

Emissions and emission reduction of UHC (and NO_x)

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Outline

- **Environmental effect of gas use**
- **Gas company perspective**
- **Case study, CHP in Denmark**
 - Basic idea
 - Development
 - Environment
 - GWP
 - Technical solution
 - Cost/society cost
- **What can the gas industry offer**
- **Conclusions**

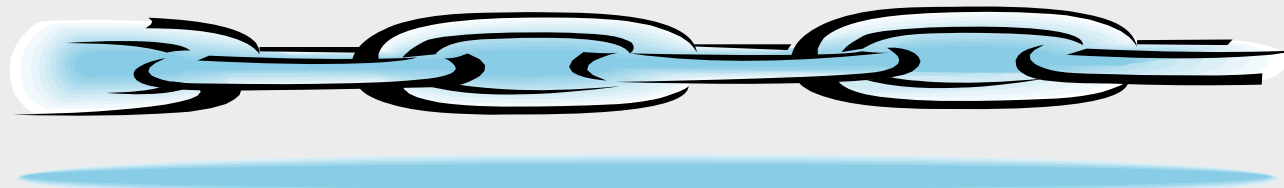


Environmental problems Utilisation of gas

- **Global**
Climate change: **CO₂, CH₄, N₂O**
- **Regional**
Acid precipitation: **NO_x**
- **Local**
Health and nuisance **CO, NO_x, UFP**
Gas Engine: aldehydes, odour, lube oil aerosol, particles, ..

Gas company perspective

- Value chain



Production

Sale

Utilisation

Feel good

Transmission

Distribution

Need

Gas company perspective

▪ Need for energy

Consumer

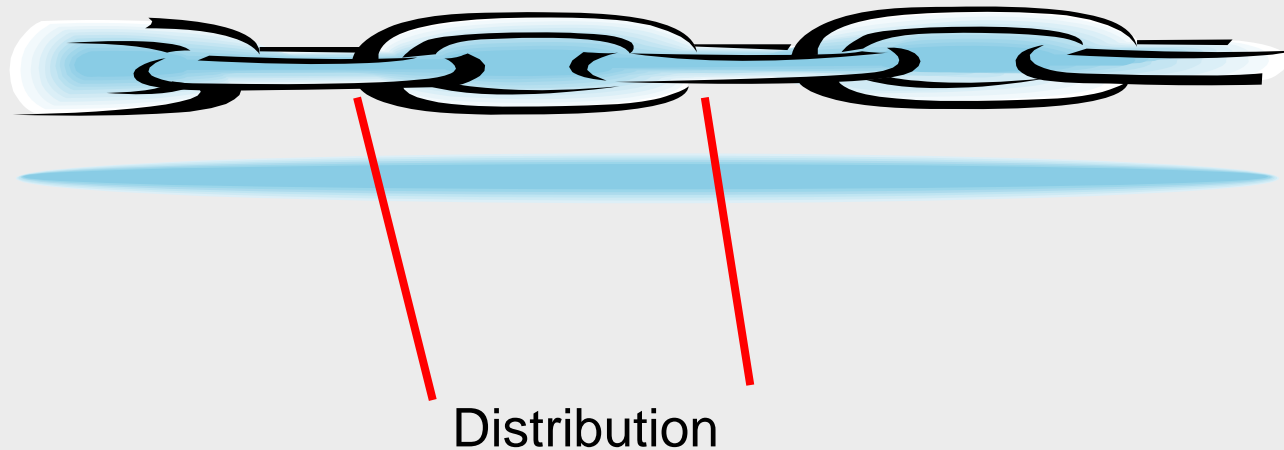
?

cost
availability
environment
...

Nuclear
Gas
Bio fuel
Wind
Oil
Coal
..

