



Ruhrgas

**Natural gas: option for biogas integration,  
source of efficient distributed generation,  
and storage of excess green power**

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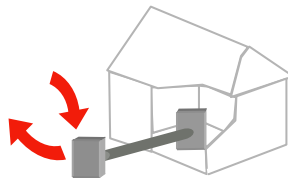
## Content

### Natural gas – the cleanest fossil fuel: today and tomorrow

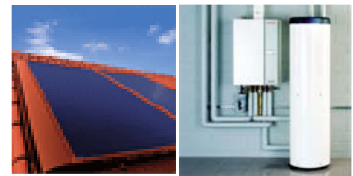
Natural gas allowing integration of bio fuel, renewable heat, and solar power



Biomethane



Gas heat pump



Natural gas & solar

Gas-based distributed generation to stabilize the power grid  
Natural gas infrastructure to store H<sub>2</sub> from excess wind energy



Distributed generation



H<sub>2</sub> storage



## Exploring the future of "green gas"

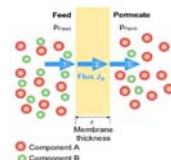
### Facts in Germany

- Approx. 50 plants in operation; 500 m<sup>3</sup>/h average size with an annual production of 50 million kWh each
- Approx. 3 billion kWh total annual production
- Standards in place (for individual process components like conditioning and grid injection plants)

### Optimization of biomethane technology

- Optimization of plant performance and measurement costs
- Development and testing of innovative biogas upgrading technology

From basic principle → to system test → on to commercial plant



### Alternative energy sources and fuels

- Identification and evaluation of new energy sources
- Technical and economic evaluation of innovative conversion chains



Solid biomass



Gasification

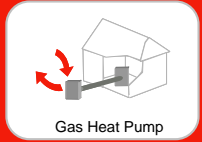


SNG



Bio SNG production plant

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## Gas heat pump technologies in Germany - Market and R&D

> 15 - 40 kW  
for new and  
existing buildings



- High efficiency demonstrated
- Operational safety and long-term stability confirmed
- **Market launch in 2009**

> 10 kW  
for new and  
existing buildings



- Newly developed appliance generation tested
- High efficiency demonstrated
- Further optimization still required for all components
- First field test installations in late 2010
- **Market launch planned for late 2011**



- Operational safety and long-term stability confirmed
- **Market launch of solar-assisted gas heat pump in March 2010**
- Test rig trials to continue for optimization of efficiency



- Component tests to continue
- First prototype available since late 2009
- Field test installations planned for 2010/2011 heating season
- **Market launch planned for 2012**

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## Natural gas applications: standards and innovations to reduce emissions



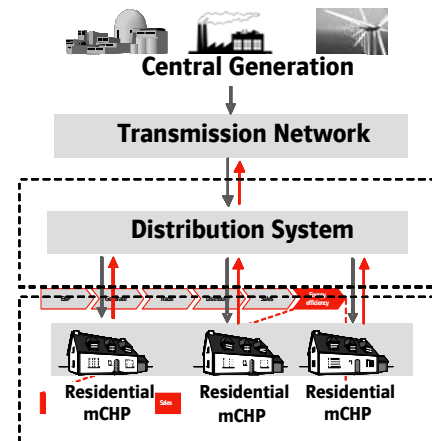
### Condensing boiler & solar

- Proven technology
- Highest efficiency
- 2.7 million condensing boilers installed in Germany (partly in combination with solar)



### μ-CHP (for one- and two-family homes)

- Close to market launch
- Goal: keep overall efficiency near to 90% but increase electrical efficiency from 20% today to 60%
- Rationale: set up a virtual power plant via a cluster of μ-CHP applications (to replace a coal-fired central power plant or to balance PV fluctuations)



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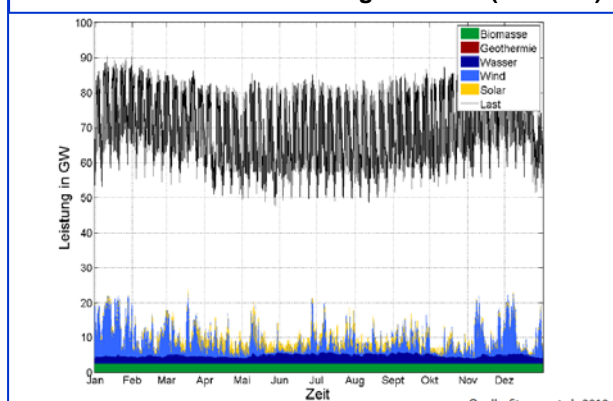
## Increasing number of wind & PV plants and, as a result, more volatile intermittent generation - a challenge for power grid operators

