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INVESTIGATION OF THE EFFECTS OF CHANGING GAS
QUALITIES ON INDUSTRIAL COMBUSTION PROCESSES

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Authors and Acknowledgments

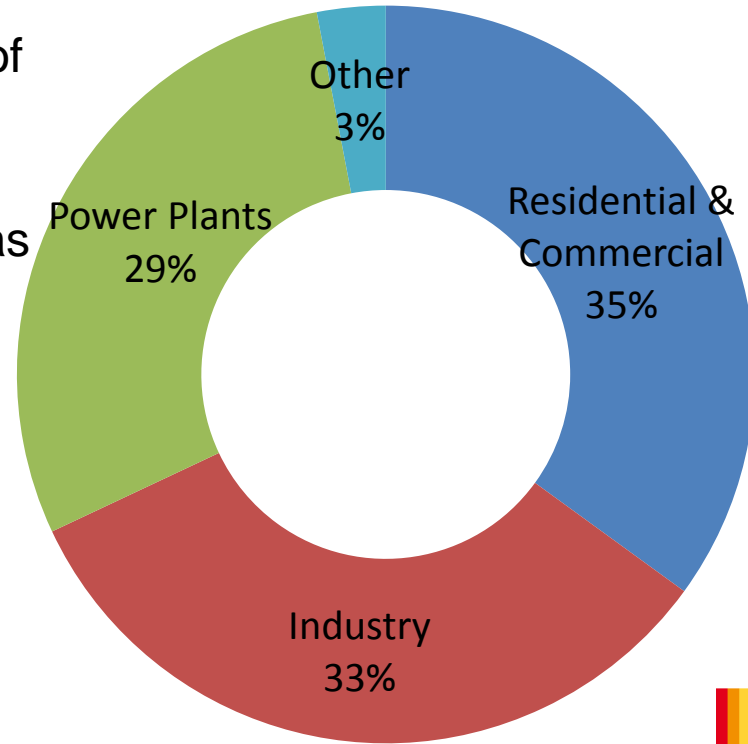
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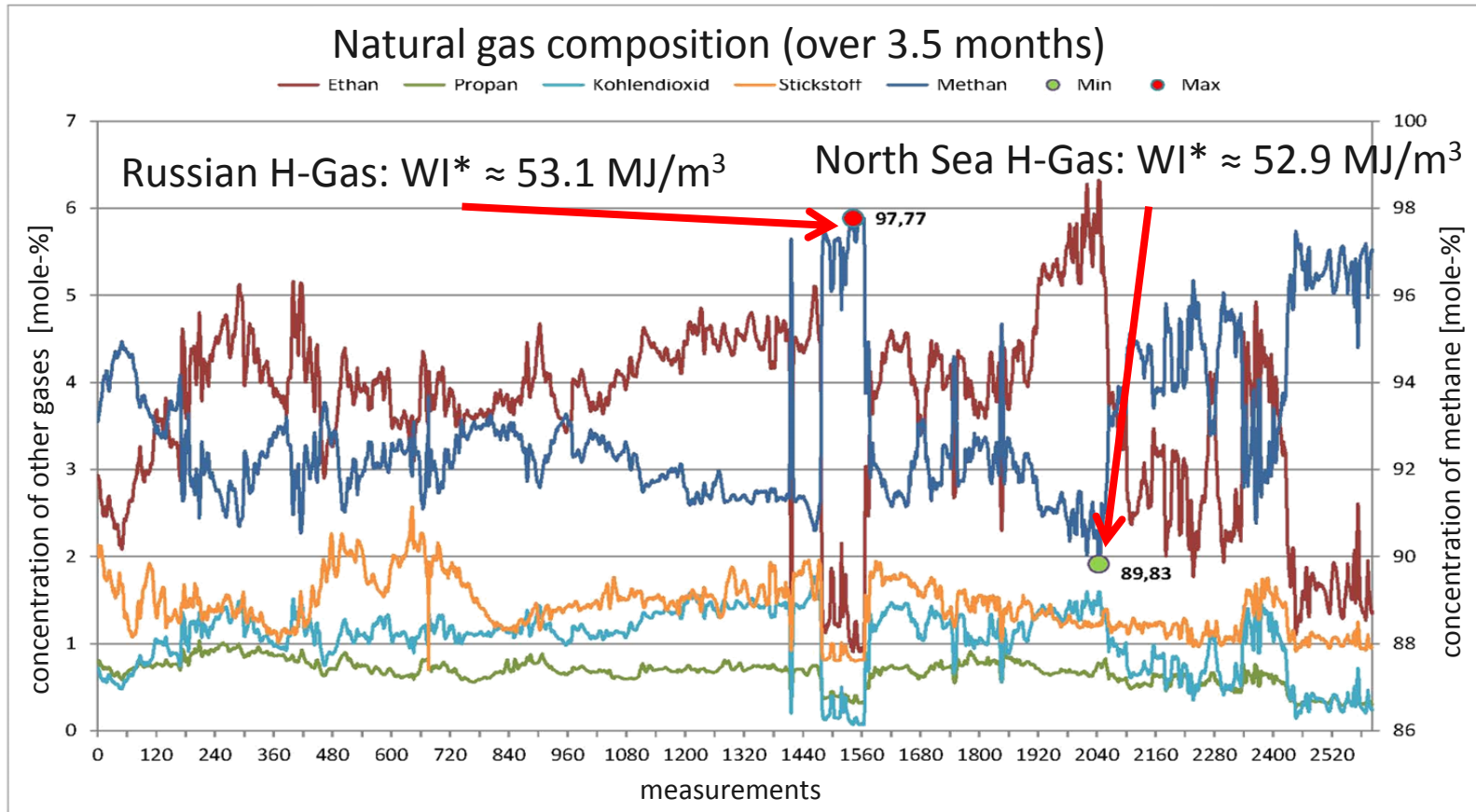