Gas company perspective

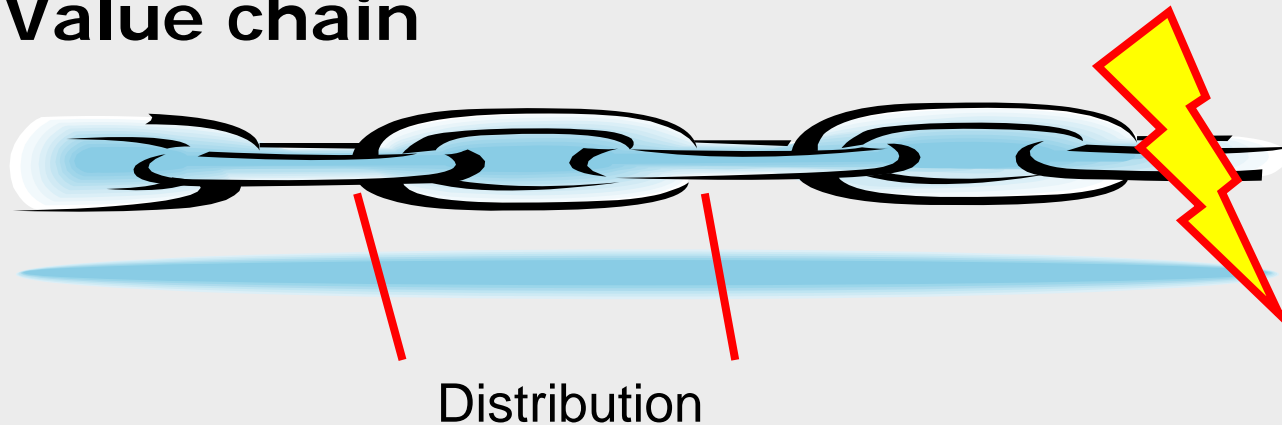
- Value chain



You can choose to focus on your part of the value chain

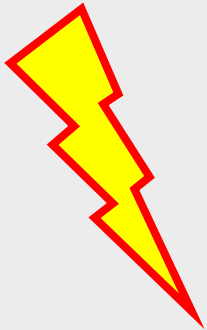
Gas company perspective

- Value chain



And run the risk of being out of business because of failure in another part of the chain

Gas company perspective



- Politicians, CO₂ emissions must be stopped
- Regulators, Strict NO_x emission levels that cannot be met
- Consumers, Don't want to use gas due to CO₂ emission
- Consumers, Stop due to other ethical problems
-

Just wait or do something about it ?

Case study, CHP in Denmark

- **The basic idea is to produce heat and power at the same time**
- **Great idea, save a lot of energy in a country with the need for heating of houses**
- **Governmental promotion of CHP and supportive power prices**