Installed power (Germany)				
Year	2010	2020	2030	2050
GW	27	42	60	86-100

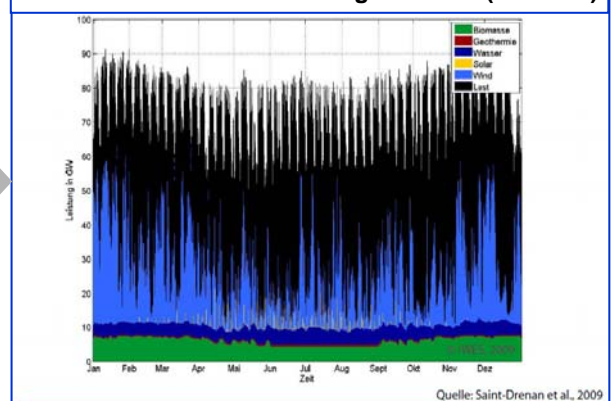
Ref: dena study "PSW-Integration 2007/2008" et alias

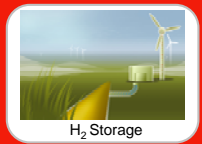


2007: demand & intermittent generation (wind ■ )

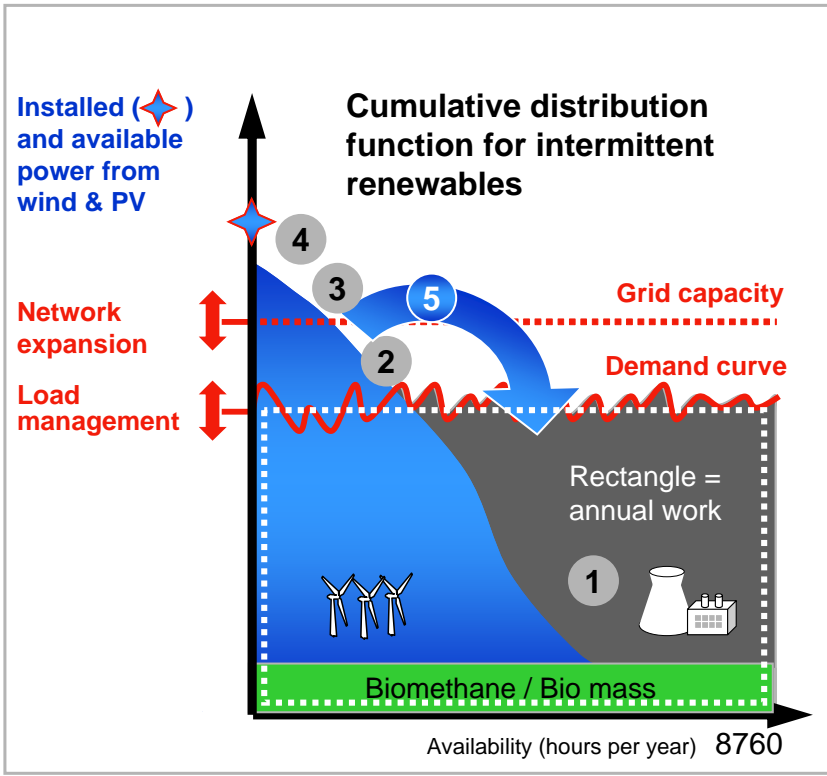


2020: demand & intermittent generation (wind ■ )





# Upgrading of power grid (copper plate) or – alternatively – storing of electricity to integrate intermittent availability of wind & PV



## Problems (and solutions)

- 1 Conventional generation increasingly uneconomic, but still indispensable
  - 2 Load management flexibility fully utilized
  - 3 Transmission capacity insufficient; lengthy capacity expansion procedure (10 years including approval)
  - 4 Oversupply: plants to be shut down; but idle power to be paid for (according to regulatory framework)
- Energy storage:**
- 5 Flattening of “inclined” distribution function for wind & PV possible; energy shifted to phases of lower generation



## Power storage

### Long-term storage

### Short-term storage

Proven technology	Room for improvement	New technologies	Known technologies with potential for improvement			
Water reservoirs	CAES	H <sub>2</sub> integration in NG	Battery	Supercap	Fly wheel	Heat (latent)

## Evaluation

In Germany, limited potential	Adiabatic storages	Wide range of options based on existing gas grid; methanation as an option	Important for e-mobility	Need for further R&D	Important for CHP optimization

