



Biomethane the Climate-friendly Substitute of Natural Gas

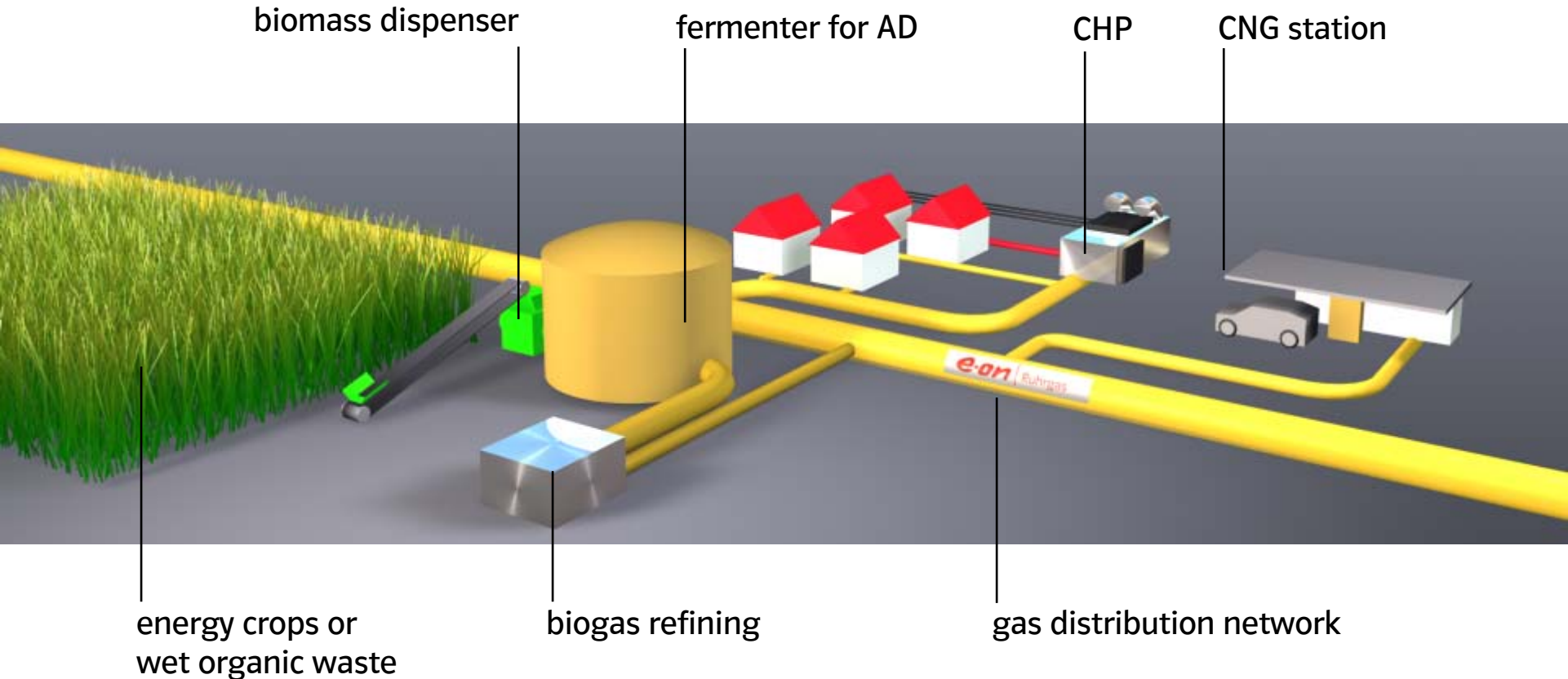
Salzburg, August 29th 2011
Dr. Thomas Stephanblome

Agenda

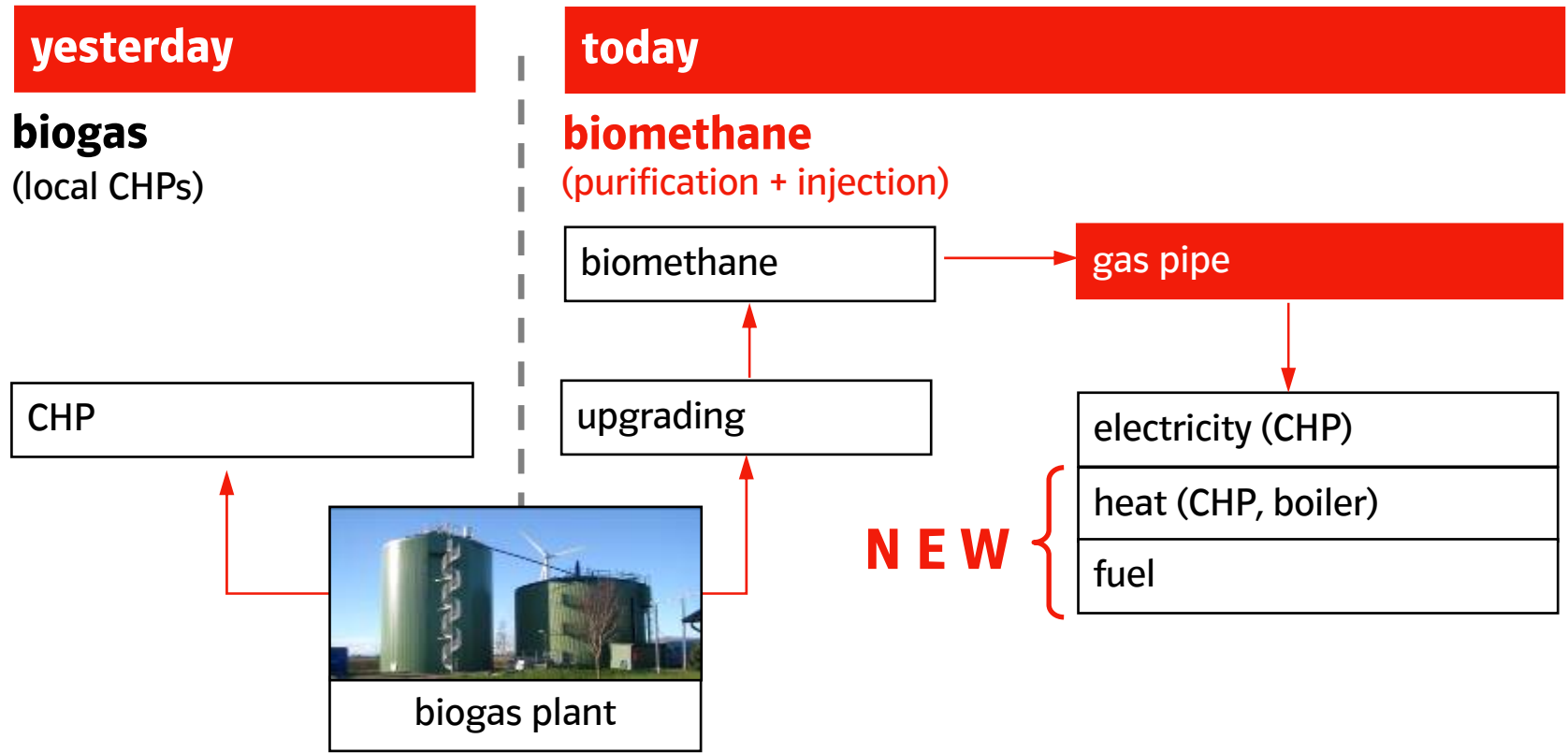
- A** **Biomethane: principles**
- B** **The German market**
- C** **Biomethane Production**
- D** **Sustainability / Reduction of greenhouse gas emissions**

