



# How to operate a flexible CHP on biogas

Gas storage and gas management forecasting model

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# Agenda

- 1 **Company Presentation**
- 2 Renewable Energy Market
- 3 Intelligent Control Technology
- 4 Results
- 5 Outlook

# EnviTec Biogas AG

## Company profile

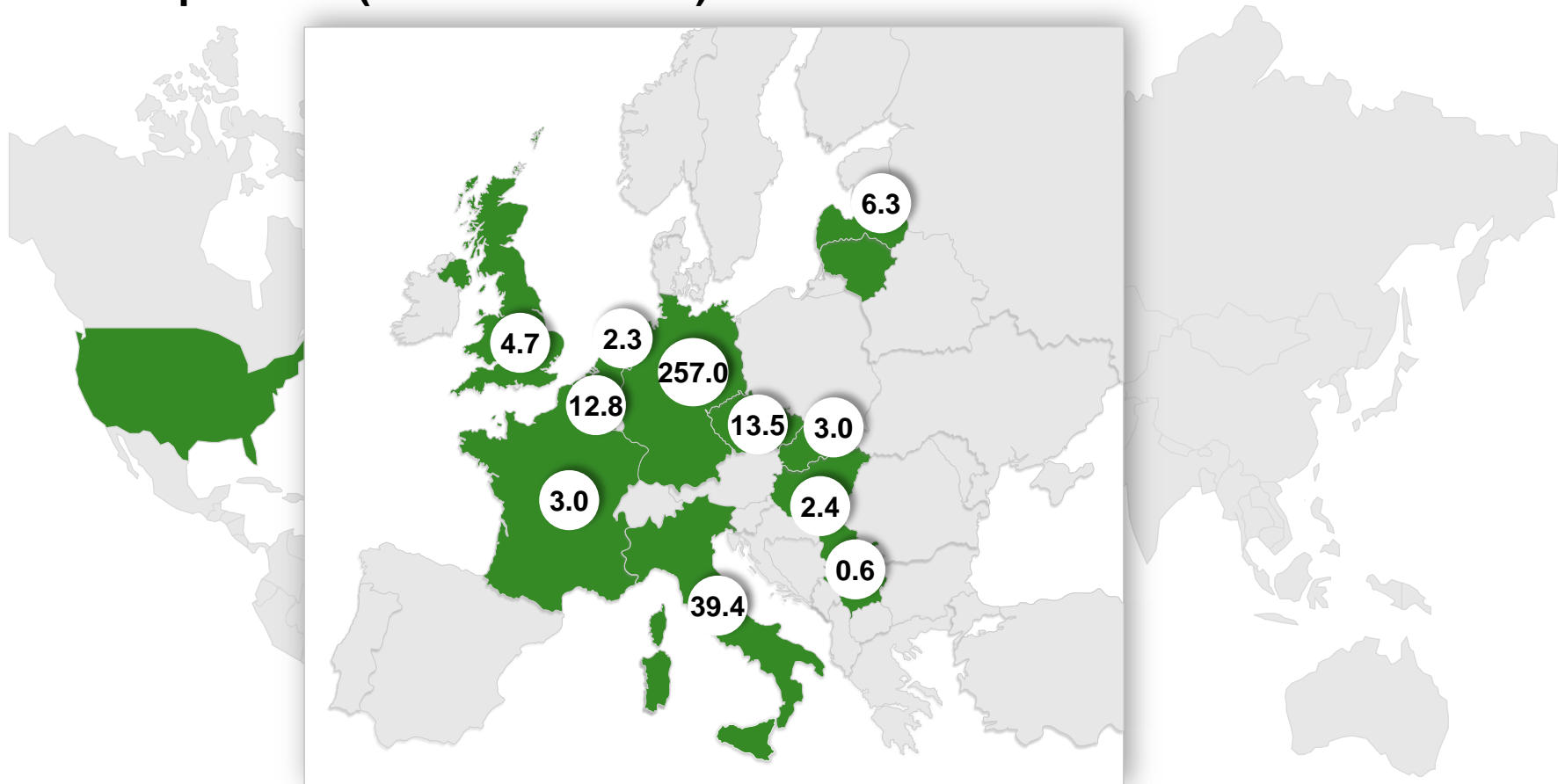
- EnviTec Biogas covers the entire value chain for the production of biogas
- Market leader in Europe
- Foundation of company in 2002 with 20 employees
- Since July 2007 listed on the Frankfurt Stock Exchange
- Headquarter and Administration in Lohne, Lower-Saxony
- Sales and Project Execution in Saerbeck, Northrhine-Westfalia
- 190.5 Mio. Euro turnover in 2012; 68.8 Mio. Euro turnover in Q 1-2 2013
- Thereof abroad 88.7 Mio. Euro in 2012; 24.9 Mio. Euro in Q 1-2 2013
- 359 employees worldwide

*As of 2013-06-30*



# EnviTec Biogas AG

## Plants in operation (as of 2013-06-30)



- Installed capacity: 345.0 MW<sub>el</sub>  
Germany: 257.0 MW<sub>el</sub>  
International: 88.0 MW<sub>el</sub>  
Thereof Own Investment 49.6 MW<sub>el</sub>

- Type of plant  
Agricultural plants: 313.2 MW<sub>el</sub>  
Waste to energy plants: 31.8 MW<sub>el</sub>

# EnviTec Biogas AG

## Integrated business model

EnviTec Biogas AG

### Construction

- Planning
- Permission
- Realization
- Commissioning
- Agricultural plants and industrial plants for bio-waste
- Repowering
- **Gasupgrading**

