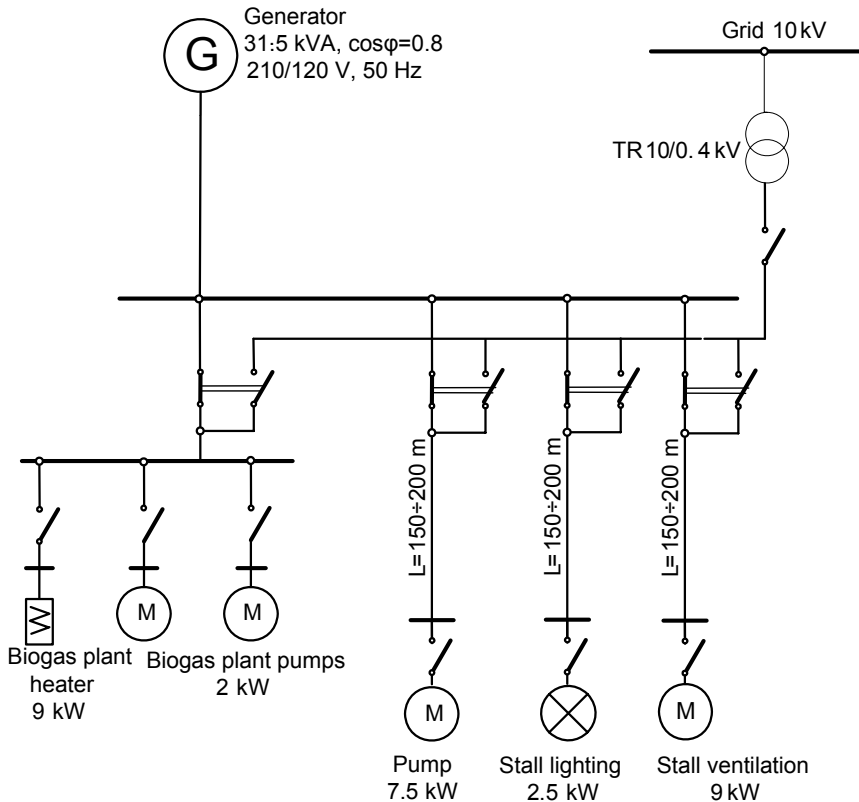
Description of the microgrid



- General description of the physical system - microgrid
 - Located in a rural area, on the pig farm AGRIA
 - Consists of several warehouse-like stalls with ventilation, temperature control and lighting systems, administrative building and few utility buildings
 - Connected to the 10 kV distribution grid
 - Equipment for biogas production and a generator set exist on the farm (before the project it was out of operation)



Description of the microgrid



Pilot microgrid single line diagram

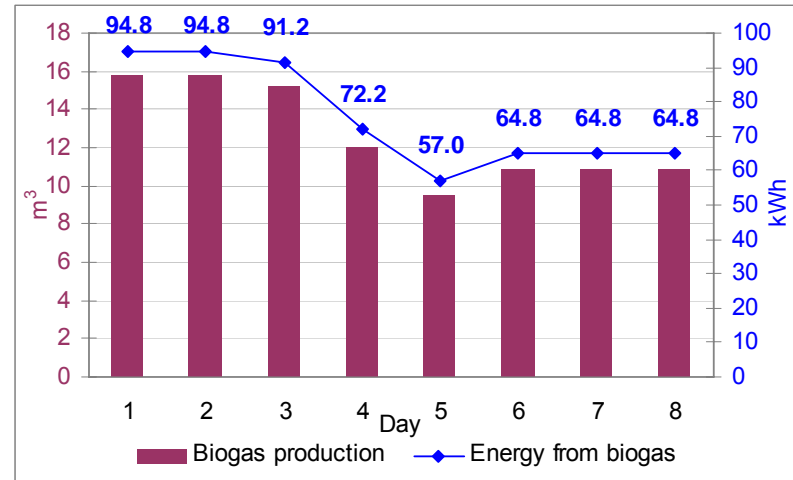
- The pilot microgrid encompasses a part of the existing low voltage grid on the farm, few loads and a generator
- Two supply possibilities:
 - by the distribution grid
 - by the DG unit fuelled with biogas from the waste water treatment
- The generator can supply continuous power at variable load, but no overload is permitted on generator's ratings