Natural Gas in Industrial Applications

- **Industrial applications** account for about **1/3** of Europe's consumption of natural gas.
- Natural gas is used to provide **process heat** in many industries. The chemical industry uses gas not only as fuel, but also as a **feedstock**.
- About **85 % of process heat** in Germany are produced by natural gas.
- Manufacturing processes have very high demands for **efficiency, process stability, pollutant emissions** and of course **product quality**. They often require a **tight control** of furnace conditions. Constant local gas qualities are a **distinct locational advantage**.



Measurements at Industrial Furnace near Leipzig, 2011

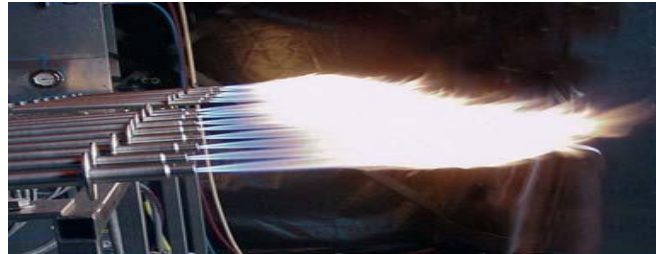
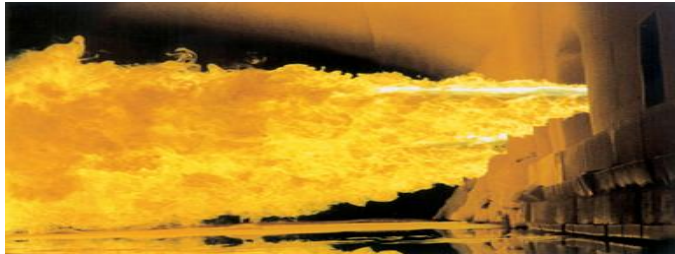


Source: GWI

* @ 25 °C / 0 °C

Industrial Experience: Glass Industry

- The glass industry is generally considered to be **very sensitive to gas quality fluctuations**. Natural gas is used in **many different production steps**: melting, feeders, shaping, annealing, ...
- A poll carried out by the Research Association of the German Glass Industry (HVG) in 2011 shows that about **75% of the participants (~90% of German glass manufacturing capacity)** have **already** encountered problems due to **fluctuating gas qualities**.
- Issues range from **loss of efficiency** and **reduced product quality** to **increased pollutant emissions** and **reduced process stability**.