Production of biomethane

- Biomethane injection uncouples the production and usage of bioenergy
- Biomethane injection enables usage of bioenergy even in metropolitan areas



Why upgrading and grid injection?



- few locations with full heat utilisation

- optimised heat utilisation = high efficiency
- high versatility of usage

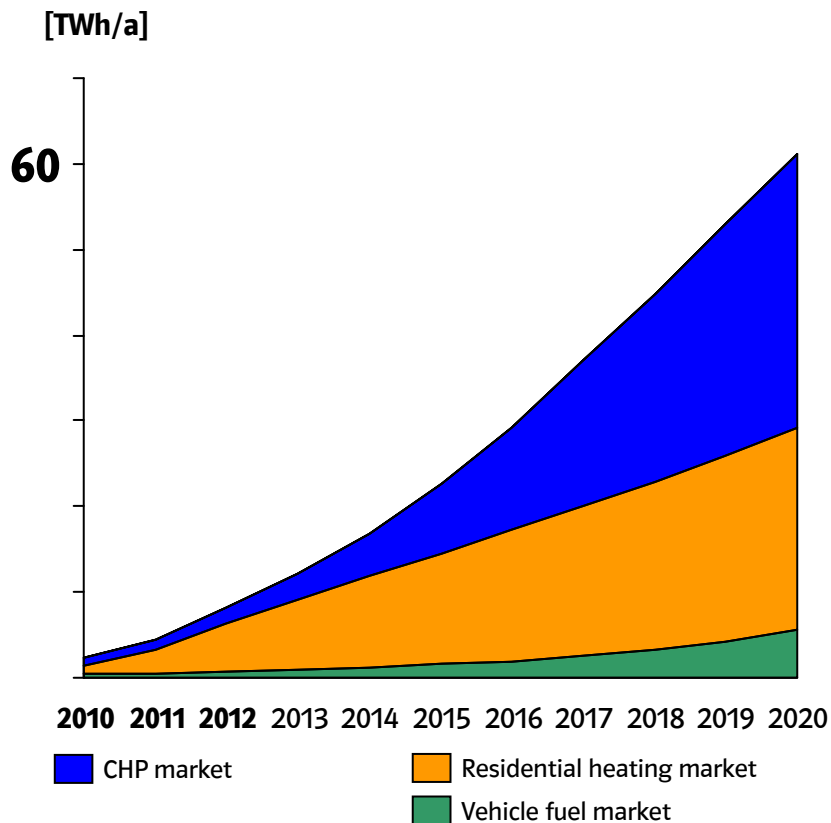
Germany's biomethane targets and potential



- EU directive to produce energy from renewable sources
- target for Germany: 18% share of renewables by 2020
- target set by German government in 2007 (IEKP):
6 bio m³ annual injection by 2020 (= 60 TWh/a)
10 bio m³ annual injection by 2030 (= 100 TWh/a)
- potential for biomethane production in 2030 calculated at 105 – 174 TWh/a
(correlating to 11 - 18% of natural gas consumption in 2009)

The German biomethane market: ~ 60 TWh/a in 2020

GERMAN BIOMETHANE MARKET: segments



Key takeaways

- CHP market: Source: dena-study "German biomethane market for heat & CHP"
 - Potential is inline with E.ON analysis of this market segment
 - EEG amendment 2012 is expected to bring improvements
- Residential heating market: Source: dena-study "German biomethane market for heat & CHP"
 - EEWärmeG amendment 2011 is expected to bring improvements
- Vehicle fuel market: Source: dena-study "Vehicle fuel market for natural gas and biomethane"
 - Slow development because of limited infrastructure (filling stations, gas- cars,..)