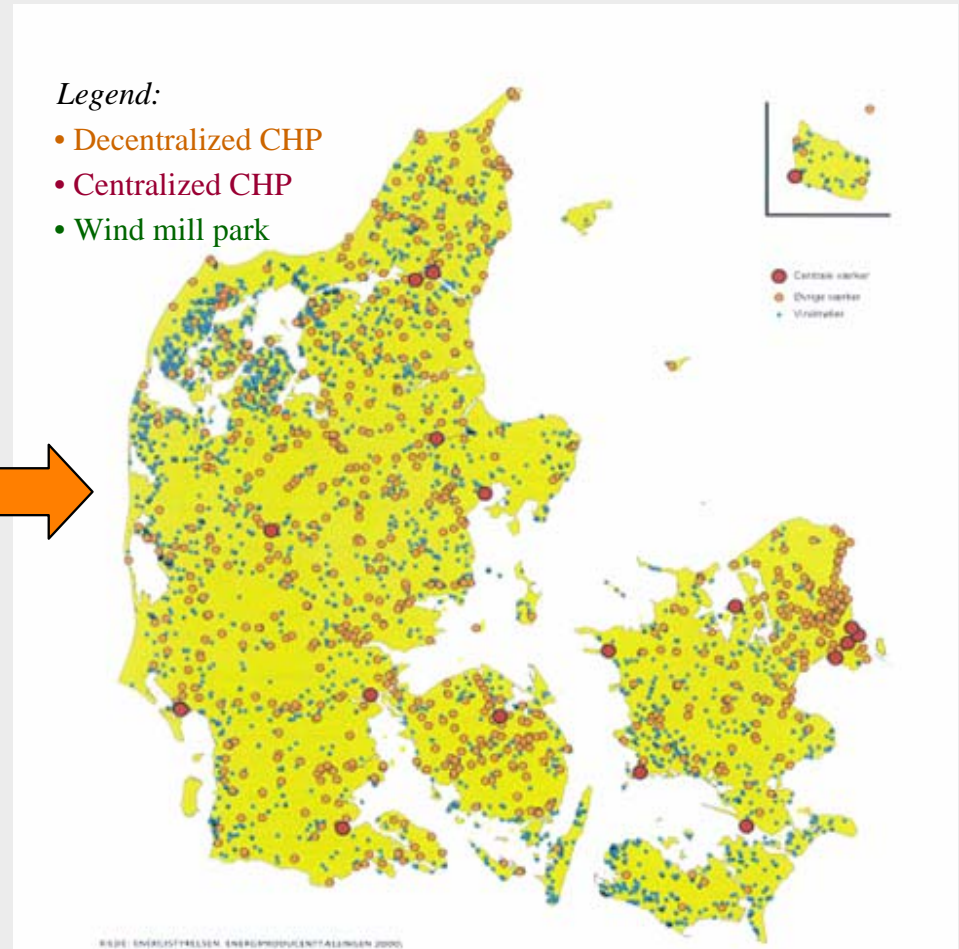


Development

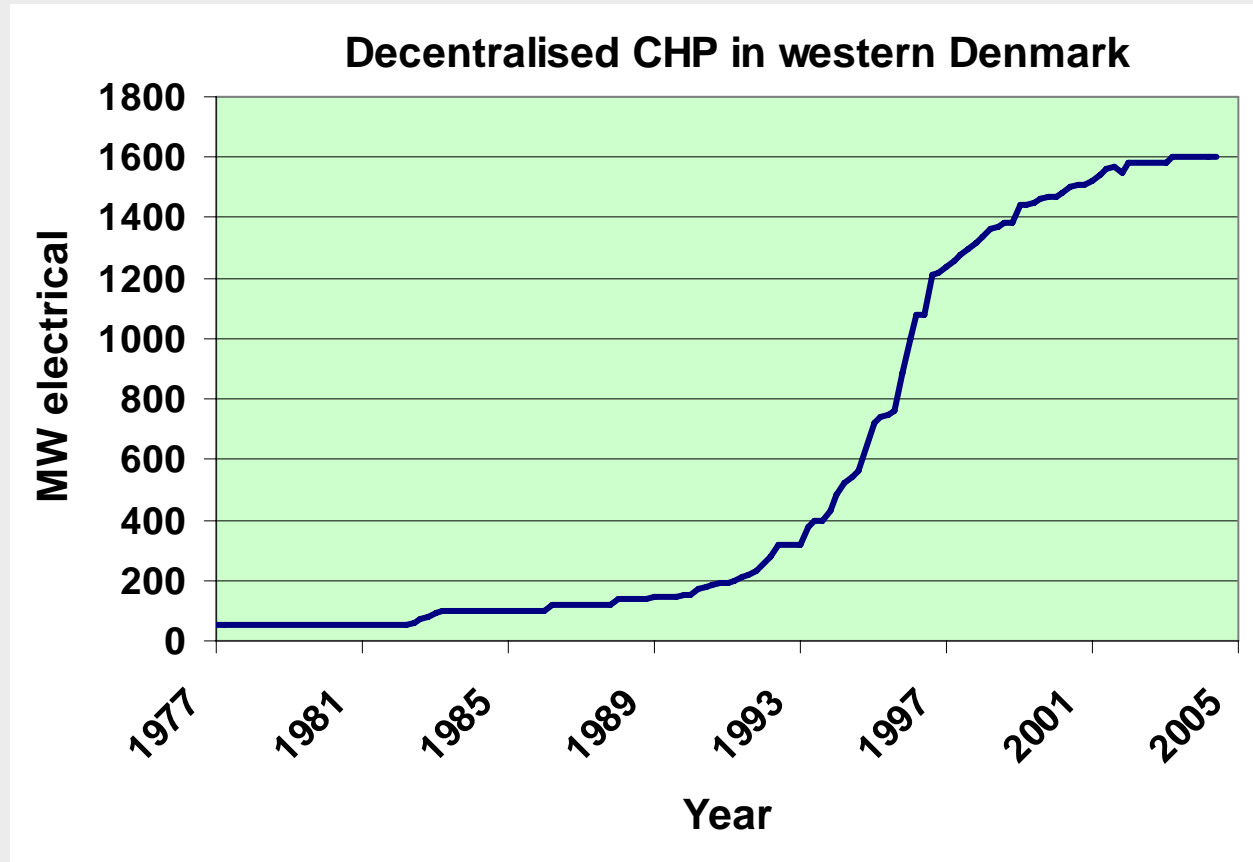
Mid 80's



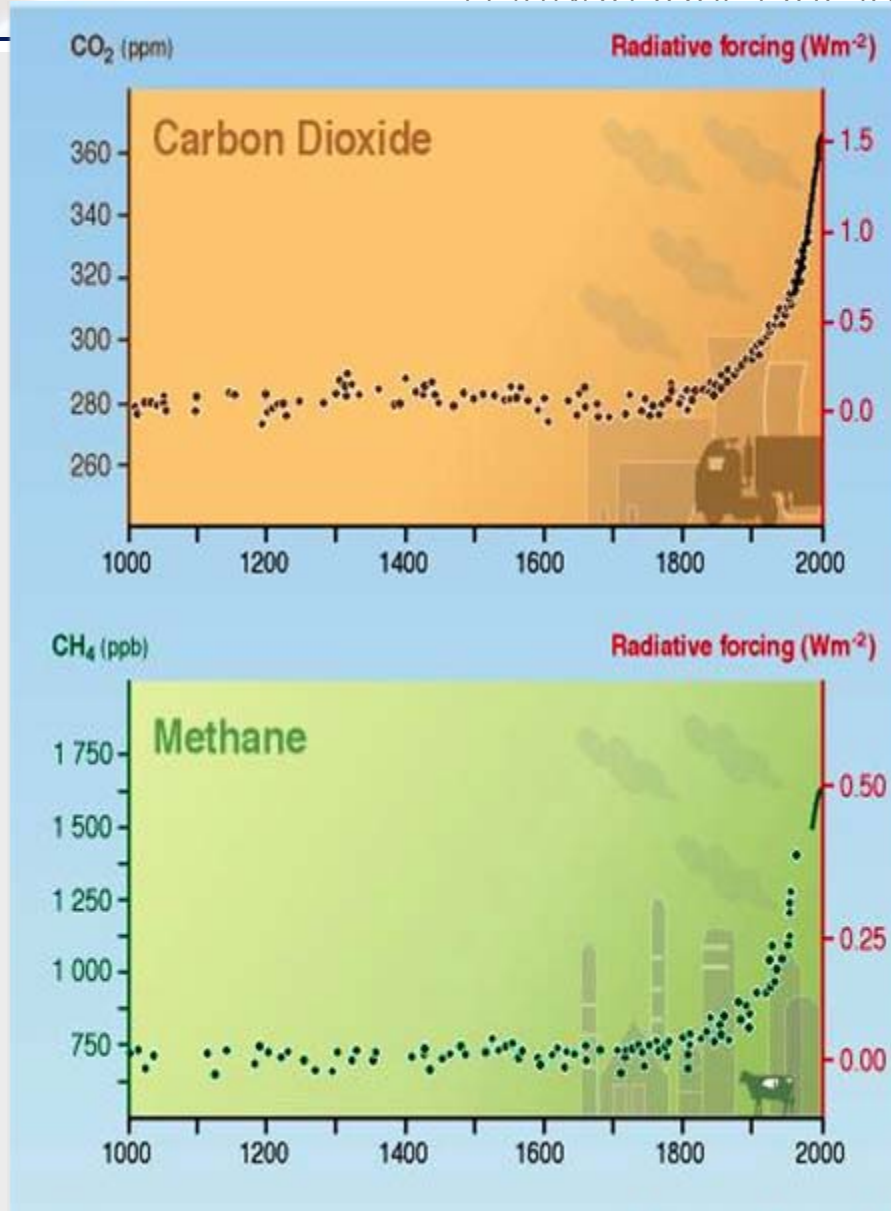
CHP in the 90's



Danish CHP