- Objectives of the demo case
 - To provide an example for inclusion of a biogas plant into a microgrid.
 - To introduce and test the microgrid concept in the power system of a country in the Western Balkans region.
 - To increase the potential and awareness of Microgrid option in non-EU regions through dissemination
 - paper presented 5th Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems and accepted as archival paper
 - paper: “Microgrids: the Agria test location” - submitted for publication in Journal of Thermal Science
 - linkages with similar existing national projects (Agro-Energy, financed by Swedish Development Agency - SIDA) established
 - project location presented at the workshop dedicated to founding of the Smart Grids platform
- Objectives of the tests
 - To validate the island mode of operation

Highlight results (Biogas production tests)

- In laboratory environment:
 - optimal biogas production technology examined
 - biogas quality investigated
 - optimal starter culture for the anaerobic digestion determined
 - optimal fermentation temperature for higher biogas production determined
- On the test location:
 - first tests done with 38 m³ waste water
 - measurements show the daily biogas production is between 10 - 16 m³, with calorific value of 21.6 MJ/m³ (6 kWh/m³)
- Final status: *successful*



Biogas production on the test location



Highlight results (Microgrid tests)



- Objectives
 - To validate isolated mode of operation
 - To investigate network harmonics
- Measuring equipment: Iskra-MIS MC 750 Network recorder
- Methodology
 - Voltages, currents, active and reactive power, power factor, THD, frequency measured
 - Network operated in isolated mode, tests with unbalanced loads on three phases consist of electric motors and heaters



Part of the measuring equipment



Preparing for tests and measurements





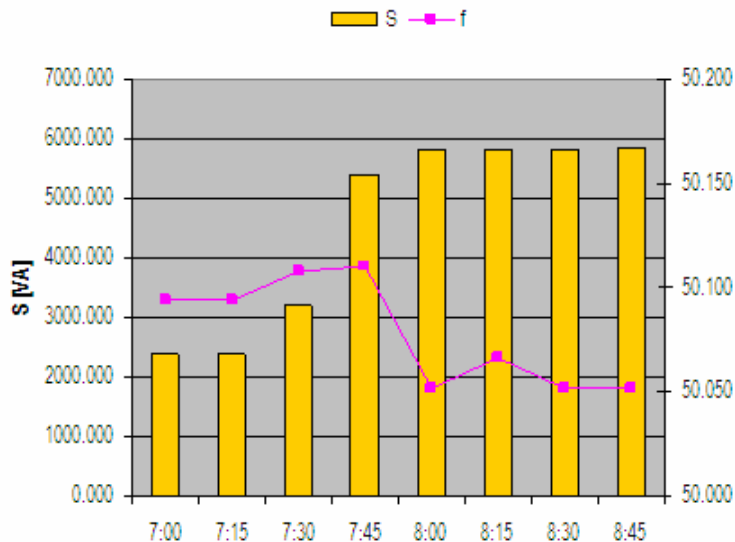
Highlight results (Measurements - morning hours)

Example of microgrid operation in isolated mode in the morning hours (7:00 - 8:45)

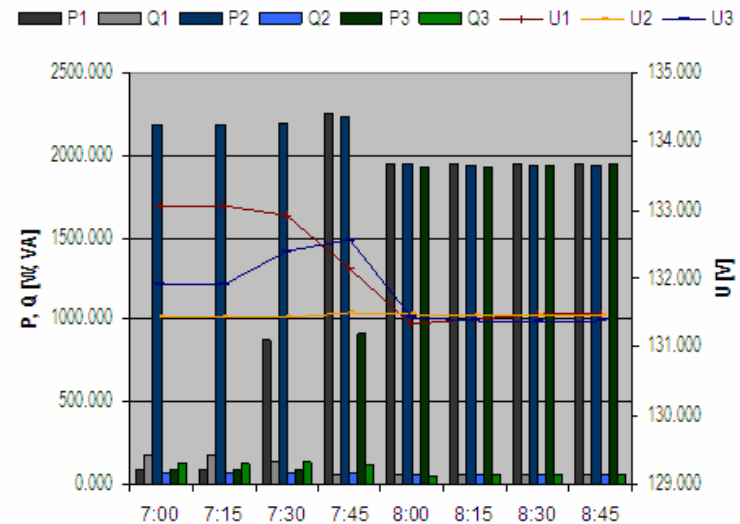
Events: About 2 kW load were switched to phase 2 at 7:00; At 8:00 loads are switched to all three phases