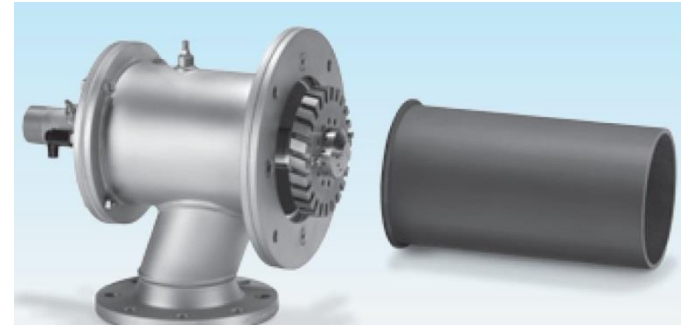


Source: HVG

GWJ Semi-Industrial Burner Test Rig Experiments



This is **NOT** industrial standard!
See CFD case study in Final Contribution
for further information!



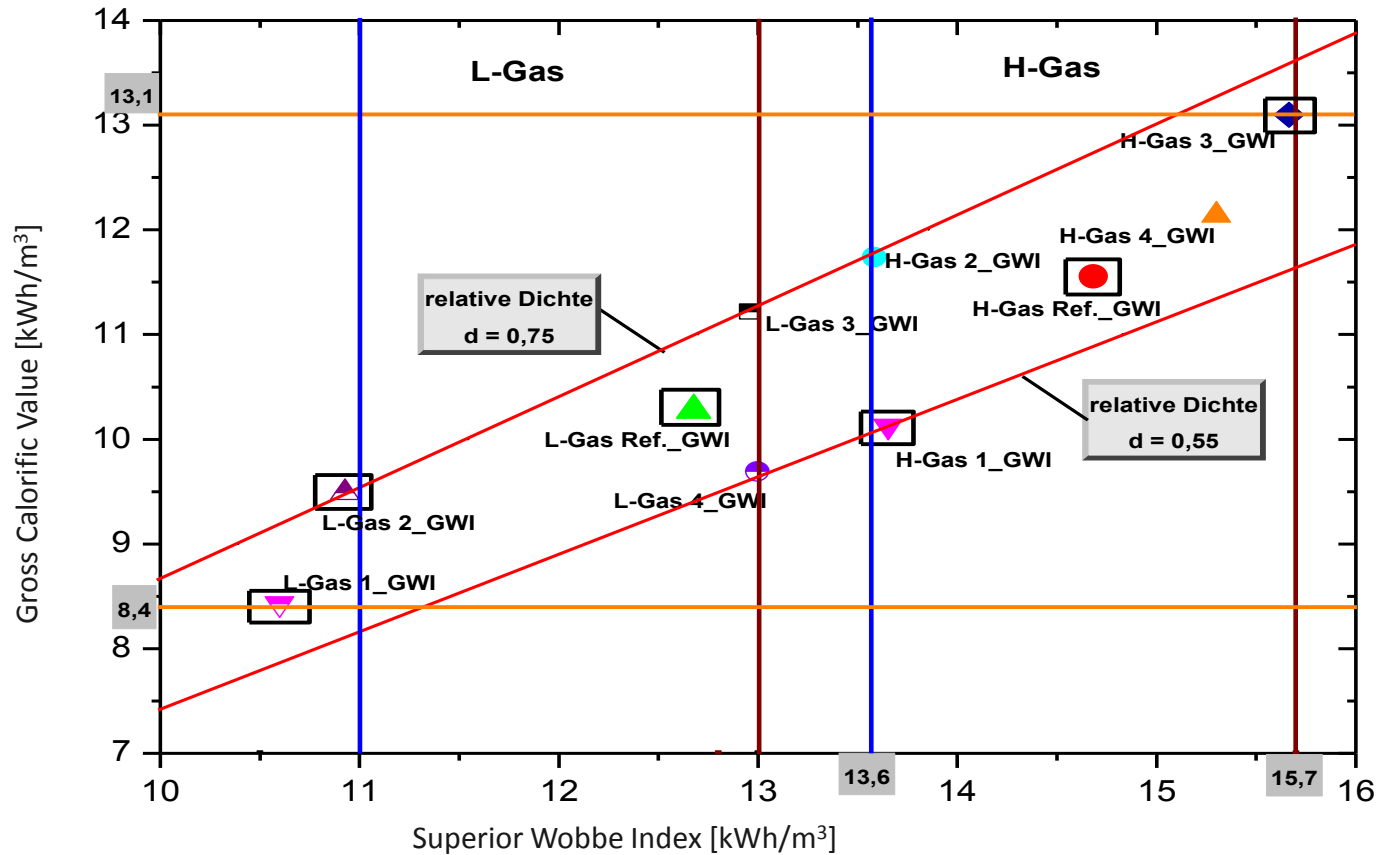
Operating Conditions:

- Burner Load: 200 kW
- Fuel: Natural Gas H and L
- Air Ratio: 1.15
- Gas Temperature: 25 °C
- Air Temperature: 200 °C

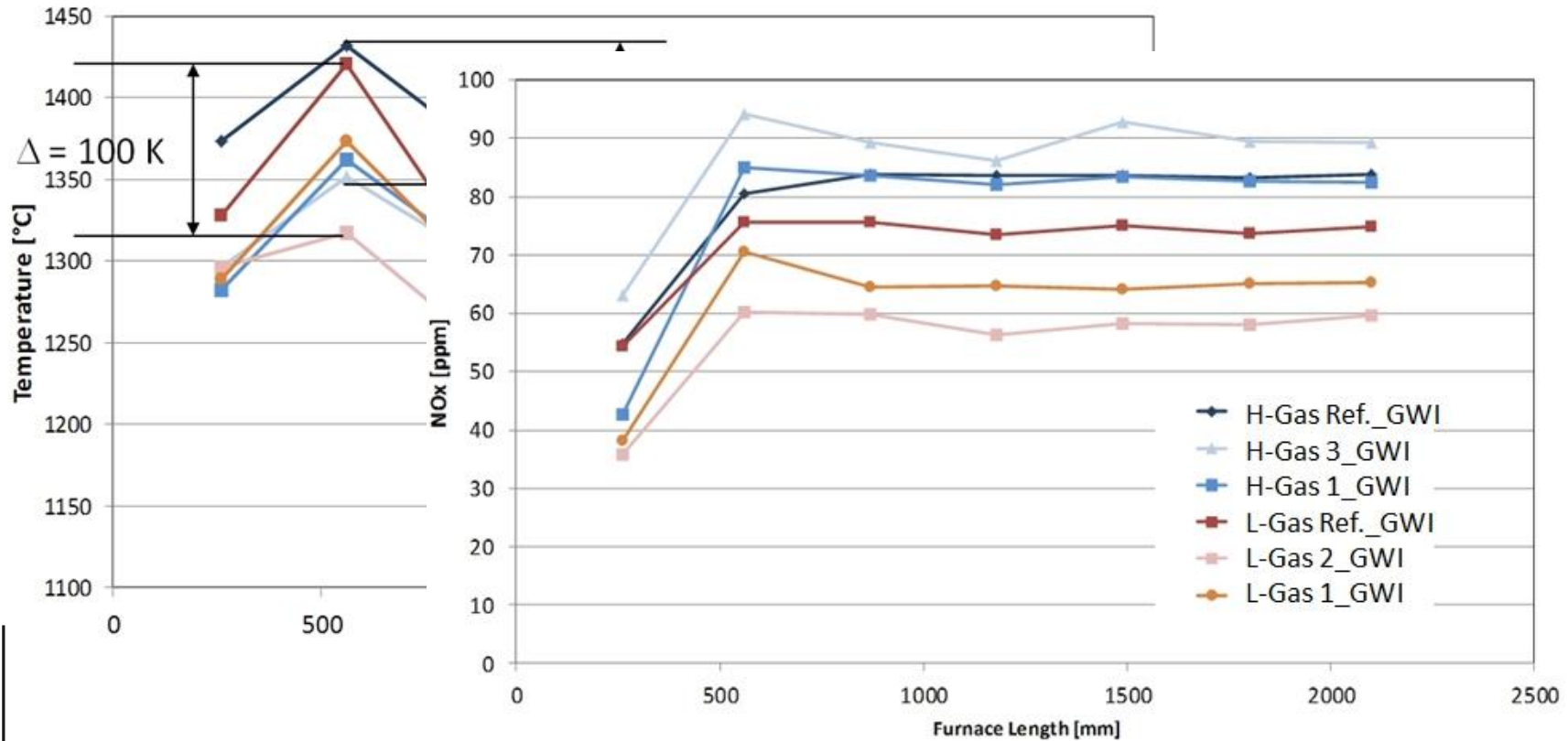
Burner Load and **Air Ratio** remained
constant for all experiments !