30% of natural gas sales goes to decentralized CHP



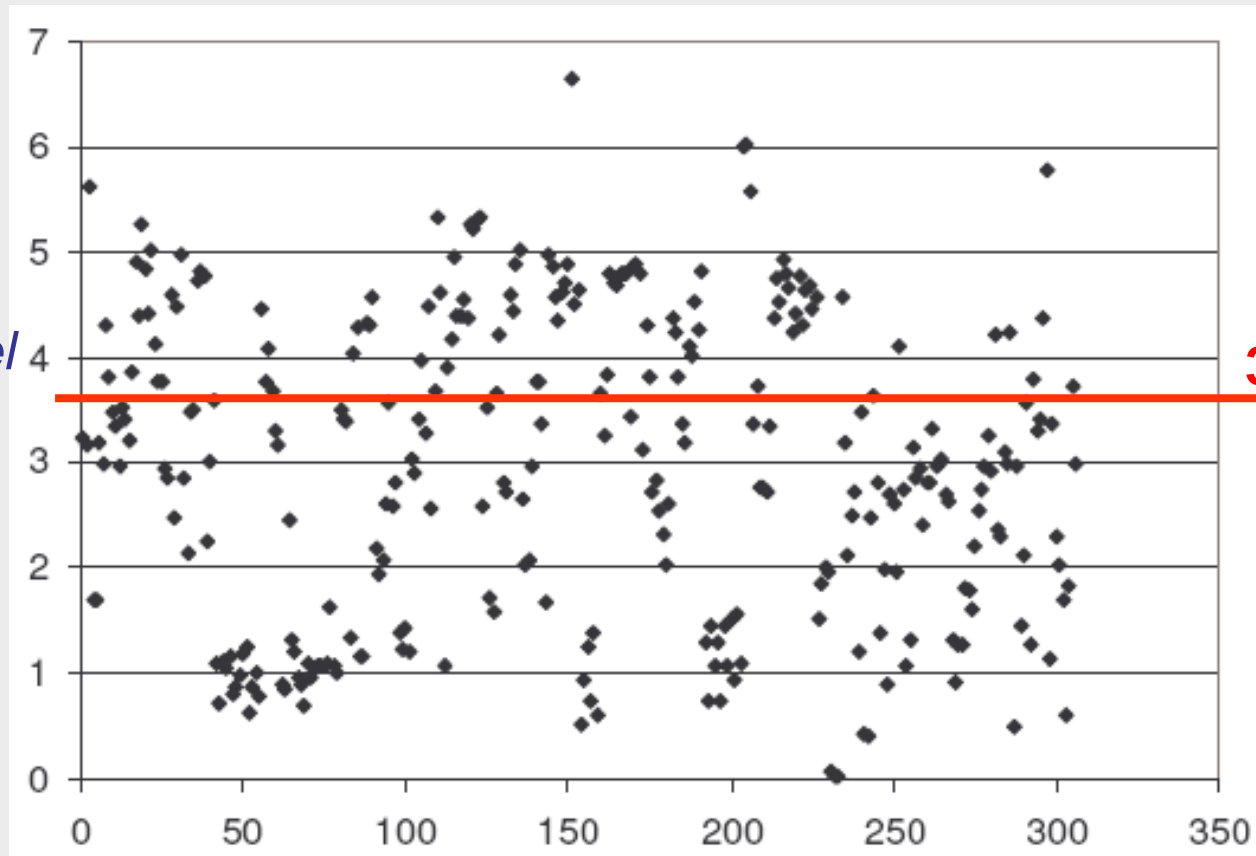
IPCC/2002



Danish gas engines

UHC emission, 100% load

*Unburned fuel
% of input*