Legal framework



- **Renewable energy act**
 - fixed feed-in tariffs for electricity produced from biogas or biomethane
 - feed-in of renewable energy has primacy over conventional energy
 - allocation of costs to consumers (EEG-Umlage 2011: 3.5 ct/kWh)
- **Renewable heat act**
 - house owners obliged to fulfill a quota of renewable heat upon renovation or new building
 - use of a biomethane / natural gas mix is one option to fulfill quota
- **Grid access regulation**
 - definition of responsibilities of biogas plant operator and gas grid operator (including definition of grid connection costs and their split between plant and grid operator)

Grid access regulation (Gasnetzzugangsverordnung) §§

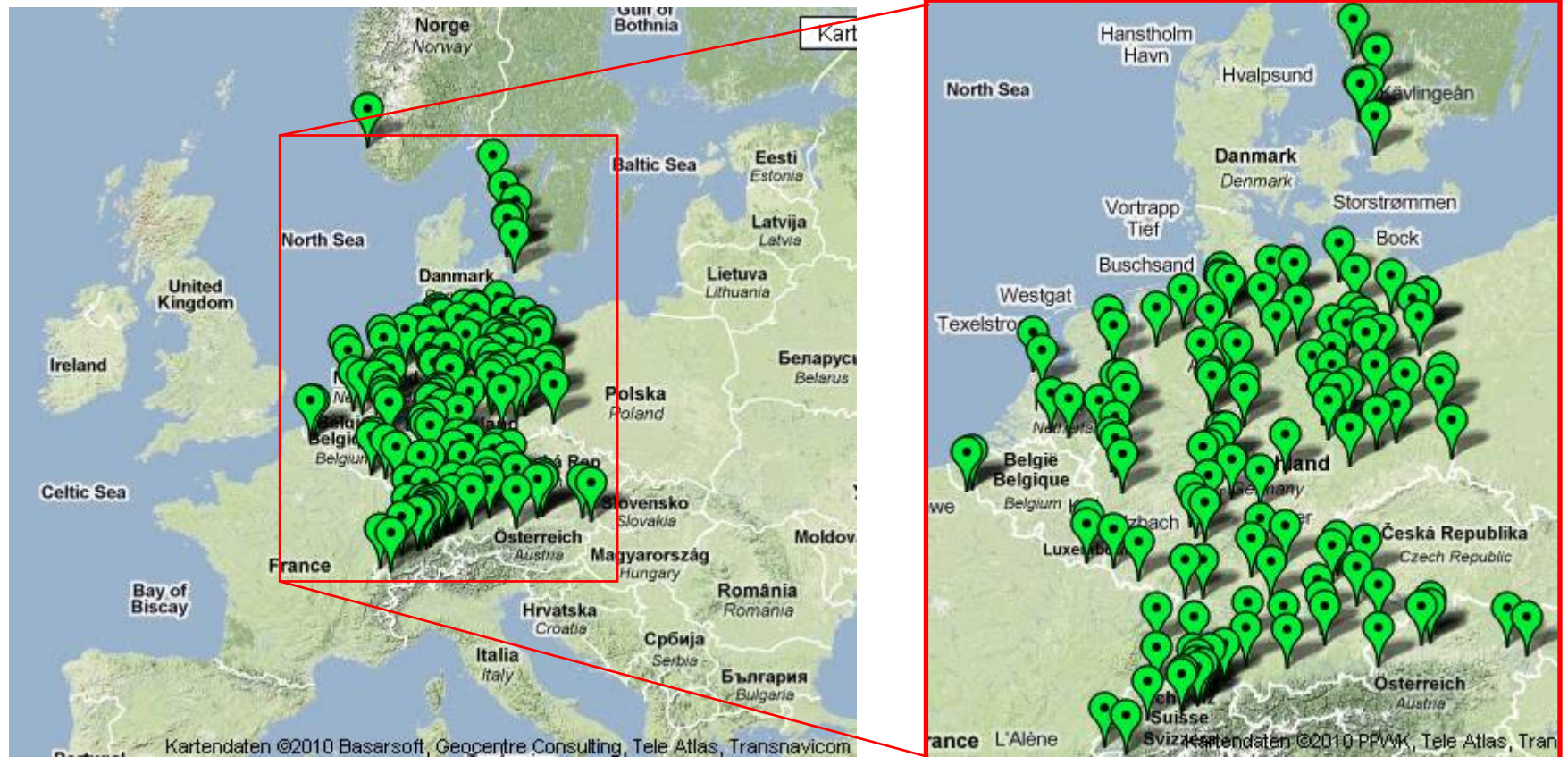
- Obligation for grid operators to connect biogas plants on demand with fixed time schemes
- Biogas plant is responsible for upgrading to (general) natural gas quality (according to standards DVGW G 260/262)
- Grid operator is responsible for adjustment to local grid conditions (e.g. by adding propane or air to adjust the calorific value)
- Grid operator is responsible for gas quality control, metering, and compression
- OPEX and CAPEX for injection station and connection pipeline paid by gas grid operator
- Fixed connection fee of 250.000 € to be paid by biogas plant operator (some exemptions if connection pipeline is longer than 1 km)