The frequency changes slightly during switching the loads, then settles at 50.05 Hz

Visible changes in voltage when loads are switched on; afterwards the values settle at about 131.5 V



Frequency and apparent load



Phase-to ground voltages and loads



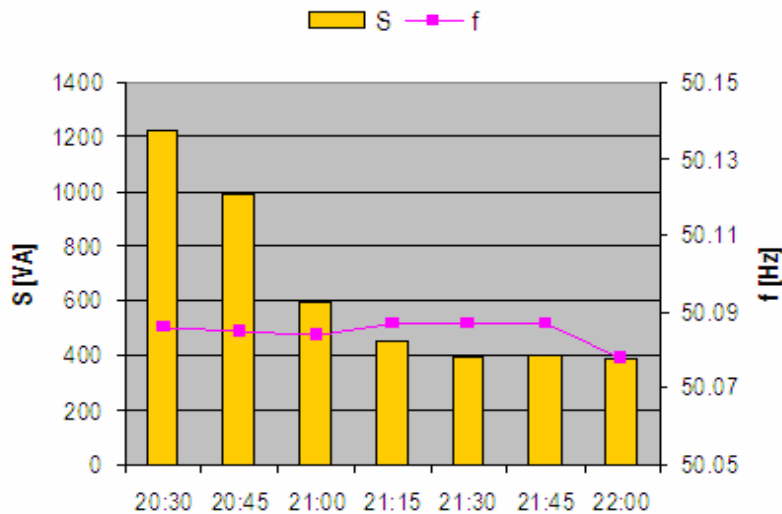
Highlight results (Measurements - evening hours)

Example of microgrid operation in isolated mode in the evening hours (20:30 - 22:00)

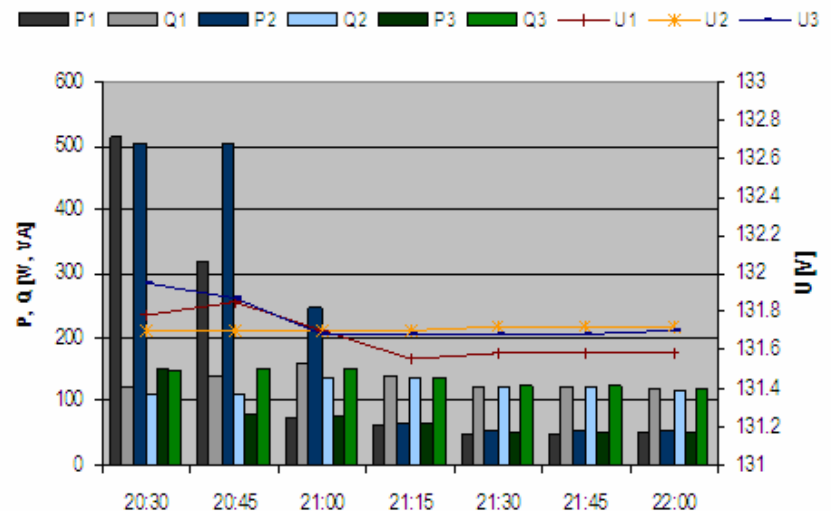
Events: Unbalanced loads mostly on two phases, reduced during the first hour

The frequency slightly varies between 50.076 Hz and 50.088 Hz

The voltage slightly changes during switching-off loads; afterwards settles at about 131.7 V