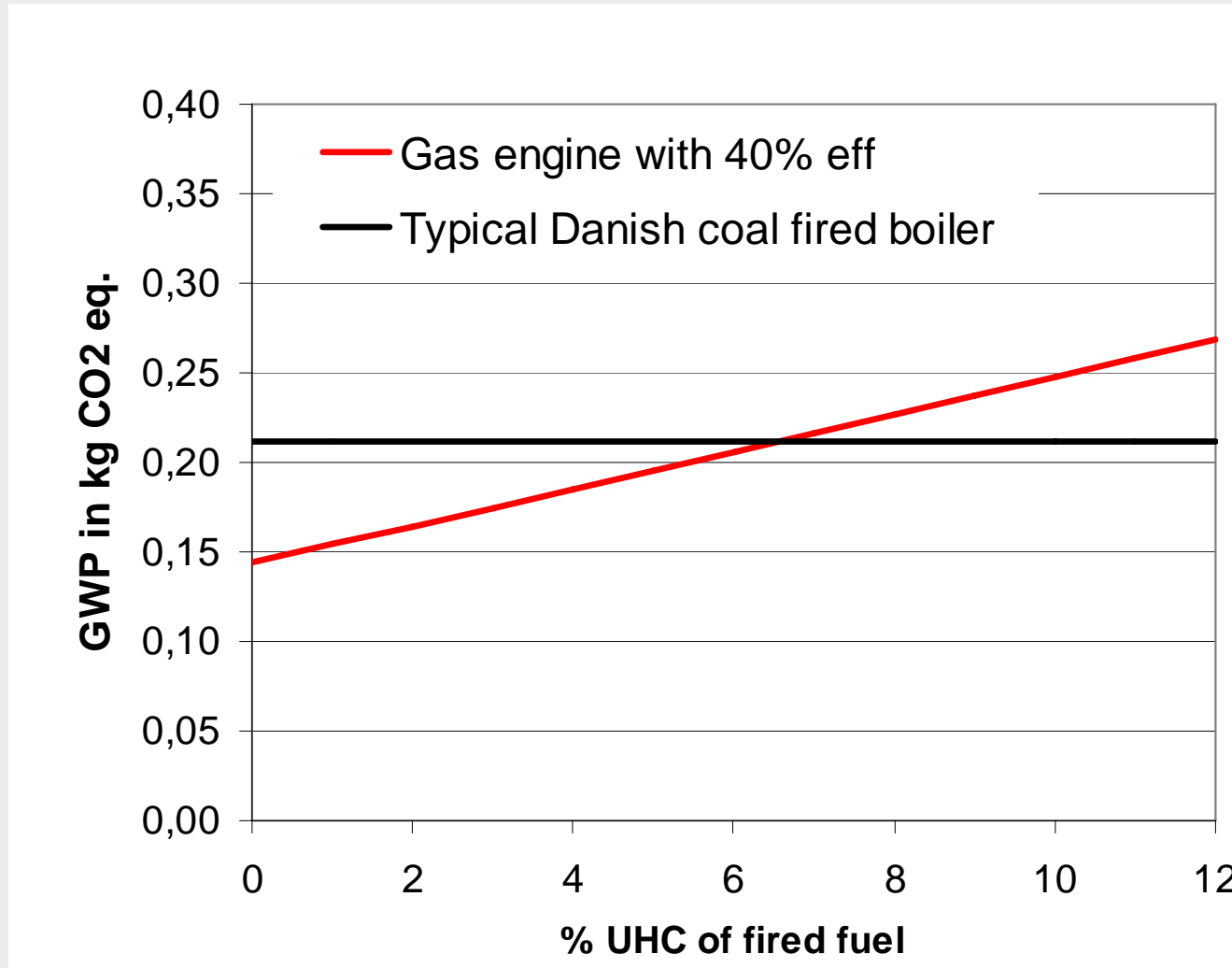
3.6%

Number of engines

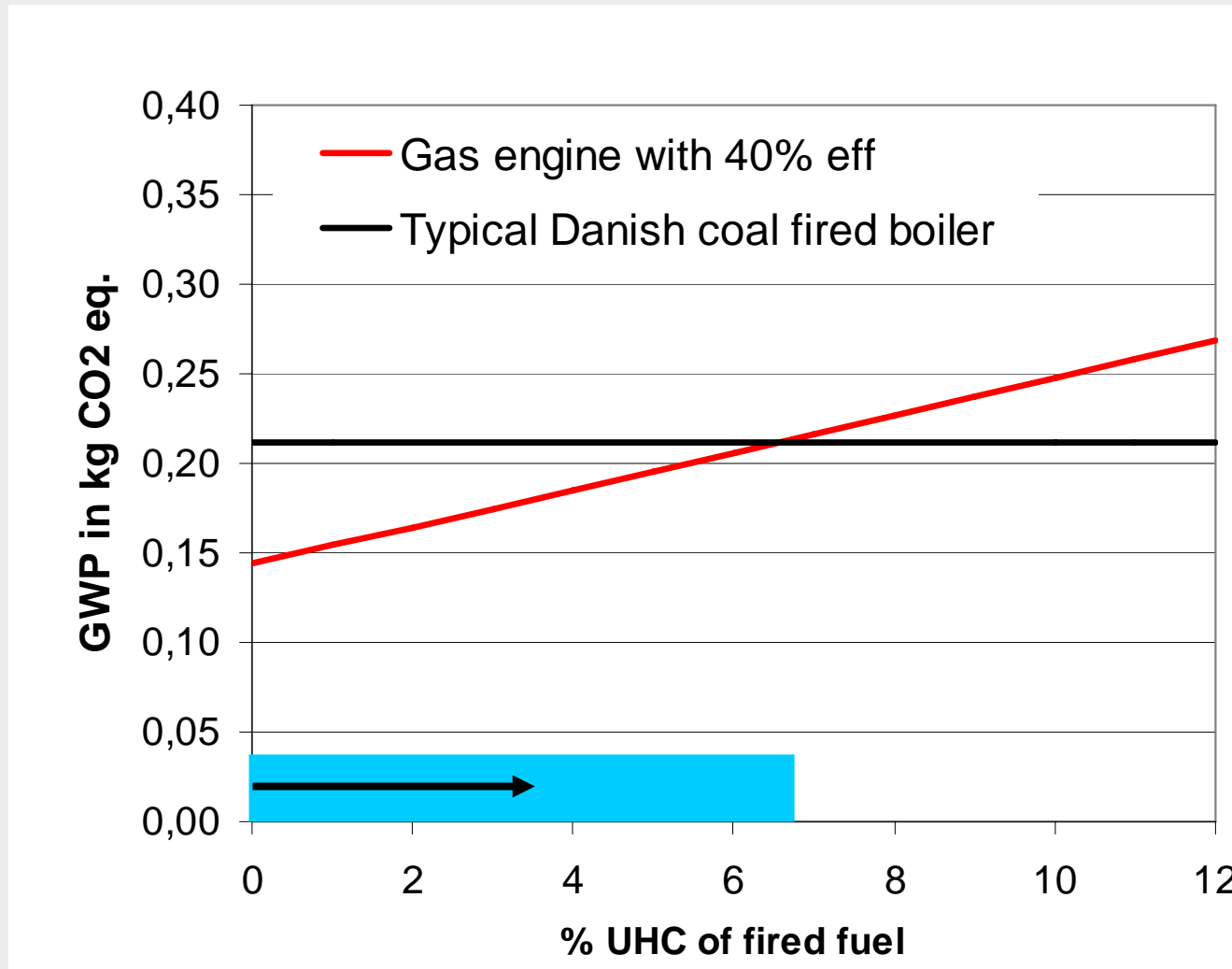
UHC emission

- **Composition almost as in natural gas**
- **NMVOOC part includes ethene and propene**
- **On mass flow average 3.6% of fuel consumed was emitted as unburned HC**
- **A 21% drawback on GWP from gas engines compared to complete combustion**