Challenges to biomethane market



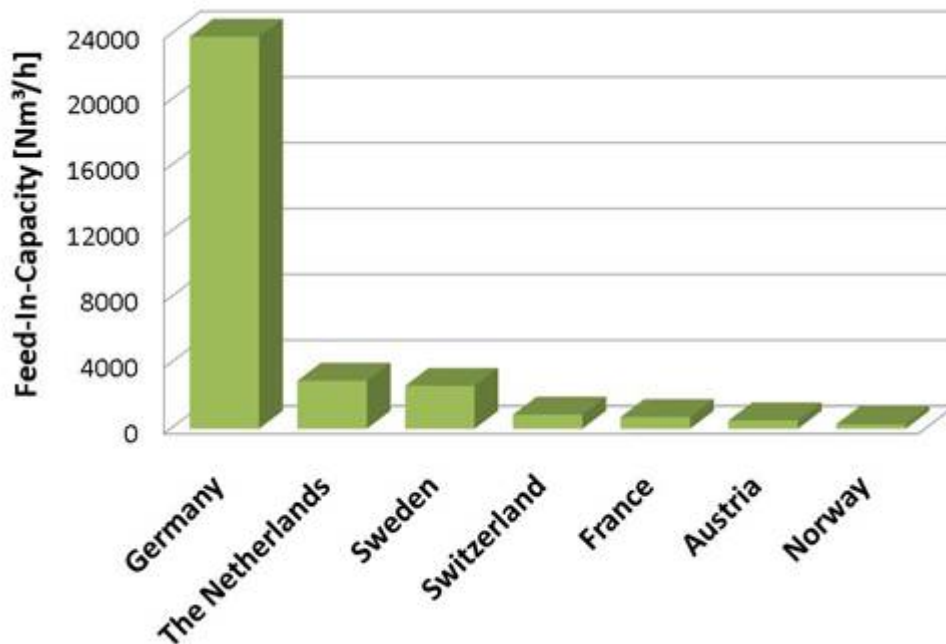
- different economics for biomethane from energy crops, agricultural residues or waste
- EEG restricts economic biomethane utilisation to small CHP
- no financial incentive to use in large scale CHP and CCGT, or as fuel for transportation
- financial incentive to use for domestic heating only in one state (of 16)
- meeting the Government target (6 bio m³ by 2020) requires increase from today's 50 biomethane plants to approx. 1,000 plants in 2020 (= building of 100 plants per year)
- target is very ambitious and can only be achieved if next amendment of the renewable energy act (EEG) better the economical situation of biomethane plants

Biomethane plants in Europe (2010; existing & planned)



- 110 biomethane plants, at least 67 with grid injection

Biomethane plants in Europe (2010)



- biomethane projects depend heavily on national incentive schemes
- European biomethane feed-in capacity 31,700 m³/h (2010)
- E.ON's feed-in capacity 8,000 m³/h (Germany: 5,900 m³/h; Sweden: 2,100 m³/h)

E.ON biomethane projects in Germany



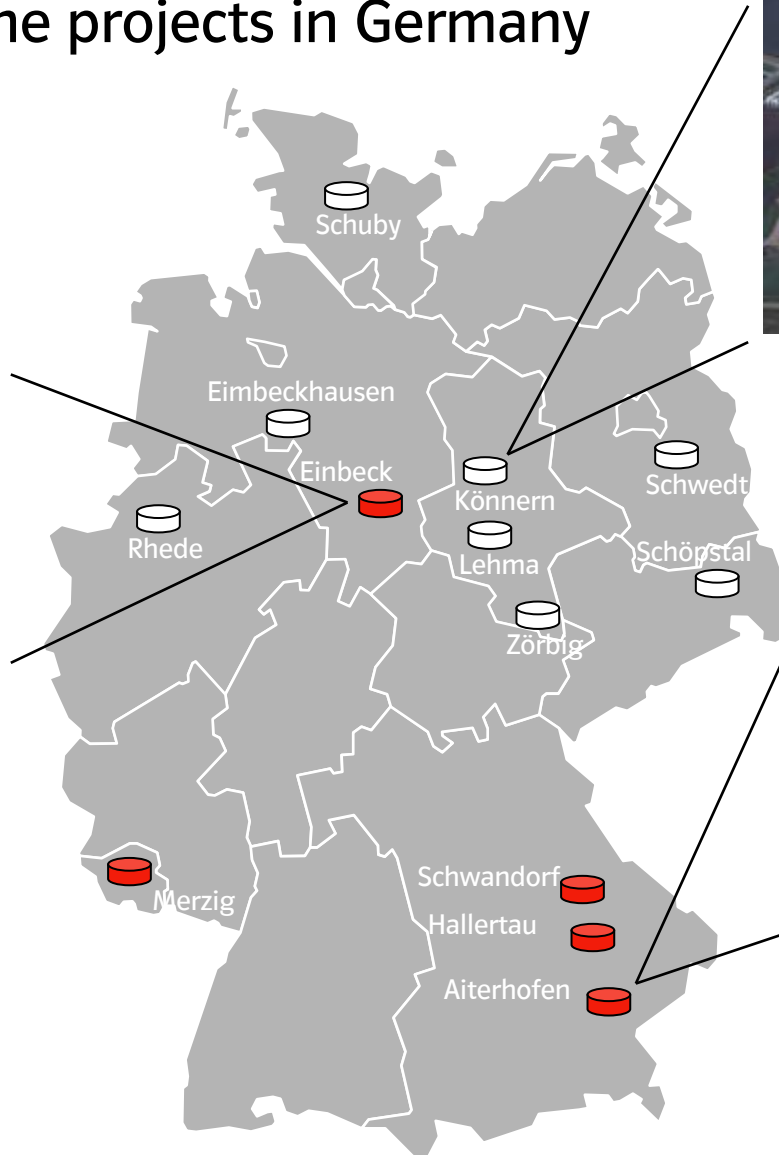
Einbeck:
50 GWh/a
in operation since 09/2009





Könnern:
150 GWh/a
in operation since 09/2009



Aiterhofen:
92 GWh/a
in operation since 09/2009



-  E.ON assets
-  long term contract

Biomethane plant Aiterhofen



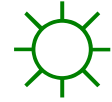
- Annual biomethane production: 90 GWh_{H_s}/a
- Substrates: 80,000 t/a (energy crops)
- Biogas production and upgrading built by Schmack Biogas
- Upgrading by PSA
- Commissioning 09/2009