### Service

- Biological Service
- Technical Service
- 24-Hour-Hotline
- Insurance

### Own Operating

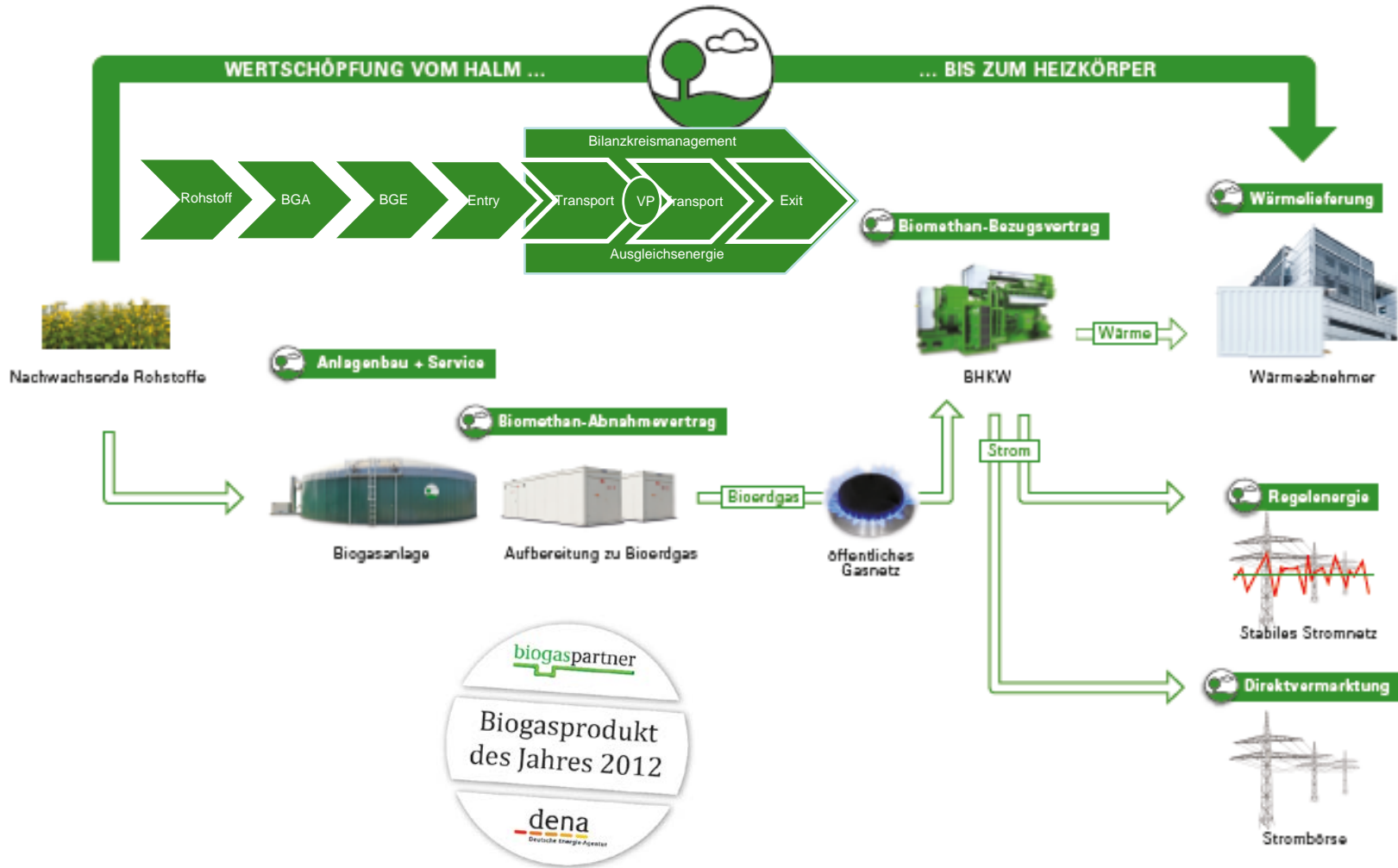
- Operation and Own Investments
- Plant Management
- Purchase of Raw Material
- Logistic

### EnviTec Energy

- Direct Marketing of Electricity
- Purchase and Sale of Biomethane
- Green Heat from Biomethane CHP

# The excellent business model of EnviTec Biogas AG

## Awarded by the German Energy Agency in November 2012



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# Renewable Energy Market

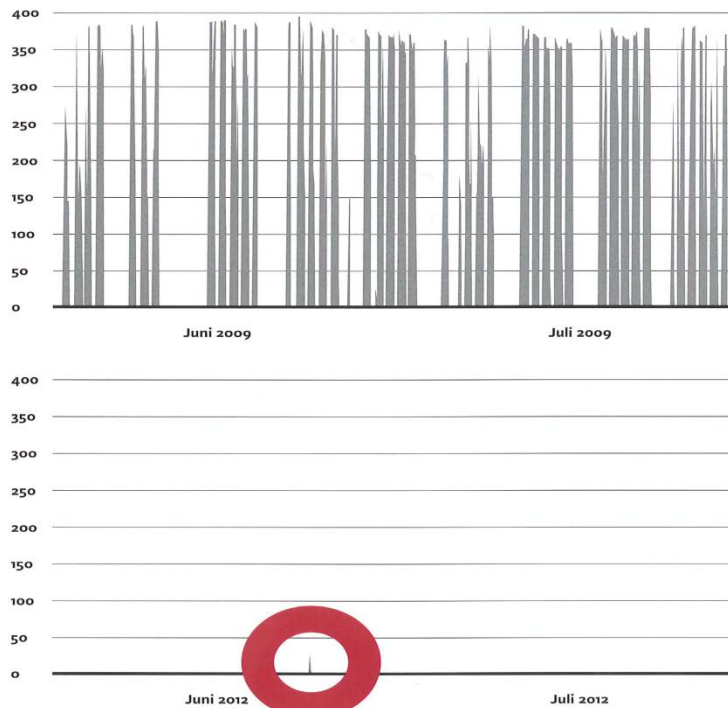
## Scope & Requirements

### Märkte und Systeme im Umbruch

BDEW-Geschäftsbericht 2012

**bdew**  
Energie. Wasser. Leben.

Auslastung eines Gaskraftwerks in Westdeutschland (427 MW)



### Markets and systems in transition

- Published by the federal association of energy and water
- Production time of gas fired power plants plummeted