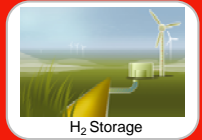
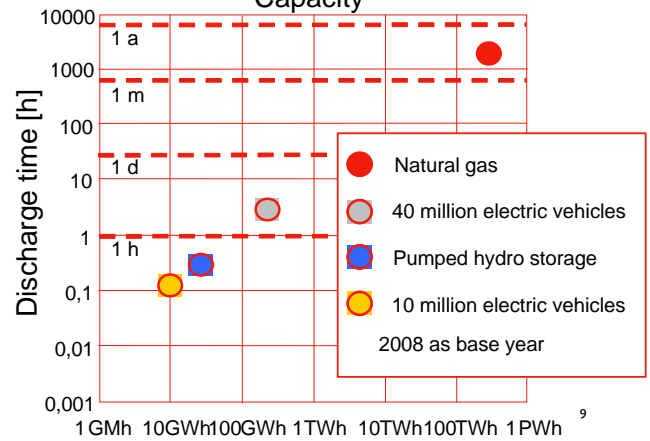
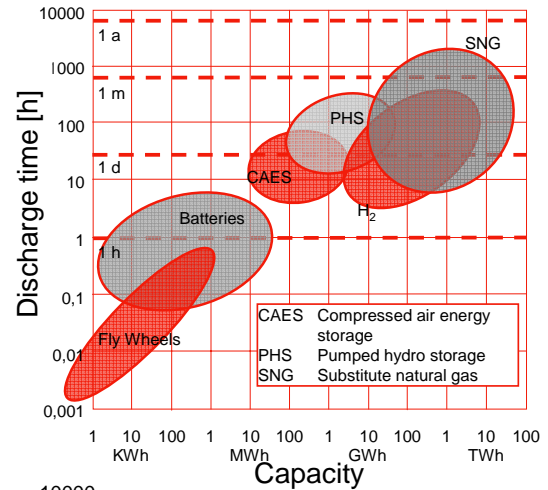




## Natural gas systems as a huge storage reservoir

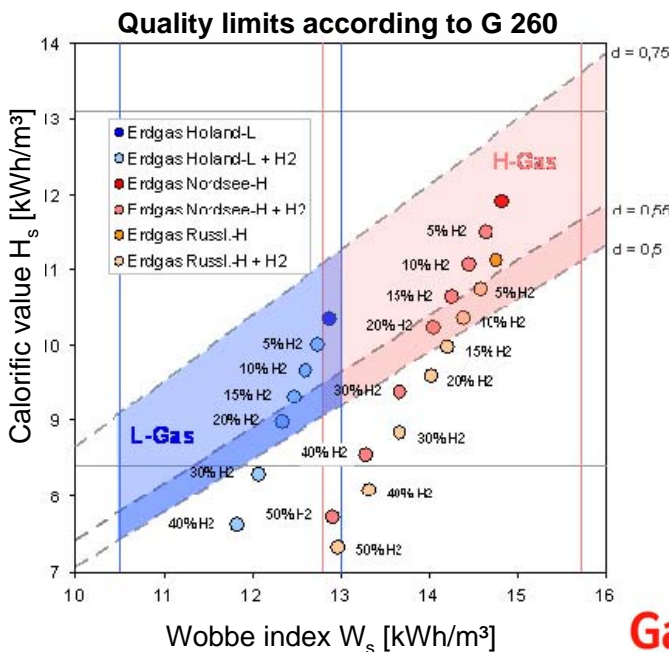
### Storage capacities (Germany)

		Electricity	Natural gas
Consumption	TWh/a	619	930
Average power	GW	70	106
Storage capacity	TWh	0.04	217
Cal. operating range	h	0.6	2000