Biomethane plant Einbeck



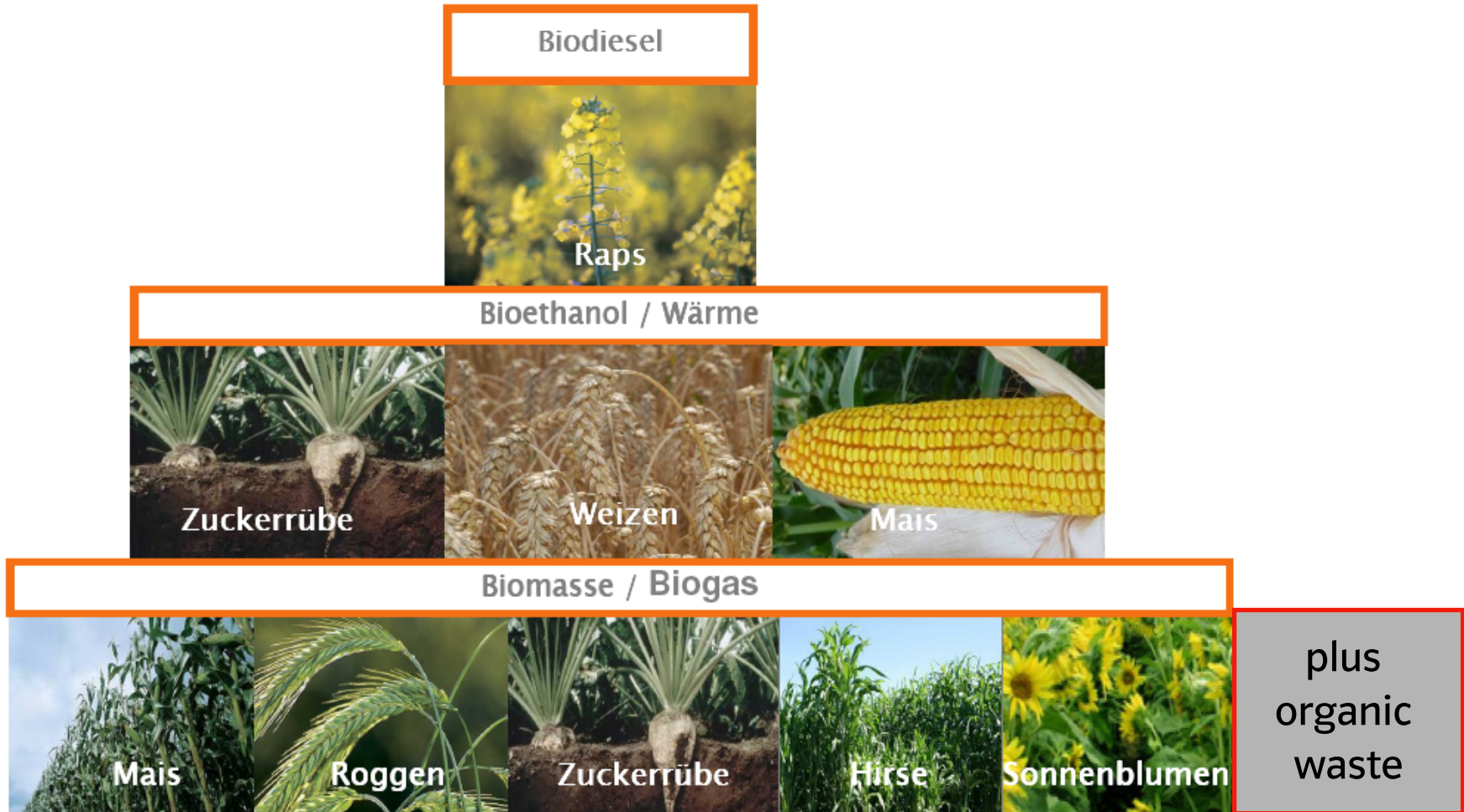
- Annual biomethane production: 50 GWh_{H_s}/a
- Substrates: 45,000 t/a (energy crops)
- Biogas production and upgrading built by MT Energie
- Upgrading by amine scrubber
- Commissioning 09/2009