# Renewable Energy Market

## Scope & Requirements

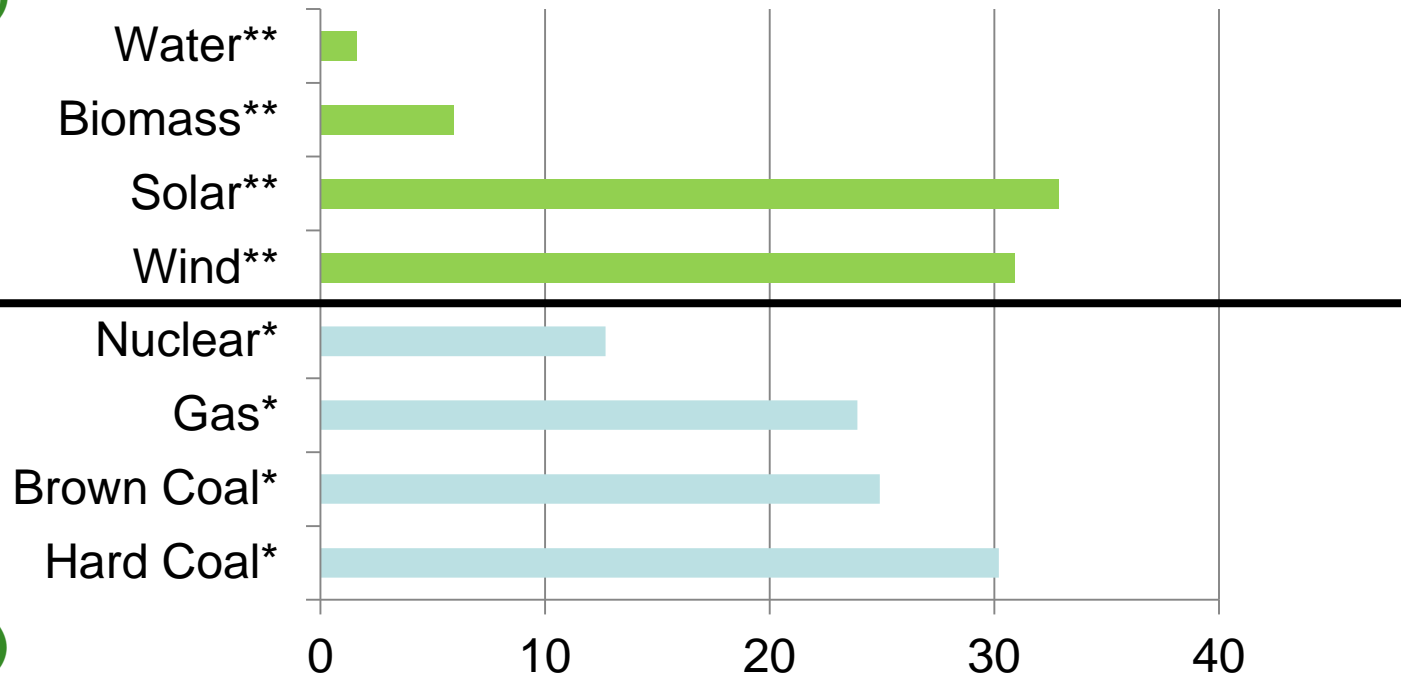
### Electricity Production Capacity

[GW(e)]

71,3 GW(e)



91,7 GW(e)



Quellen:

\* [de.statista.com/statistik/daten/studie/250973/umfrage/nennleistung-der-kraftwerke-nach-energetraeger-in-deutschland/](https://de.statista.com/statistik/daten/studie/250973/umfrage/nennleistung-der-kraftwerke-nach-energetraeger-in-deutschland/)

\*\* [www.bmu.de/fileadmin/Daten\\_BU/Download\\_PDF/Energiewende/direktvermarktung\\_datenquartalsbericht\\_6\\_bf.pdf](https://www.bmu.de/fileadmin/Daten_BU/Download_PDF/Energiewende/direktvermarktung_datenquartalsbericht_6_bf.pdf)

# Renewable Energy Market

## Scope & Requirements

### Scope

- Fluctuating renewable energies like wind and solar dominates the energy production in the future and determine the demand of a flexible controllable energy.
- Biogas plants could make a significant contribution as renewable energy

### Requirements

- Supply of energy from biogas plants on a needs basis
- Software solution for regulation of gas production, gas storage and operation of CHP
- Interface to the energy exchange market
- Control energy can be offered with high forecasting accuracy.

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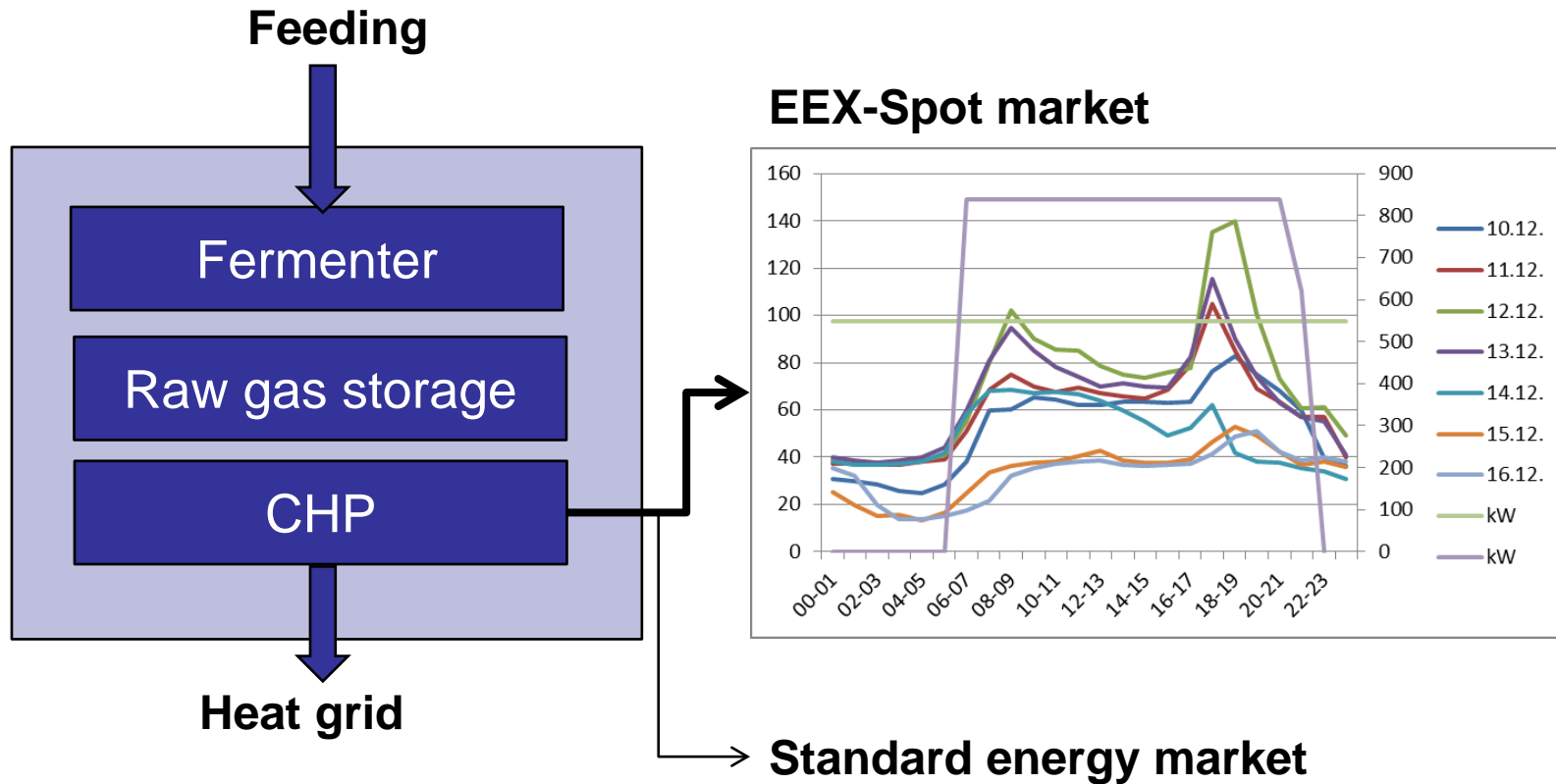
# Intelligent Control Technology