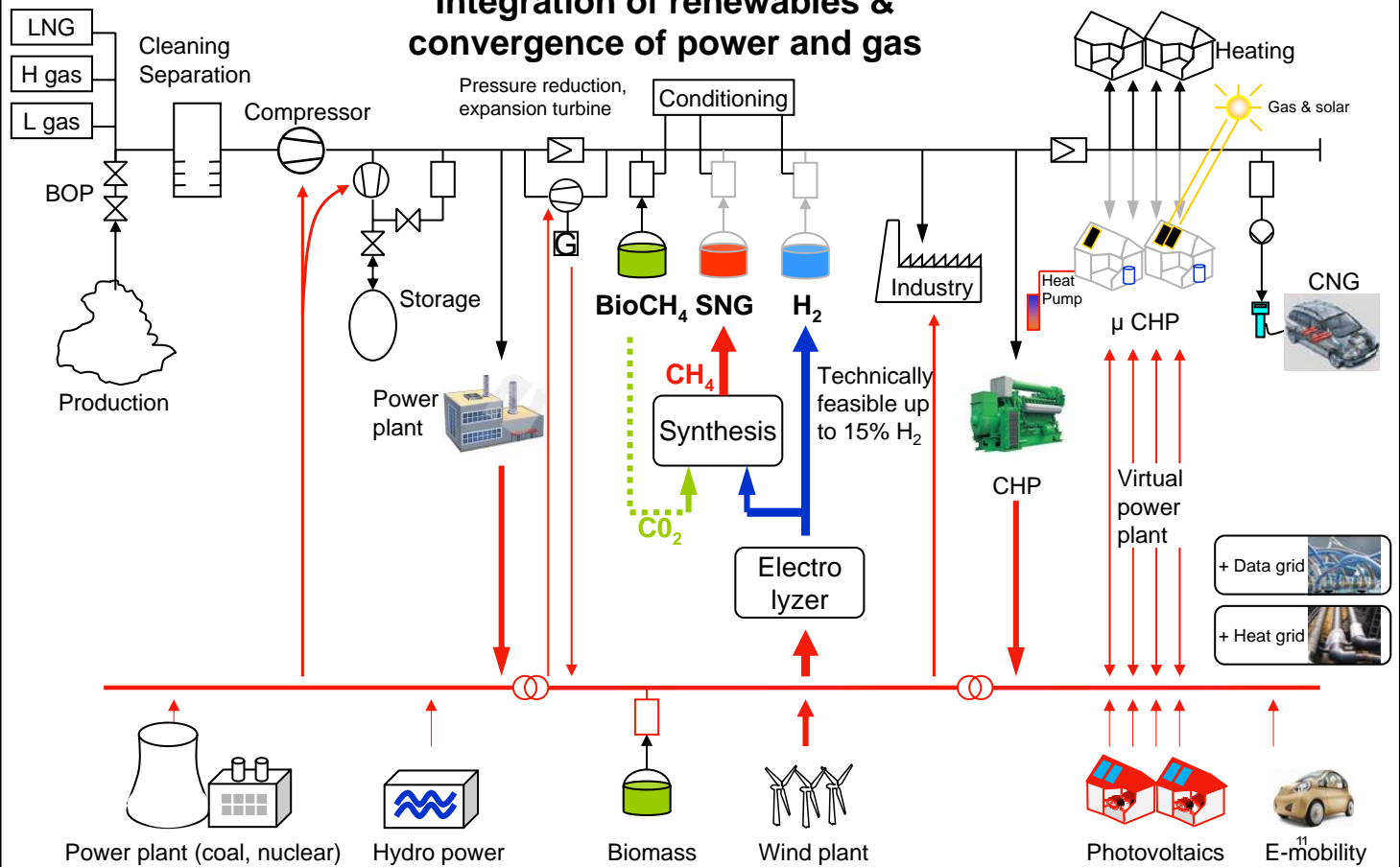
## H<sub>2</sub> concentration in natural gas systems: limits

A mixture of up to 15% H<sub>2</sub> and 85% natural gas is a product (hythane) with properties (calorific value and Wobbe index) that meet all requirements under DVGW Code G260 (gas quality specifications)



Germany:  
15% H<sub>2</sub> in the natural gas grid equals approx. 15 bcm. 33 GW excess wind power over 2000 h/a would be necessary to generate this amount of energy.

## Integration of renewables & convergence of power and gas



## Summary

### Natural gas

- ... is the cleanest fossil fuel
- ... has a renewable share (biomethane)
- ... can be combined with geothermal energy (gas heat pump)
- ... offers proven technology to integrate solar power
- ... enhances energy efficiency (via distributed generation) and can compensate local power fluctuations

### The environmental footprint of natural gas can be designed

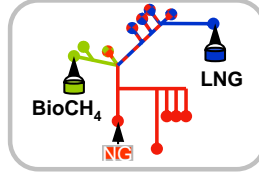
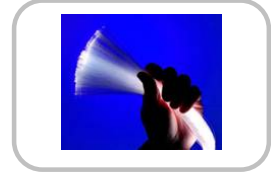
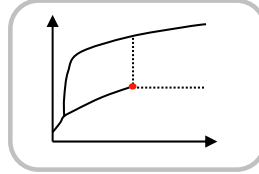
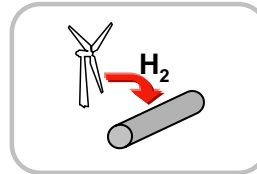
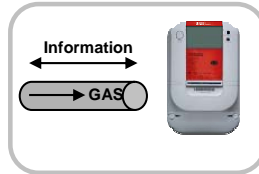
- ... by increasing the share of biomethane
- ... by hydrogen integration (hythane from excess wind power)
- ... by applying CCS technologies

### Natural gas contributes to solving the problem of power storage





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**Stone age is not over because  
 we ran out of stones – we evolved.**

**Thanks for your attention.**

