UNIVERSITY OF TWENTE.

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# Gas infrastructure, a key asset for a sustainable energy supply

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# Final conclusion

**The GAS INFRASTRUCTURE, integrated with electricity and heat networks, will be an essential part of a reliable, sustainable and affordable energy supply.**

# Agenda

- **Today**:
  - gas (energy) demand and supply
  - gas (energy) infrastructure
- Challenges for **future** gas (energy) supply and gas (energy) infrastructure systems
- Research in progress: EDGaR
- Conclusions

# Current **Energy Supply (1)**

## Example: The Netherlands, 2008

| Input | | Output | | | |
|---|---|---|---|---|---|
| Uranium (1%) | | "Products" | 658 | PJ | (16%) |
| Heat/Bio (4%) | | Energy consumers | 2032 | PJ | (49%) |
| Coal (8%) | | | | | |
| Natural gas (35%) | | | | | |
| Oil (50%) | | Conversion losses | 640 | PJ | (16%) |
| | | International transport (airplanes, ships) | 810 | PJ | (20%) |
| | | Total | 4140 | PJ | (100%) |

Source: CBS (see also www.kiviniria.nl/energie )

# Current Energy Supply (2)
## (The Netherlands, 2008)

- Where are the various energy carriers used?

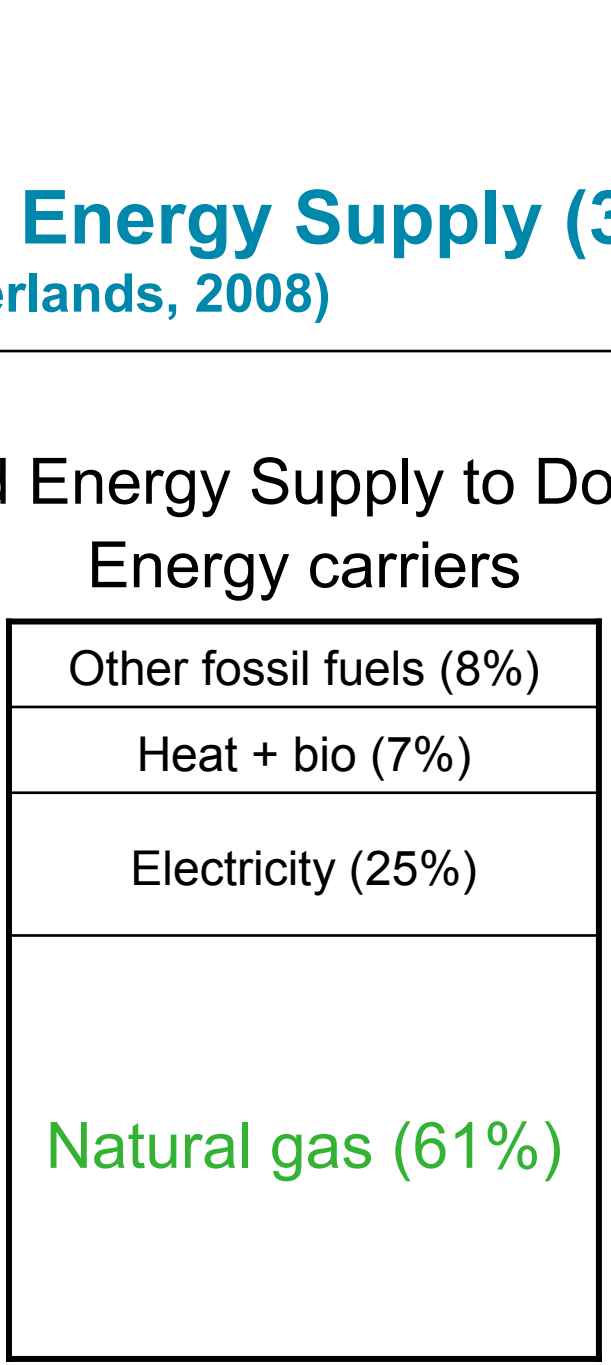
| Energy carriers | User groups: Products | Industry | Domestic/ commercial | Transport | Agriculture |
|---|---|---|---|---|---|
| Heat (4%) | | 60% | 36% | | 4% |
| Natural gas (28%) | 9% | 25% | 57% | | 9% |
| Oil (56%) | 25% | 5% | 3% | 66% | 1% |
| Coal (2%) | | | | | |
| Electricity (10%) | 9% | 31% | 50% | 1% | 10% |



Source: CBS (see also www.kiviniria.nl/energie )

# Current Energy Supply (3)
## (The Netherlands, 2008)

- Detailed Energy Supply to Domestic/Commercial sector




**More than 7.1 million domestic / commercial users.**



Source: CBS (see also www.kiviniria.nl/energie )