## Previous state-of-the-art

- Biogas: Production of base load electricity
- Basic requirements for providing adequate quantities of gas for CHP → maximizing quantity
- Conventional level measurements did not provide sufficient detailed information about percentage level in gas storage
- Power control "EnviTec Feedcontrol" successfully in current-controlled CHP
- However, no systems currently on the market that can face in the future predict gas yields and gas reservoir levels

# Intelligent Control Technology

## Requirements



### Technical requirements are

- Flexible feeding
- Automated interface for marketers
- Control of the CHP by setpoint

### Module 1: Cogeneration power control as a function of time in a performance curve

- Electricity demand for the next day as reference values, derived from the energy exchange e.g. Leipzig
- The energy demand set a target curve for the control system.
- Appropriate programming is necessary to include both target curve and actual curve
- Integrating of a separate communication box

# Intelligent Control Technology

## Module 1 – CHP-power control



- Target and actual curves of CHP output are superimposed directly.
- Control of CHP-performance as a flexible setpoint is narrowly possible over the time.

Graph: CHP target/ actual with gas storage level

### Module 2: Gas storage measuring systems and gas storage management

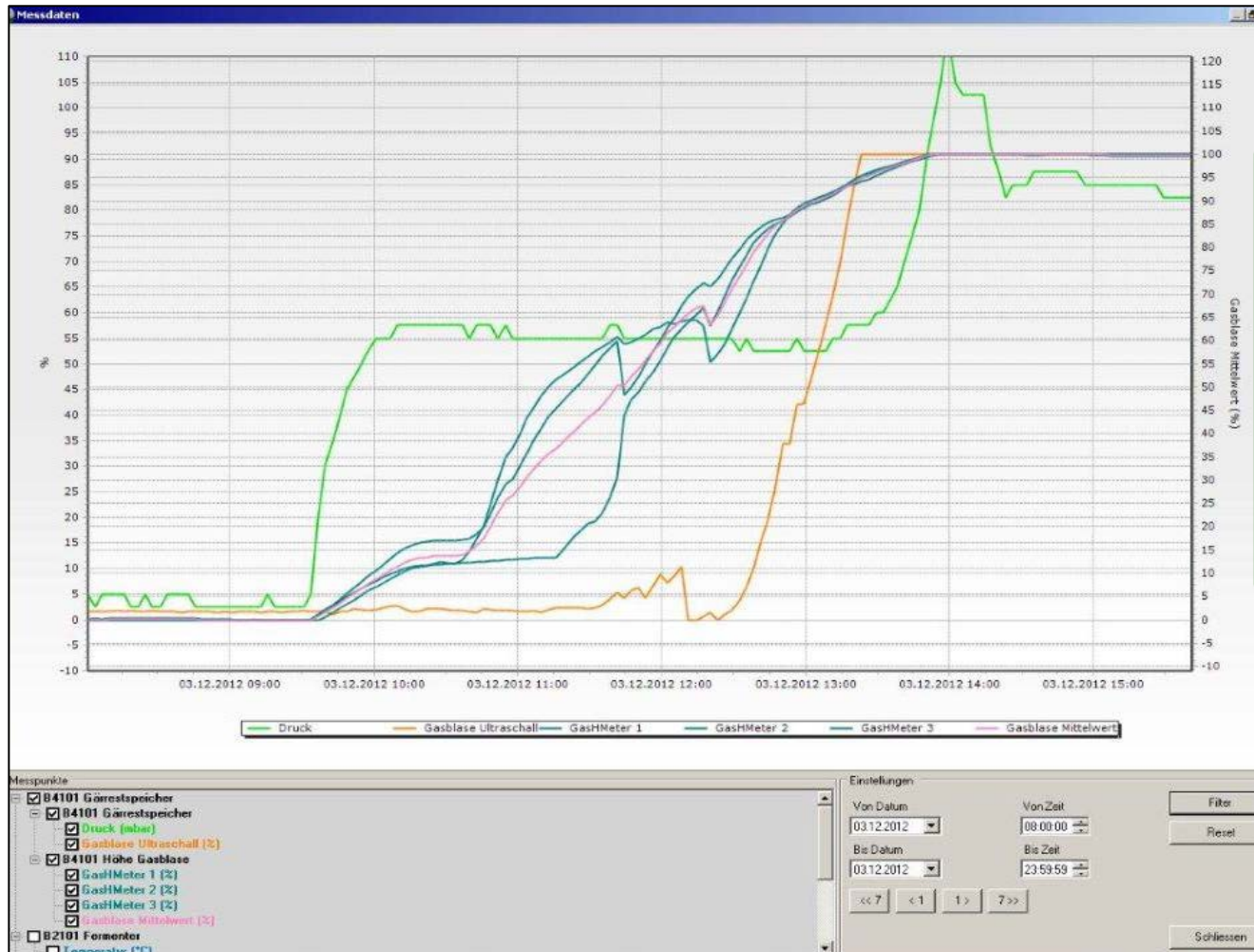
- Accurate detection and control of a gas storage is a condition for providing adequate quantities of gas for the cogeneration plant.
- To improve the current technology EnviTec has developed a level measurement and control system.
- This allows a continuous recording of the level in the gas storage and thus a precise control.