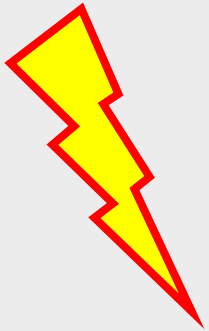
GWP Coal - Gas competition



GWP Coal - Gas competition



Gas company perspective, CHP



- Politicians, CH₄ emissions must be stopped
- Regulators, Strict UHC regulation that could not be met by many engines
- Consumers and local decision makers: “Don’t use gas, go for bio fuels, which are also without tax”

The Danish gas companies put up a large R&D effort (engine suppliers did as well)

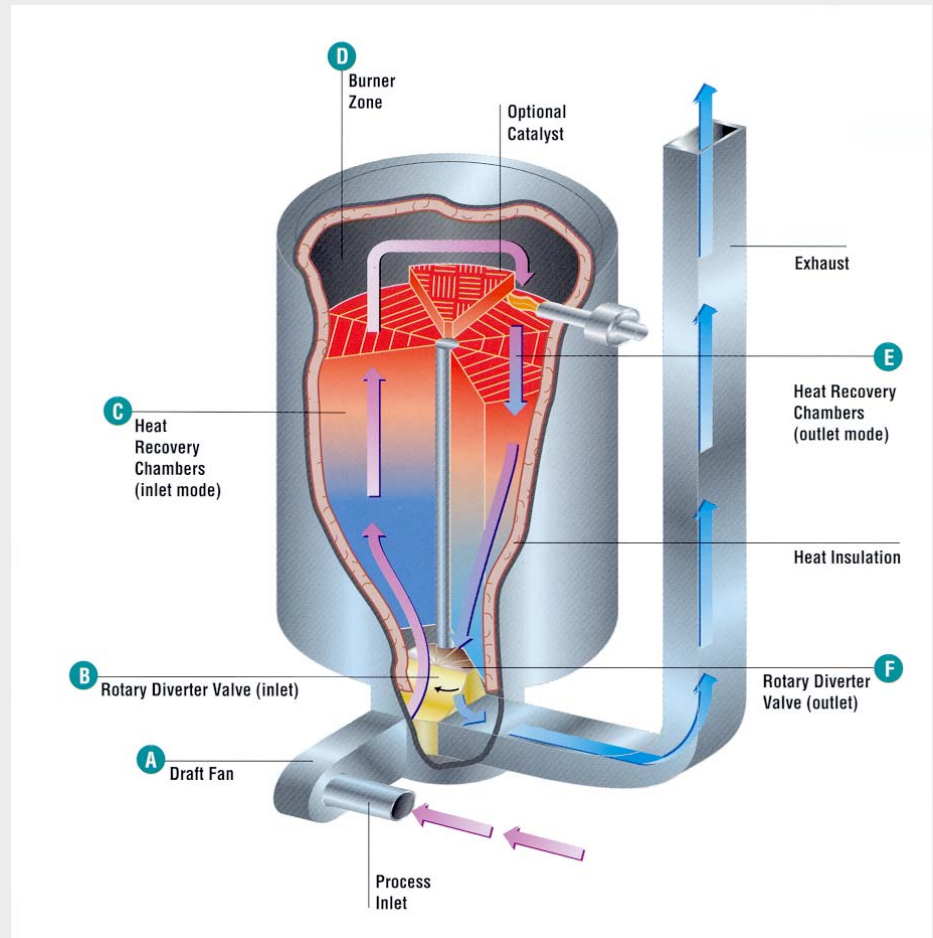
Catalytic UHC reduction

- CO oxidation catalysts are common technology and generally used
- Some CO oxidation catalysts reduces formaldehyde and higher HC compounds as well.
Field test of dedicated formaldehyde catalysts are ongoing
- Cost: 20,000 € per MW_e
- Catalytic reduction of CH₄ is complicated and the technology is not reliable