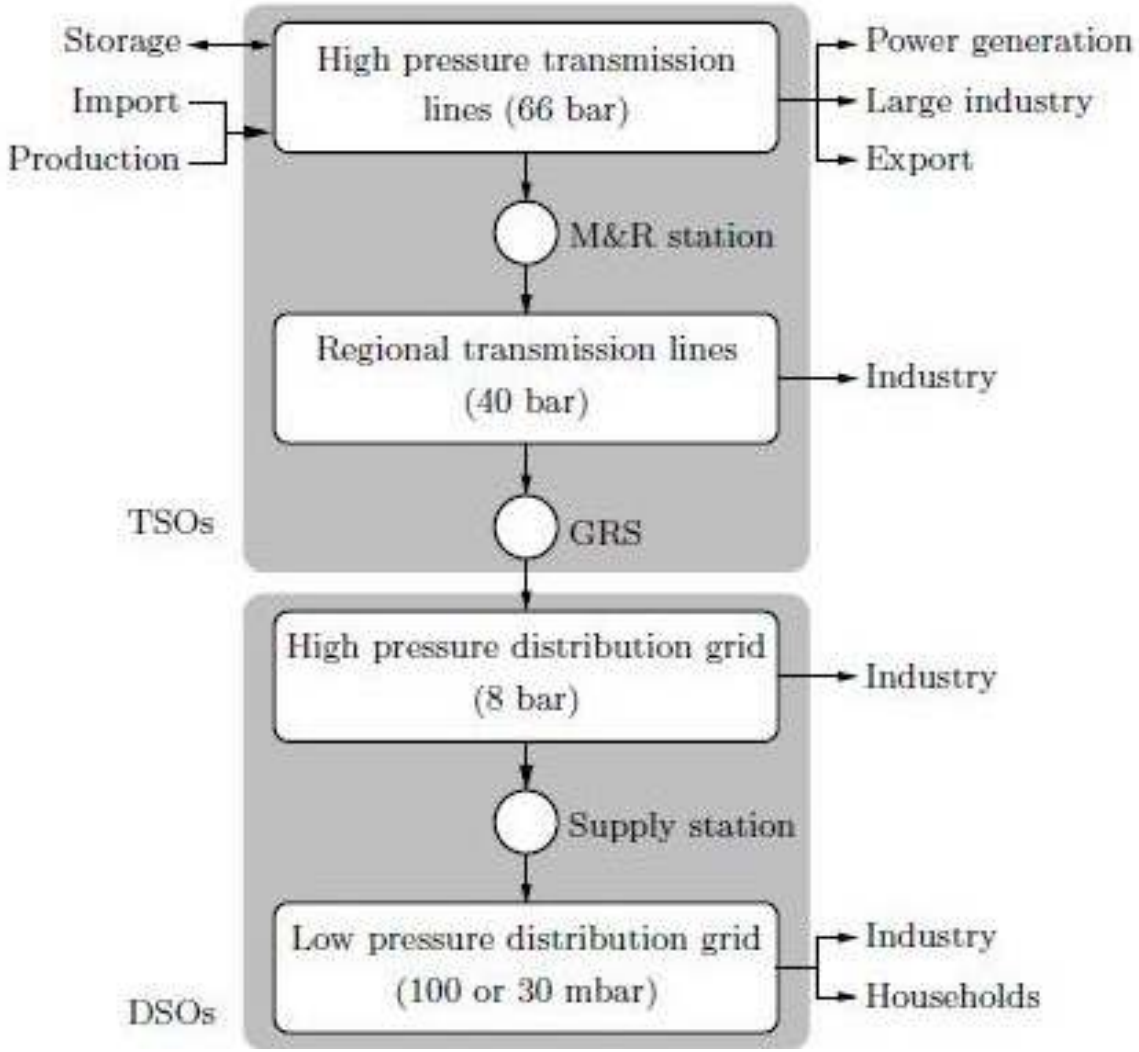
# Conclusions from Current Energy Supply

- Natural gas is main source of energy for most energy consumers (domestic & commercial users, industry, agriculture)
- Many decentralized consumers; therefore a large supply network is necessary

# Current Energy Supply Networks

- Natural gas
- Electricity
- Heat
- Transport fuels (oil, etc.)

# Dutch gas grid supply chain



# Conclusions on current gas infrastructure/supply

- Reliable and safe
- High security of supply
- Backbone of Dutch energy supply
- But, what about future?

# Foreseen changes in gas (energy) supply

- Dutch gas reserves diminishing; increase of natural gas imports
- Inbalance of gas (energy) supply and demand increases: need for gas (energy) storage
- Liberalisation and globalisation of the energy market
- Drive for a transition to a sustainable energy supply
- More decentral production of energy