# Intelligent Control Technology

## Gas storage measuring system and gas storage management

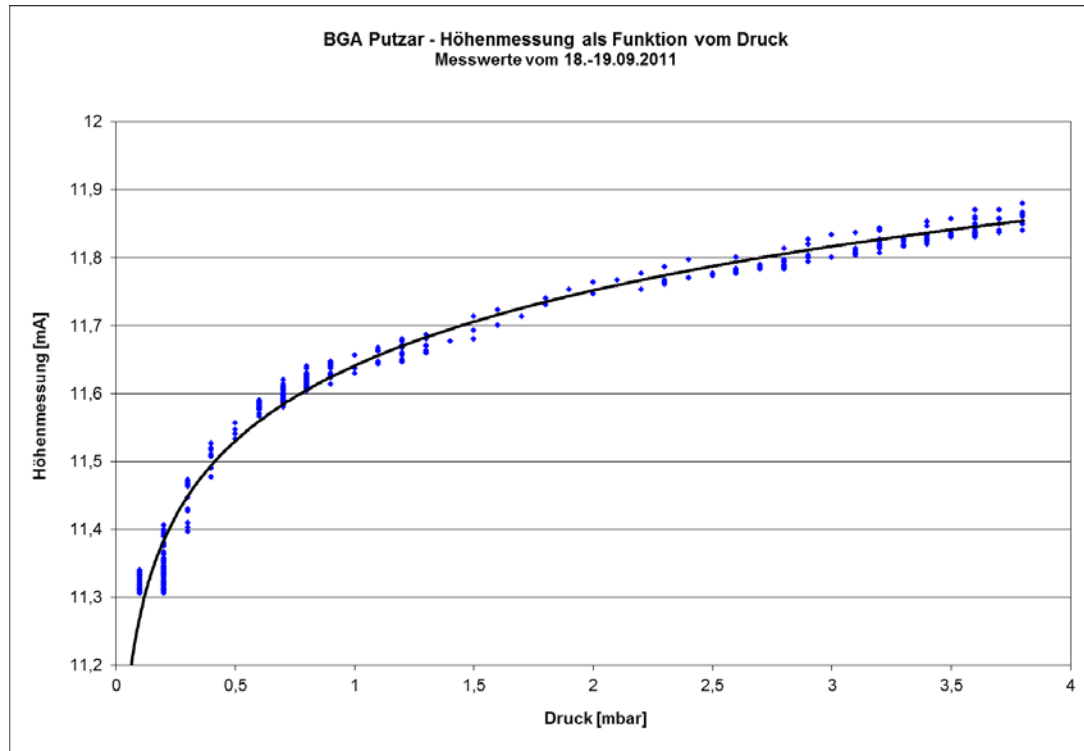


- Individual pressure or ultrasonic measurements in air-supported roof do not provide suitable results.
- With the aid of two to three meters specific level is accurately detected and regulated.

Graph: Level measurement in an air-supported roof

# Intelligent Control Technology

## Gas storage measuring system and gas storage management



✓ Essential requirement for a loop is provided

# Intelligent Control Technology

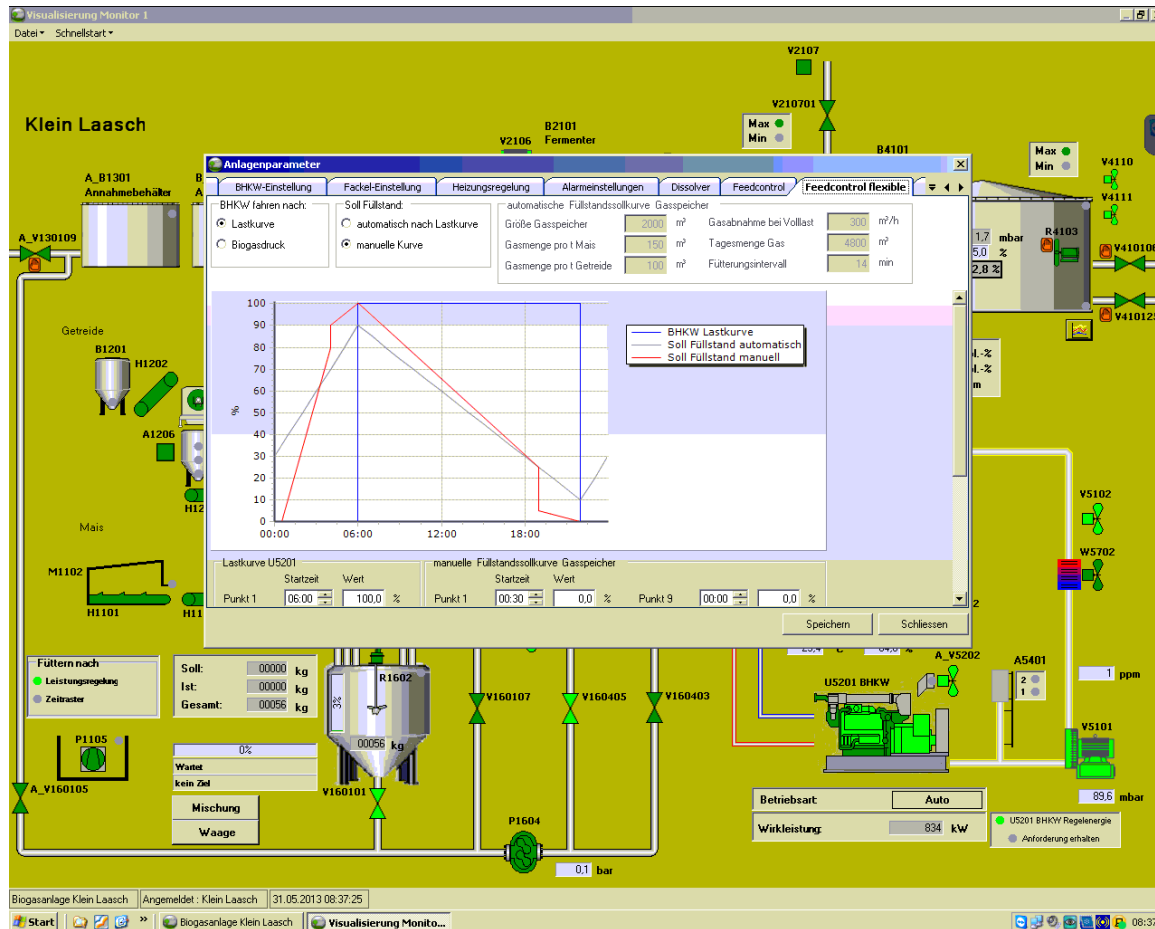
## Gas storage measuring system and gas storage management