Sustainability of biomethane



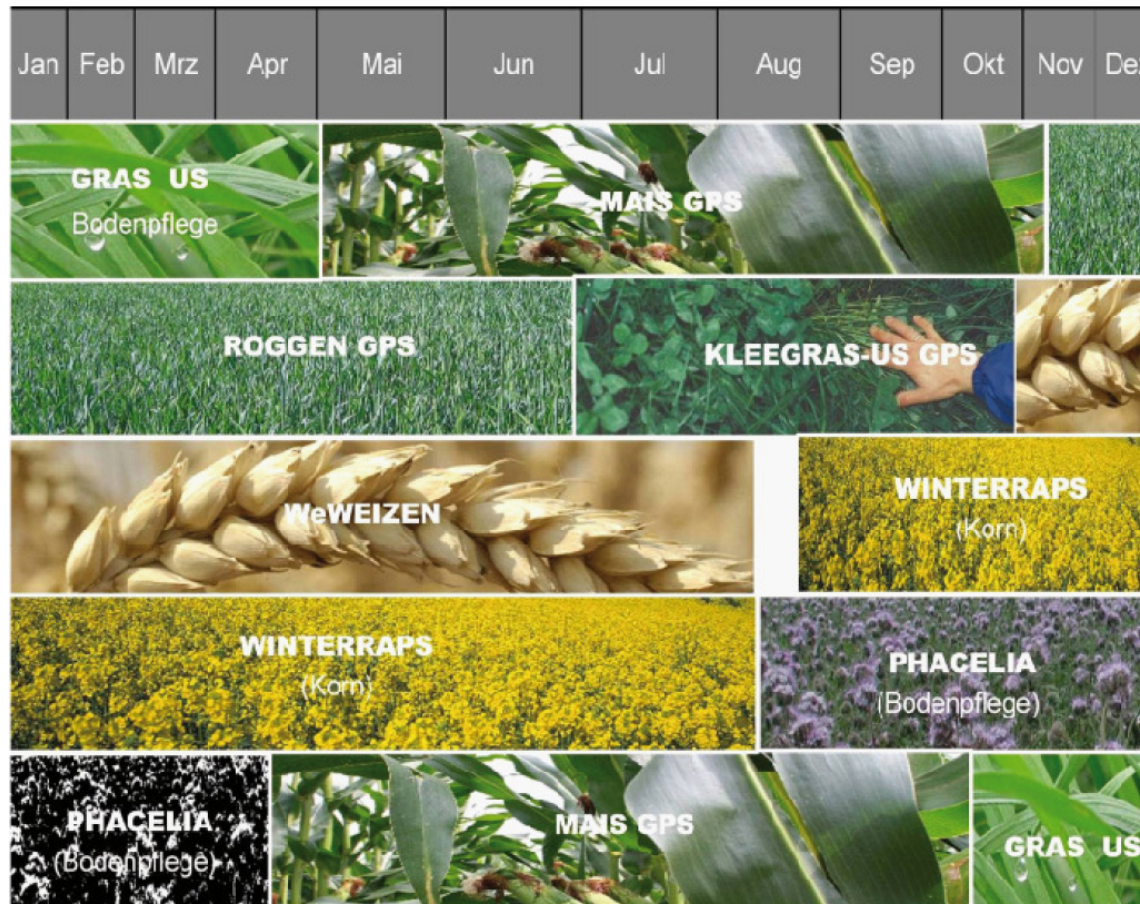
- renewable energies are not a priori sustainable
- sustainability requires protection of soil, water and air
- keys to sustainable production:
 - efficient utilisation of substrates
 - high versatility of substrates including organic waste
 - production of energy crops with high agricultural standards ("Cross Compliance") and high energy yield per area cultivated
 - low emissions on production level
 - high CO₂-avoidance on utilisation level

Biomethane has highest versatility of input materials



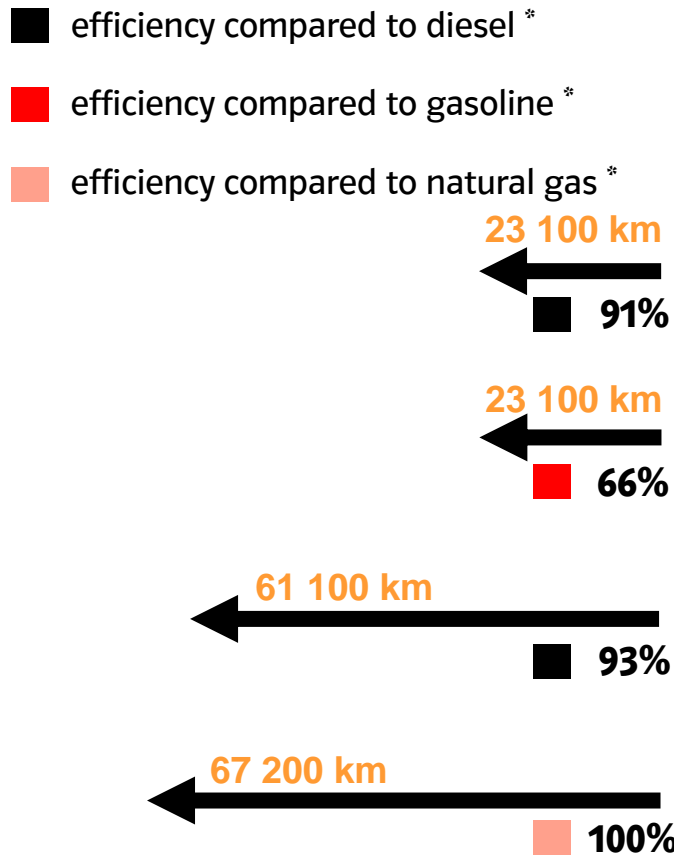
Crop rotation for sustainable production of energy crops

- Extra advantage: lower pests pressure



(Schmack 2008)