Frequency and apparent load



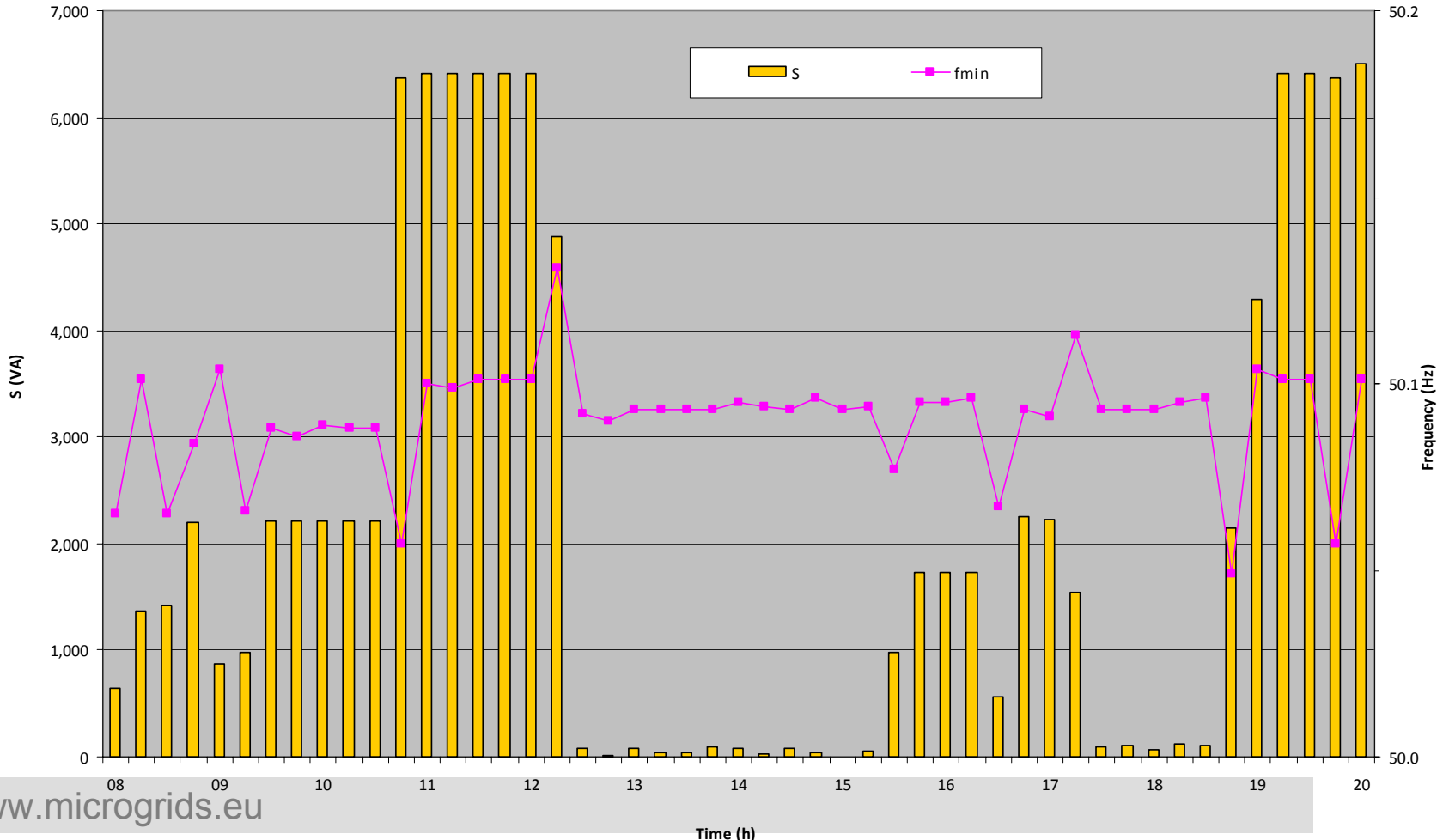
Phase-to ground voltages and loads

Highlight results (Measurements - 12h operation in isolated mode)



Example of 12h microgrid operation in isolated mode, the frequency is kept at 50.1 Hz
Min frequency changes slightly when load increases or decreases

Three phase apparent load and lowest frequency in 15 min



Highlight results (Measurements - 12h operation in isolated mode)