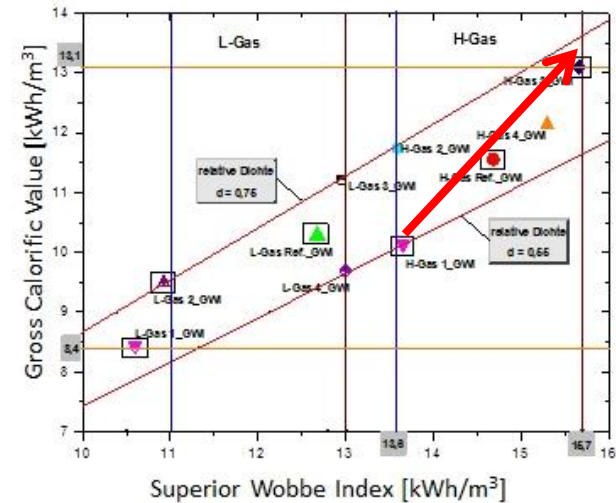
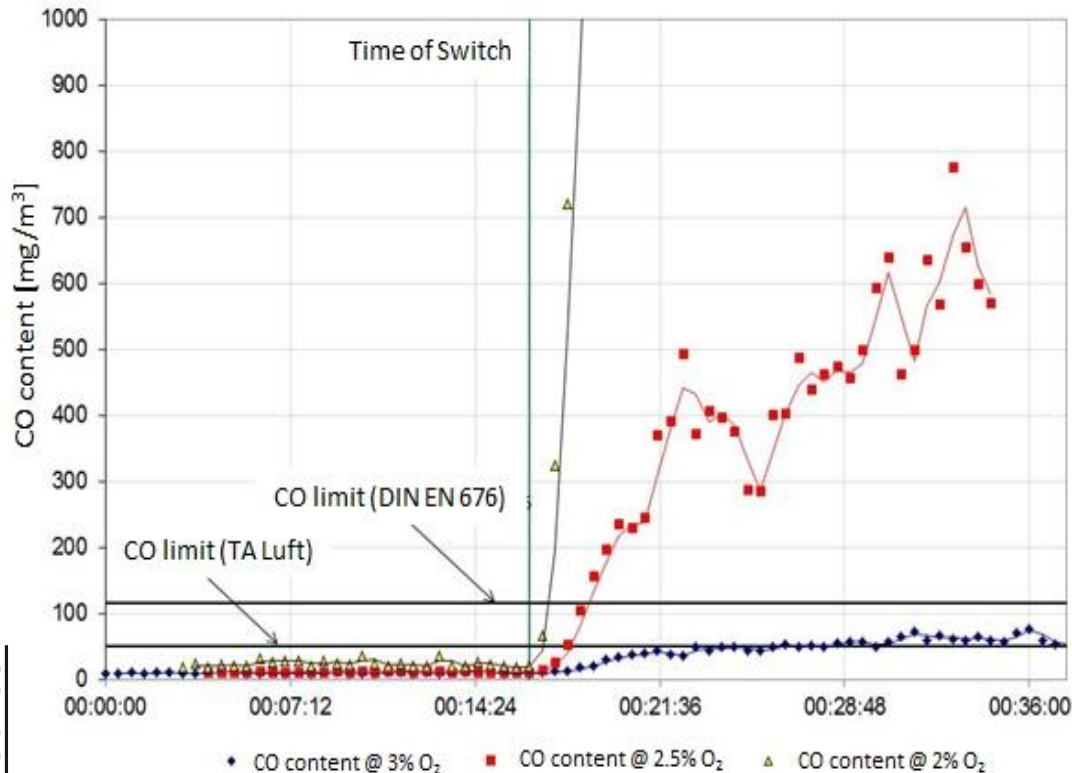
Test Gases in DVGW G260 Range