Graph: Control gas storage level

### Module 3: Forecast and control of biogas production

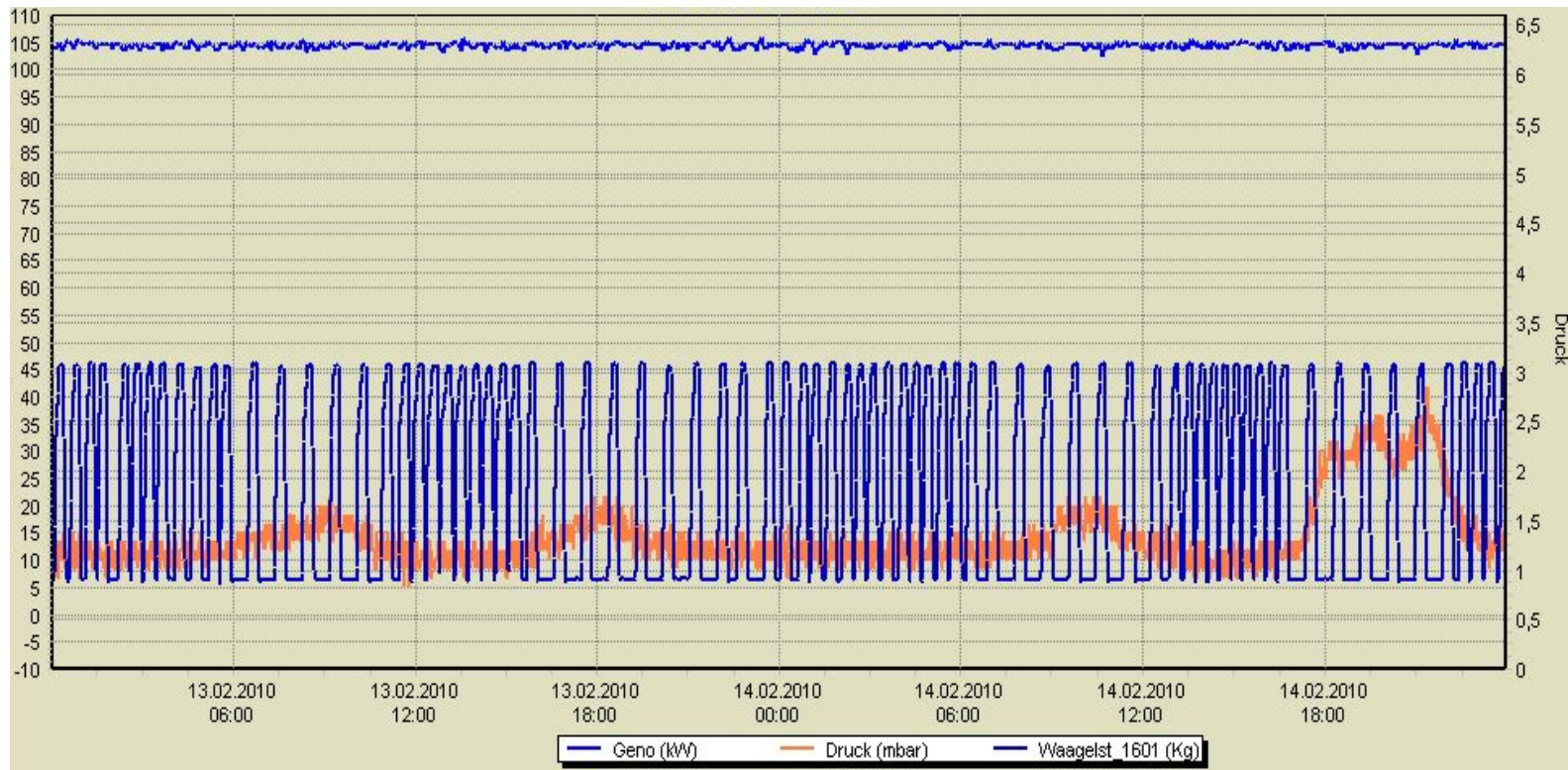
- Control of the biogas production to the target value with "EnviTec Feedcontrol" successfully realized in current-controlled CHP.
- New: Control of biogas production referring to a floating target value and not to a constant value.
- In future, gas production, gas storage and gas consumption with different forms in time and amount .
- For this purpose EnviTec has developed a system of floating target values.