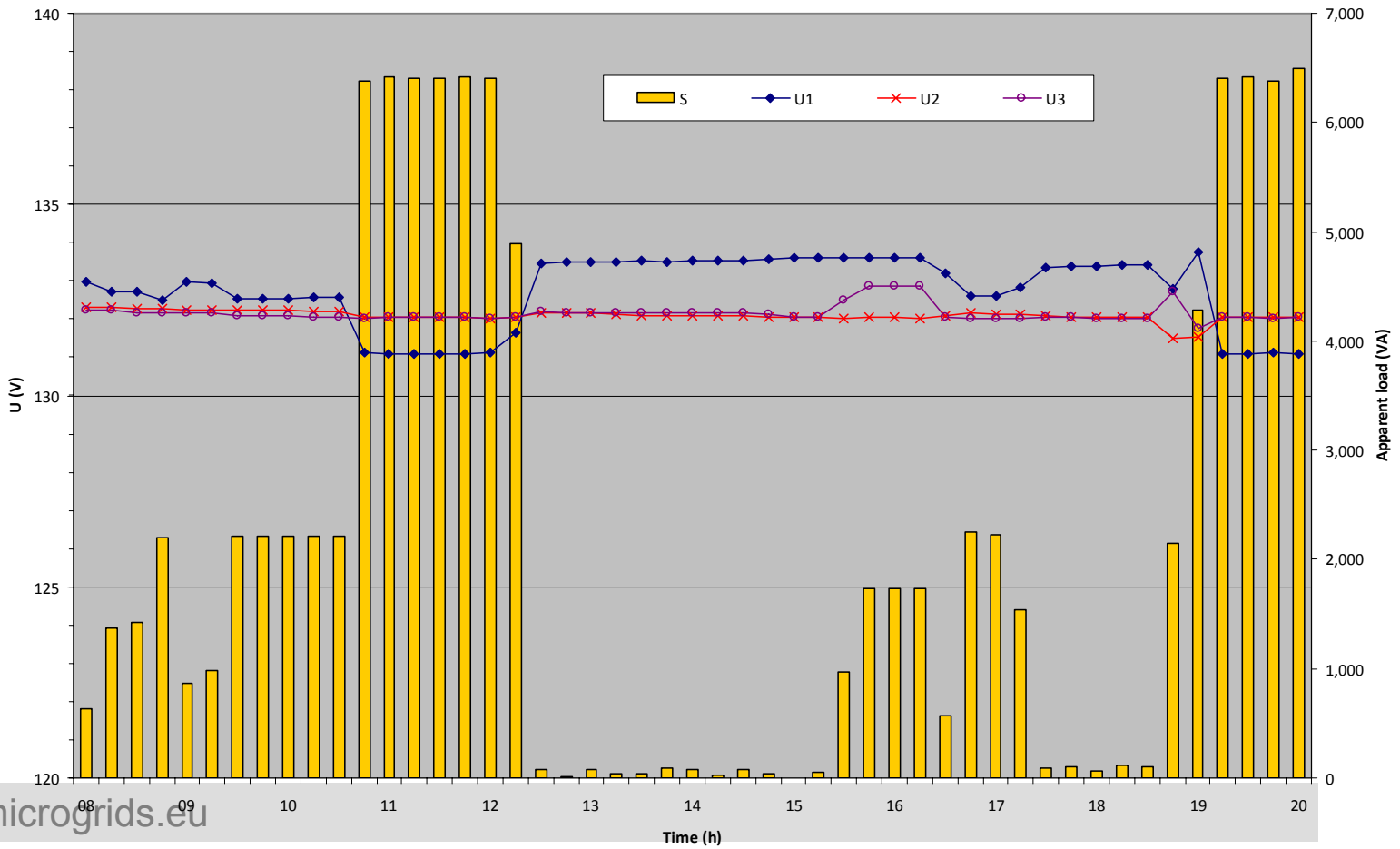


Example of 12h microgrid operation in isolated mode; All voltages kept within narrow margin