GWJ Test Rig Results



DBI Experiment: Influence of Local Adjustment






Industrial burners are usually adjusted **in the field**, based on **excess O₂** in the flue gas!
Air ratios tend to be **close to $\lambda = 1$** for emissions and efficiency reasons.

Sensitivity Assessment (DVGW Study, 2013)

Industry	Process	Efficiency	Safety (Emissions and/or Thermal Overload)	Product Quality
When switching from lower to higher Wobbe Index (maximum possible range according to DVGW G 260)				
Heat	boilers	Yellow	Red	Green
	luminous radiant heaters	Yellow	Red	Green
	direct and indirect drying	Yellow	Yellow	Yellow
Metallurgy	pre-heating (metals)	Yellow	Red	Yellow
	thermochem. heat treatment	Yellow	Yellow	Green
	zinc coating	Yellow	Green	Red
	melting (non-ferrous metals)	Red	Red	Red
Ceramics	calcination	Yellow	Yellow	Yellow
	brick & tiles manufacturing	Yellow	Red	Red
	porcelain firing	Yellow	Red	Red
Glass	glass melting (float)	Red	Red	Red
	glass melting (container), feeder	Red	Red	Red
	glass finishing treatment	Red	Red	Red
Other	chemical engineering, plastics	Red	Red	Red

Assumption:
no detection or compensation strategy for gas quality fluctuations
(common situation in many furnaces today)

Can all processes actually be operated with such a wide WI range?

 no intervention required
 intervention possibly required
 intervention required

Conclusions

- Natural gas is a **very versatile fuel**, used in **many different industrial processes** for very different purposes. About **2/3** of the EU natural gas consumption do **not** go into domestic appliances... yet gas quality discussions tend to focus on the domestic sector!
- The gas quality criteria used in the gas industry are often not suitable for thermal processing applications. The relevant combustion characteristics **cannot be described by one property alone!**
- Industrial furnaces and plants usually operate in a **very small window of optimum performance** with regards to **product quality, efficiency** and **pollutant emissions**. Fluctuating fuel qualities can have severe consequences.

Conclusions

- Contrary to household appliances, industrial systems are generally designed for a **specified local (average) gas composition** and operate with **very little excess air** (or even **sub-stoichiometric**), depending on the process. Most of them were never intended to be operated with strongly **fluctuating gas qualities**.
- There is **no single way** to prepare a thermal processing plant to fluctuating gas qualities. Each process is different and requires its own **tailor-made solution**.

Contact Info

Thank you for your attention!

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The final report (in German) of this DVGW research project is available at the GWI website:

www.gwi-essen.de