Biomethane has highest energy yield per area



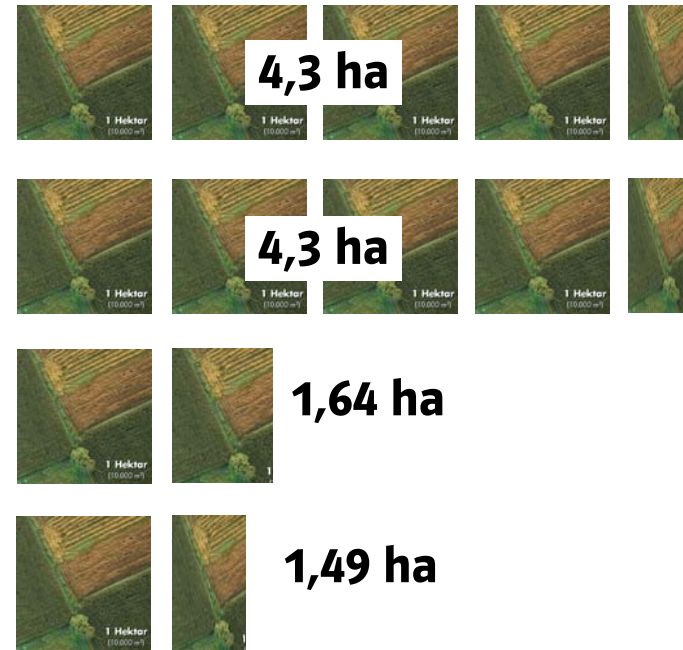
biodiesel (RME)
1550 liter **

bioethanol
2560 liter **

BTL (Sunfuel)
4030 liter **

biomethane
3560 kg **

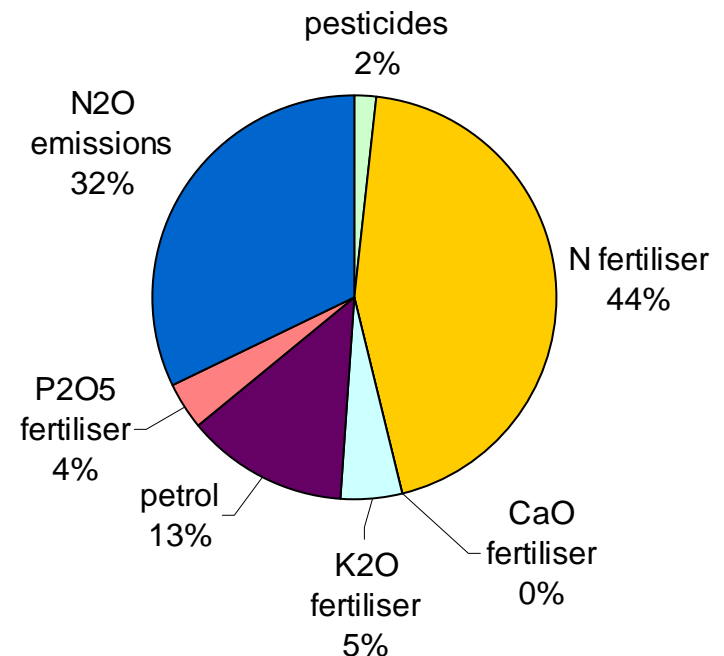
farm area needed
for a drive of 100,000 km



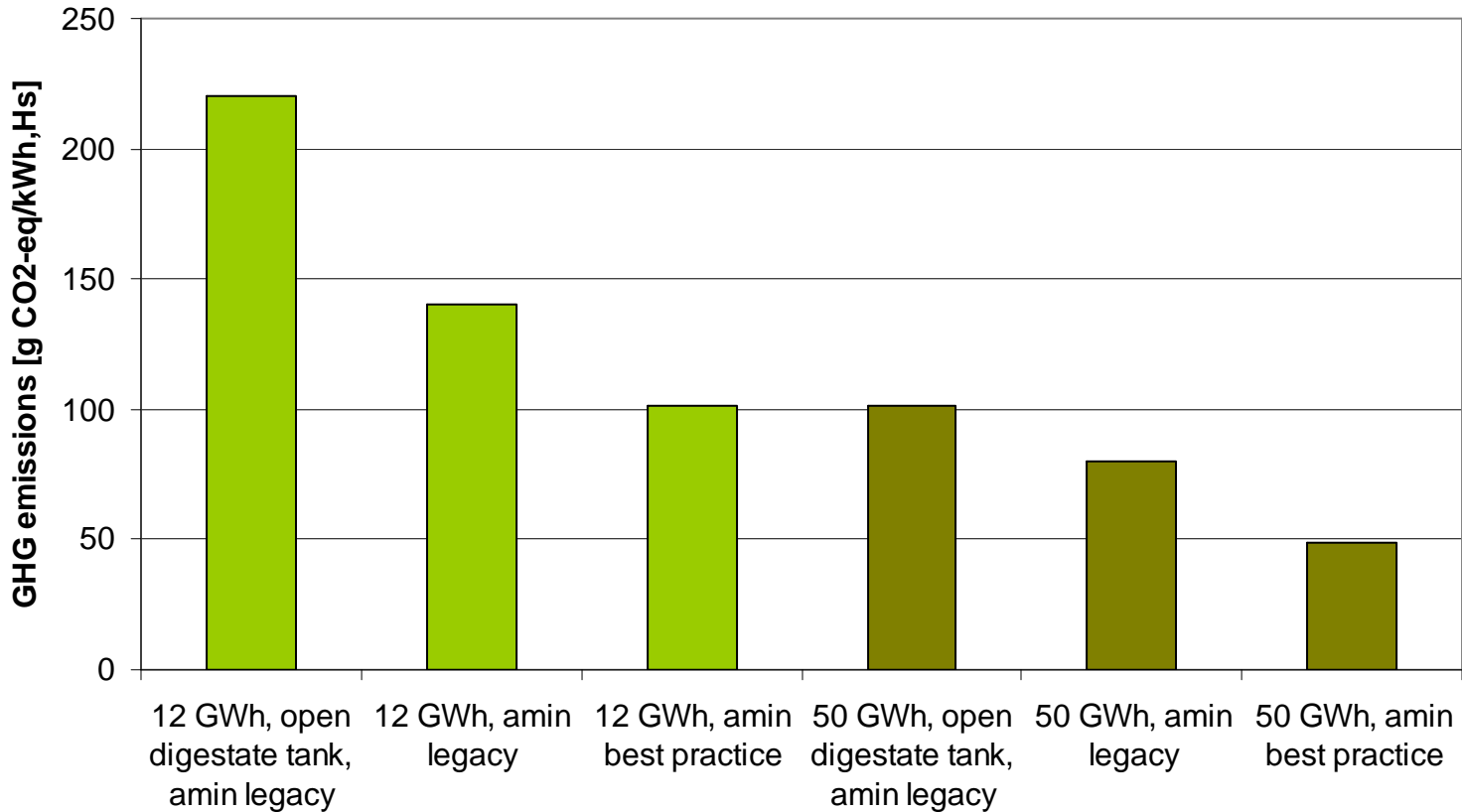
* base: fuel consumption of Opel Zafira (gasoline, diesel, CNG)
 ** source: Fachagentur Nachwachsende Rohstoffe