✓ Target curves of electricity and biogas production

# Intelligent Control Technology

## Module 3



Graph:  
EnviTec  
Feedcontrol

- *Excellent feeding regime under constant setpoint → permanent constant CHP performance*
- *Gas production process worked very well at realized Feedcontrol plants (some hundreds).*
- *Variations in input quality and changes in kind of input are successfully compensated.*
- *Variation in presented innovation: regulation of feeding by sliding setpoint.*

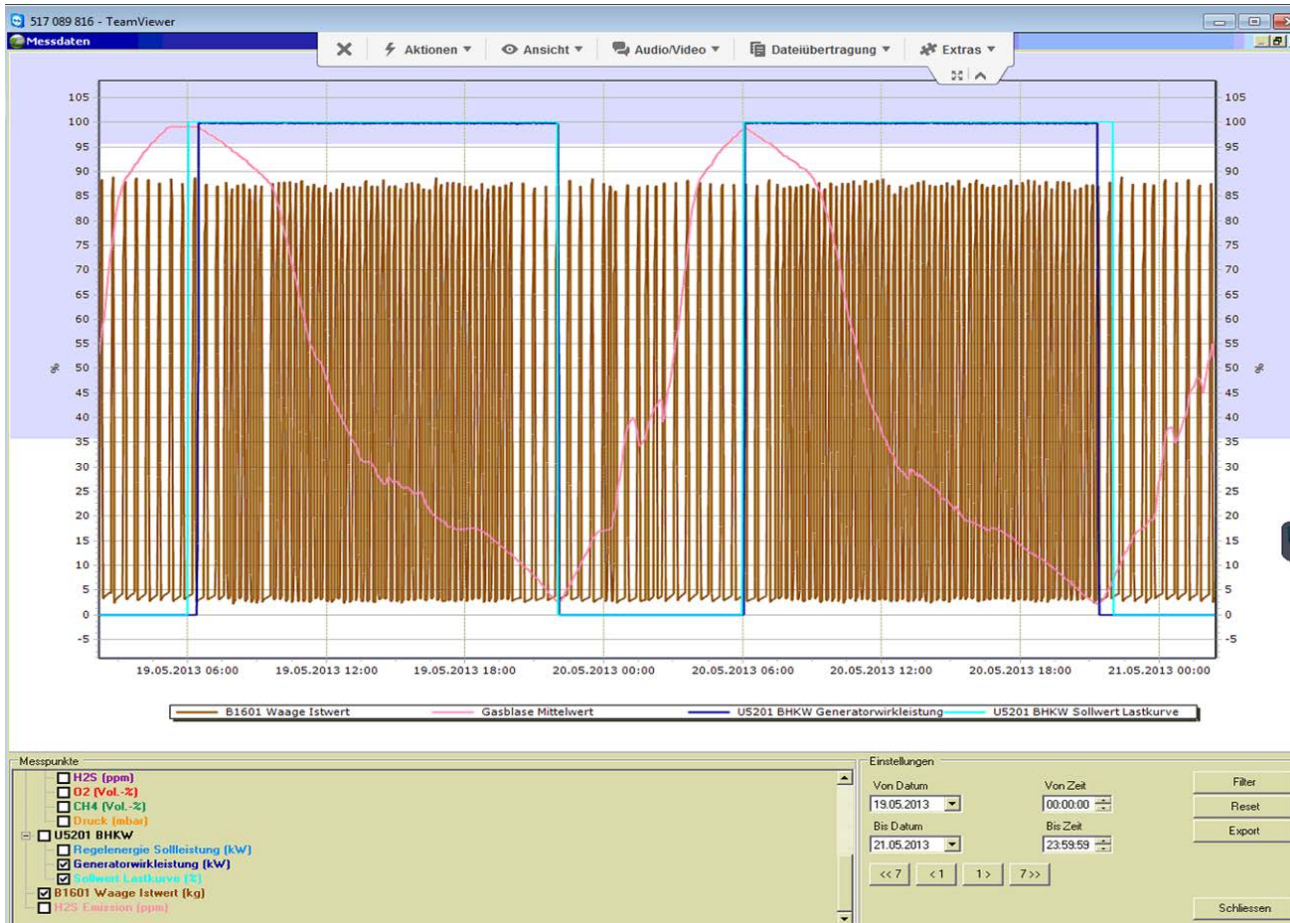
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# Results

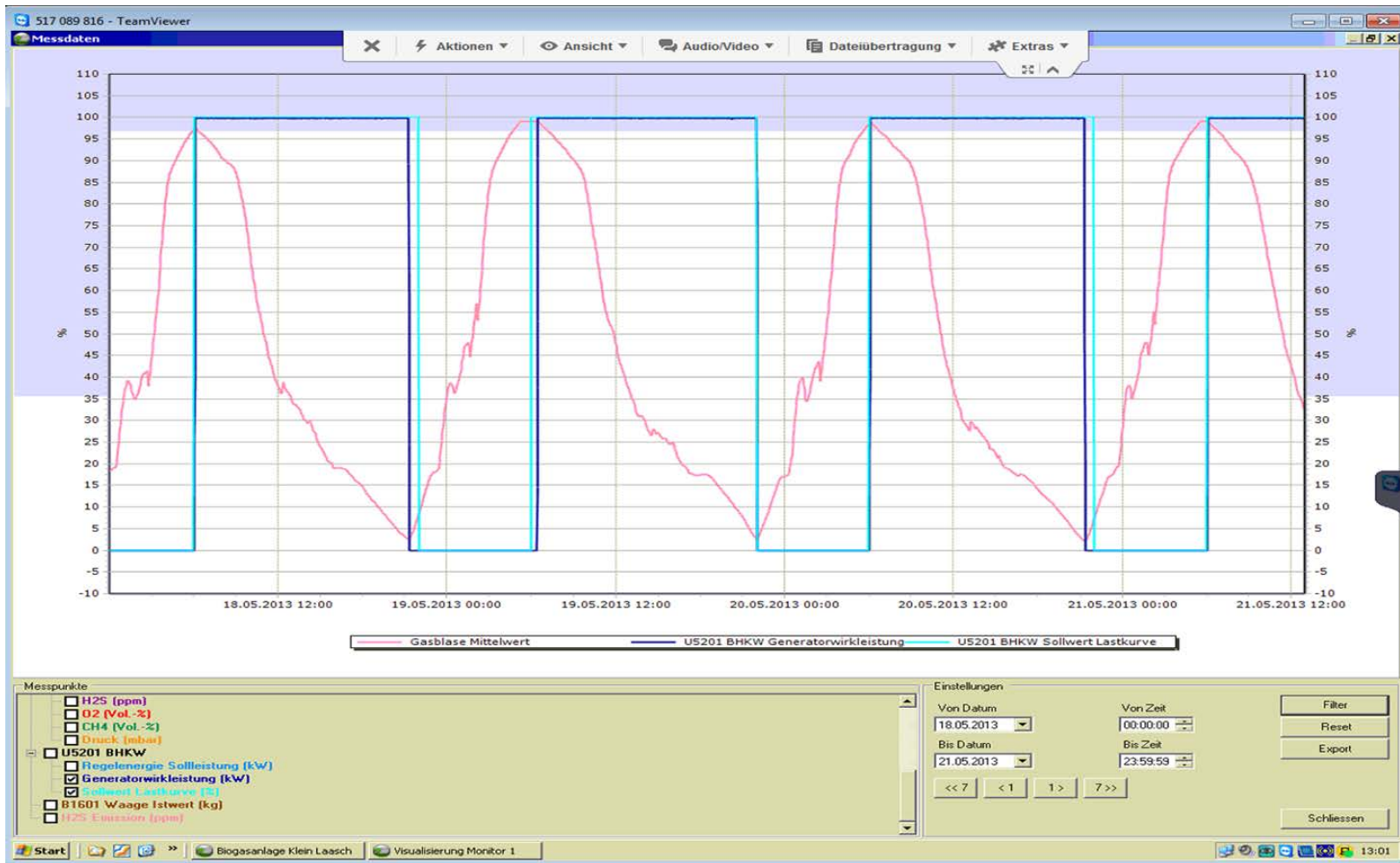
## Interaction of feed-control, gas-storage-volume and electricity