Events: approx 3 kW load (mostly on phase 1) is switched at 10:45, U1 drops

At 12:30 the load is drastically reduced and U1 rises

Phase-to-ground voltages and apparent load

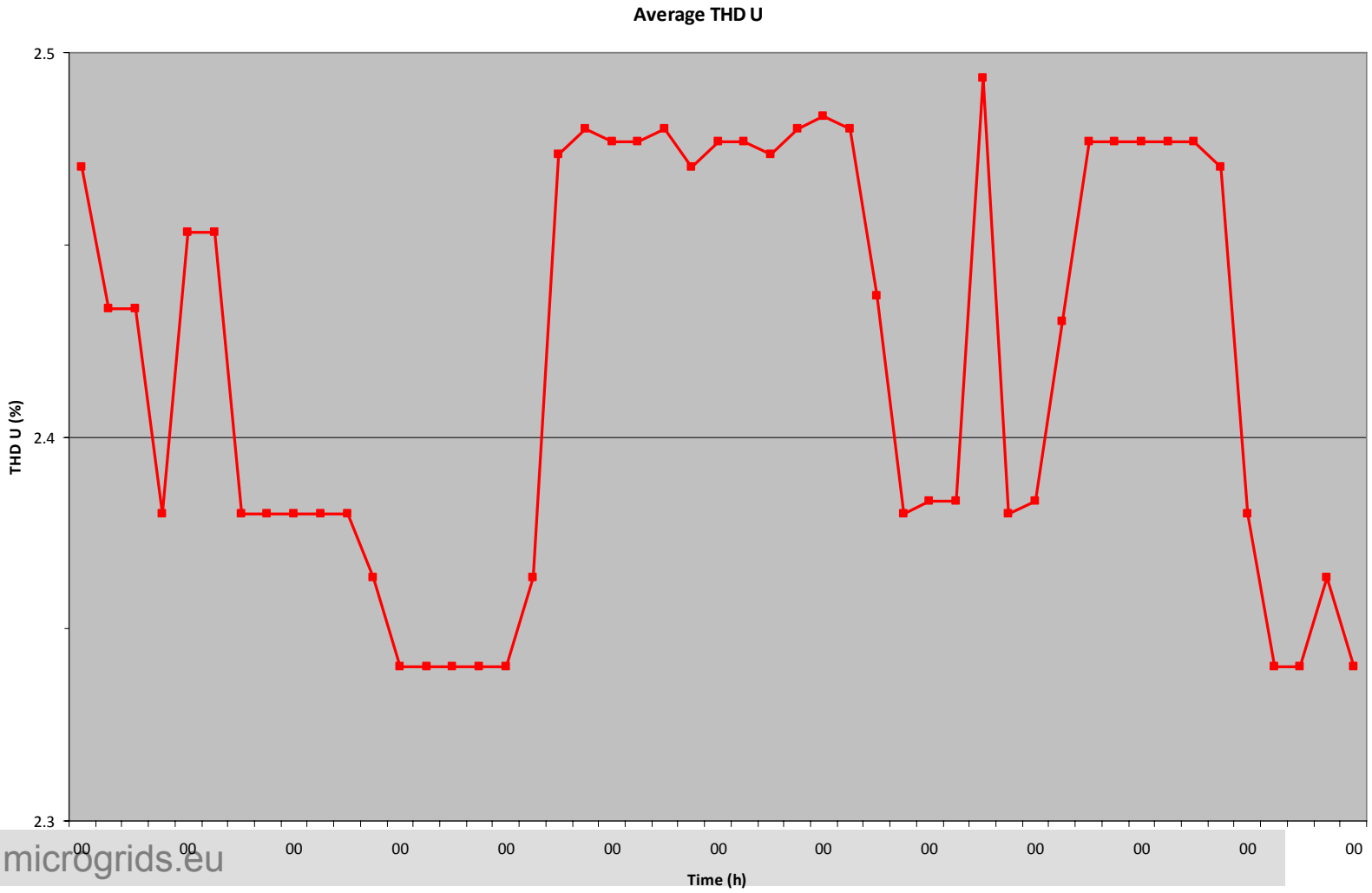


Highlight results (Measurements - 12h operation in isolated mode)



Example of 12h microgrid operation in isolated mode - average THD U varies around 2.4%

EN 50160 limit for THD U is 8%





- The microgrid is performing adequately
 - is capable to supply with the existing consumption quality power
 - the measured network parameters were in the requested limits and no problems were detected during steady state operation
 - the farm management is planning to extend the microgrid to the nearby stall
- Lessons learnt:
 - Microgrids with biogas plants can be successfully implemented on other similar locations in the country and in the WB region
- Final status: *successful*



- The benefits of heat and electricity production in biogas plants can improve fulfilment of the environmental standards related to farm waste management and greenhouse gases reduction.
- Based on the experiences from the pilot microgrid, the farm management considers implementation of a full size biogas plant in order to use the maximum waste potential.