Crop production accounts for appr. 65% of GHG emissions

- GHG potential
 - CO₂ = 1
 - CH₄ = 25 CO₂ equivalents
 - N₂O = 298 CO₂ equivalents ¹
- mineral fertiliser is largest source of greenhouse gases; will be minimised by using digestate as organic fertiliser
- petrol consumption is ecologically not crucial but important for economics
- N₂O emissions yet based on assumptions
- pesticides are climate-wise irrelevant (but energy crops require less pesticides anyway)



GHG emission of biomethane depends on plant size+design



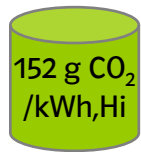
- small plants have higher emissions per kWh than large plants
- best practise plant design and operation cuts emissions by >50%

Method to calculate GHG savings

CO2 emissions of biogas/biomethane

applications and their efficiencies

GHG emissions of (avoided) reference



biogas in local CHP with no heat utilisation



62% loss

38% power

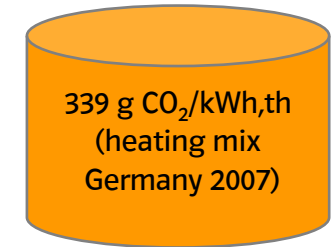


biomethane in heat-steered CHP, full heat utilisation



19% loss

38% power
43% heat



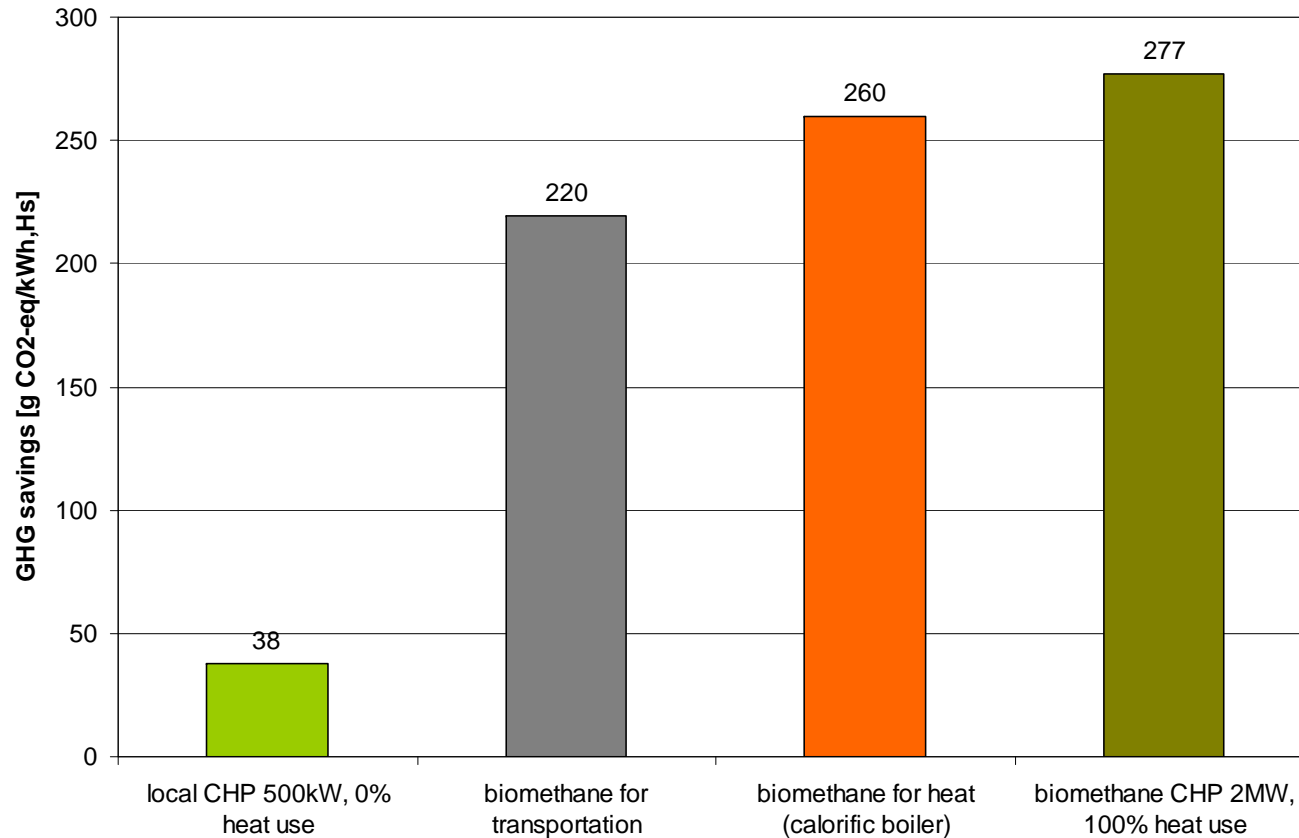
biomethane in calorific boiler



9% loss

91% heat

GHG savings of biogas/biomethane applications



- biomethane has near equally high GHG savings in all applications
- in CHP maximum heat utilisation is crucial

Summary of advantages of biomethane

- Biomethane is a dispatchable and storable energy source (unlike wind and solar power) with the highest end usage versatility of all renewable carriers: fuel for transport, heat and electricity
- Biomethane is available year-round (24/7); plants run in base load
- Anaerobic digestion has the highest energy yields per area and the highest versatility of input materials:
 - dilute organic waste, solid organic waste, wet crops, dry corn
 - root, stem, leaves and fruit
- Anaerobic digestion has a closed cycle of matter: nutrients from biomass return as organic fertiliser to the fields
- Biomethane in all usages has a high climate change mitigation effect

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