- Accurate control of CHP according to the target value is important.
- New plants show significant improvements in load control.

# Results

## Perfect match between setpoint and actual values



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# Outlook

- The crucial factor is the combination of the individual modules.
- Intelligent software pretends performance curves of the CHP.
- About inflow and outflow calculation of the gas storage and its level the program generates specifications for the feeding in quantity and time, combined with forecasting model of gas production.
- Additional module for compensating external influences to the level in the gas bubble (e.g. temperature and sunlight) → weather data will be used for gas volume calculation.
- First plant is currently being under operation.
- The next step: Interaction between energy exchange market and the production curve

# Outlook

- Generation of electricity by timetable is fundamental for Energy transition.
- Biogas plants could provide significant contribution with provision of energy on a needs basis.
- Control of gas production, gas storage and CHP-operation with a software solution.



➤ Shift of maximum 12 hours

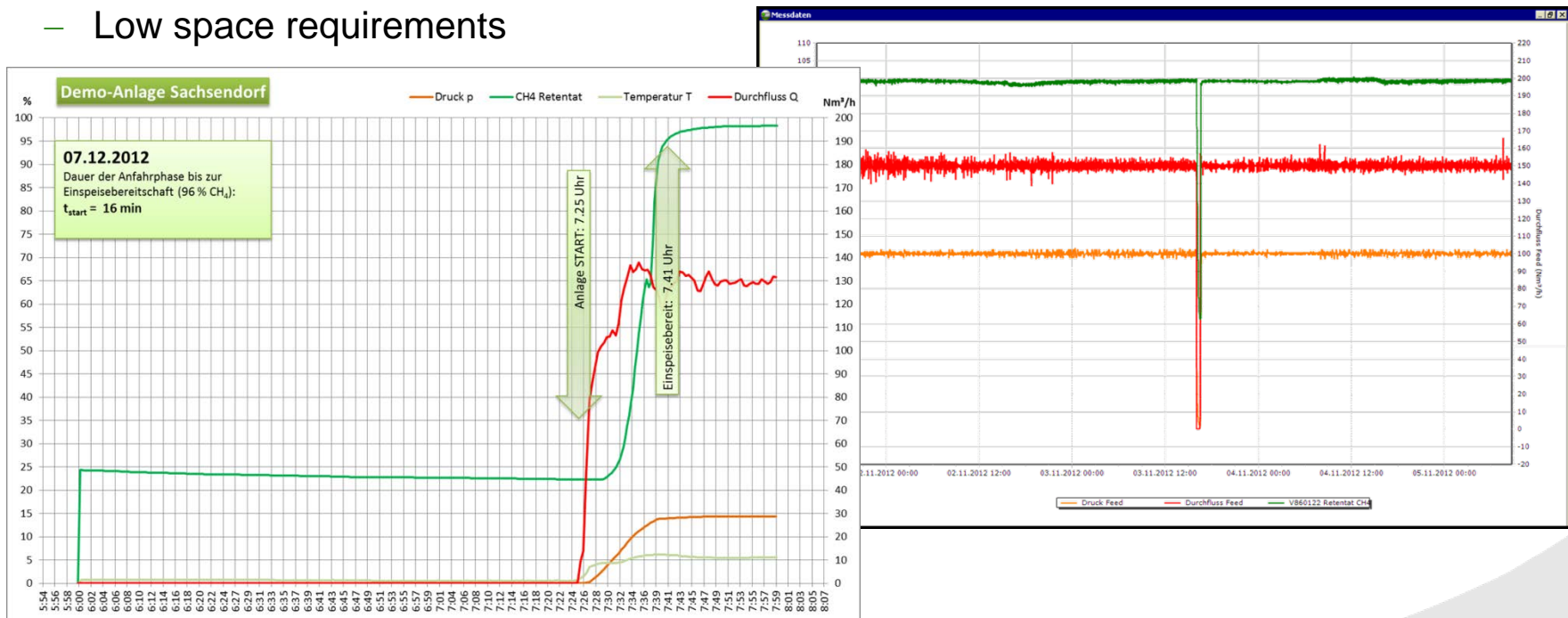
**BIOGAS** 2013  
INNOVATIONSPREIS  
DER DEUTSCHEN LANDWIRTSCHAFT

# Outlook

... and if you want to shift more than 12 hours

## biogas upgrading and injection into the gasgrid

- The gas upgrading system EnviThan is based on the membrane principle.
- High spontaneous load change behavior
  - Cold start within 20 minutes
  - CH<sub>4</sub>-qualities of over 97%
  - No waste water or chemicals
  - Low space requirements



Thank you very much  
for your attention !

## Contact

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