Thermal UHC reduction

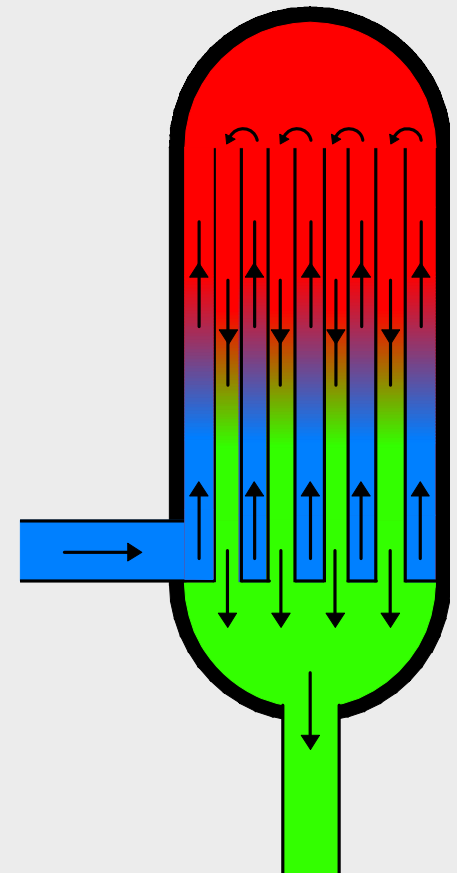
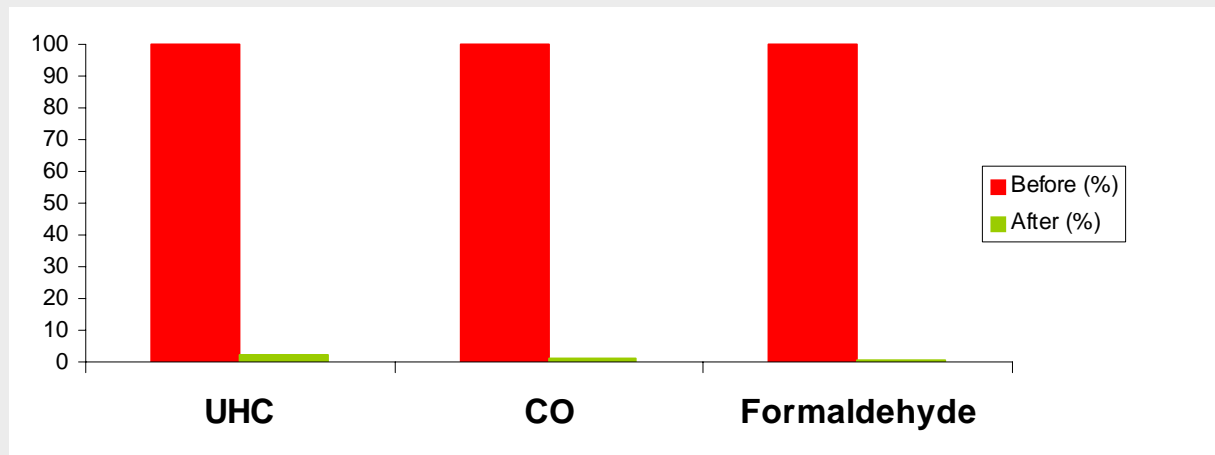
- Thermal reduction of organic compounds is a well proven technology.
- A regenerative incineration process has been developed and demonstrated at a 6 MW CHP (engine) plant. Organic compounds are reduced close to 100%.

Cost: 200,000 € per MW_e



RECCAT – RECuperativ CATalyst (www.reccat.com)

- Recuperative catalyst
- Use of non noble-metals
- Cost: 100,000 € per MW_e



Cost of UHC reduction

- You gain additional heat
- You buy less natural gas for same production of heat
- Less operating hours
- Less power sale
- At best, the payback time is 10-15 years

Cost for society

- More energy efficient
- Lower CO₂ emission
- Lower local environmental cost on health (formaldehyde, and other components)
- Cost for society is **NEGATIVE!** The society as a whole will benefit from the use of the technology
- Lack of stimulus (regulators consider solutions)

What can gas industry offer

- Emission reduction of CH₄ on all of the value chain
- Improve overall efficiency by energy rating of appliances
- You can go into energy saving projects
- Infrastructure – green gas or H₂
- CO₂ storage

Conclusion

- **Acknowledge the value chain**
- **You can act pro-active to minimize environmental problems**
- **Never stop – look for opportunities**

Acknowledgement

- **Energinet.dk and Danish gas distribution companies have supported the R&D work done in Denmark**
- **If you need further info:**
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Plasma De-NO_x - Chemistry



Followed by water scrubbing:



NO_x removal – pilot scale tests