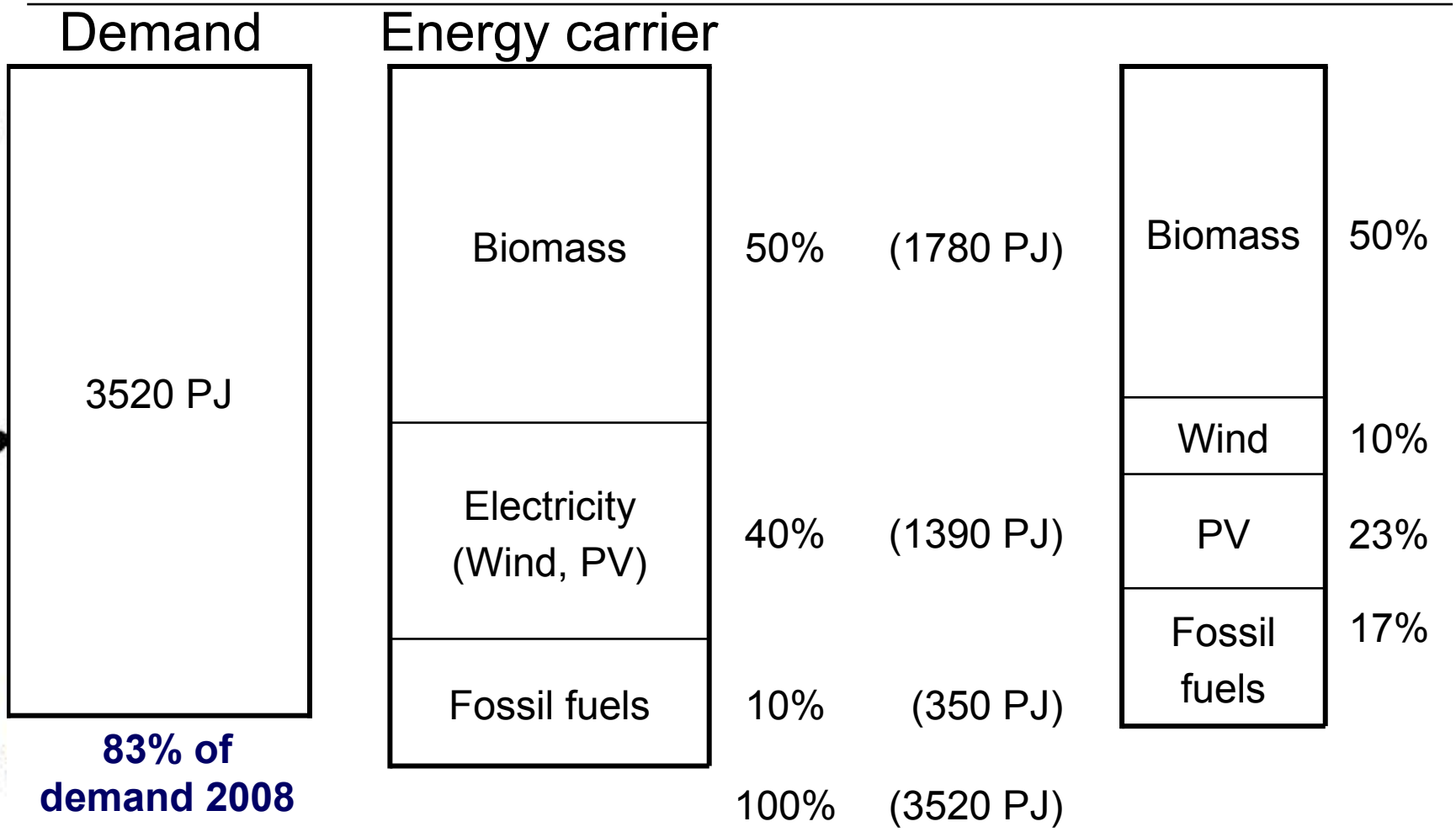
- But also many uncertainties

# Future Energy Demand
## (The Netherlands, 2050)

- Three developments:
  - Autonomous growth (e.g. new energy applications, more equipment)
  - Efficiency improvements (e.g. insulation of buildings)
  - System changes (e.g. road transport going “electric”)
- Quantitative estimate:
  - Energy demand 2050 = 83% of Energy demand 2008
  - Electricity demand 2050 = 3x Electricity demand 2008

Source: TU Delft, 2010 (www.kiviniria.nl/energie)

# Future Energy Supply (1)
# Possible role of Renewables (Netherlands, 2050)




**83% of demand 2008**

Source: TU Delft, 2010

# Future Energy Supply (2)
# Possible role of Renewables (Netherlands, 2050)

- Area needed to supply the required energy:

  (based on current technologies)

  - Biomass : 109,000 km2 (320% of Dutch area)
  - PV : 2,190 km2 ( 6.4% of Dutch area)
  - Wind onshore : 500 km2 ( 1.5% of Dutch area)
    offshore : 3,320 km2 ( 9.6% of Dutch area)

Conclusion:

"National" renewables cannot fulfill by far the future energy demand in The Netherlands

Source: TU Delft, 2010

# Future Energy Supply (3)
# Consequences of “All electric” (Netherlands, 2050)

- Renewables cannot supply the required energy (nuclear option?)
- High investments in the electricity infrastructure necessary
- Many challenges for a reliable and secure supply of electricity (energy)
- Rather high conversion losses

# Future Energy Networks
## (Netherlands, 2050)

- In operation:
  - electricity networks
  - gas networks
  - (district) heat networks
- Features of these networks:
  - probably these networks will be integrated
  - more active control is foreseen
  - flexibility seems to be a must
  - platform to facilitate the energy market
  - much more complexity

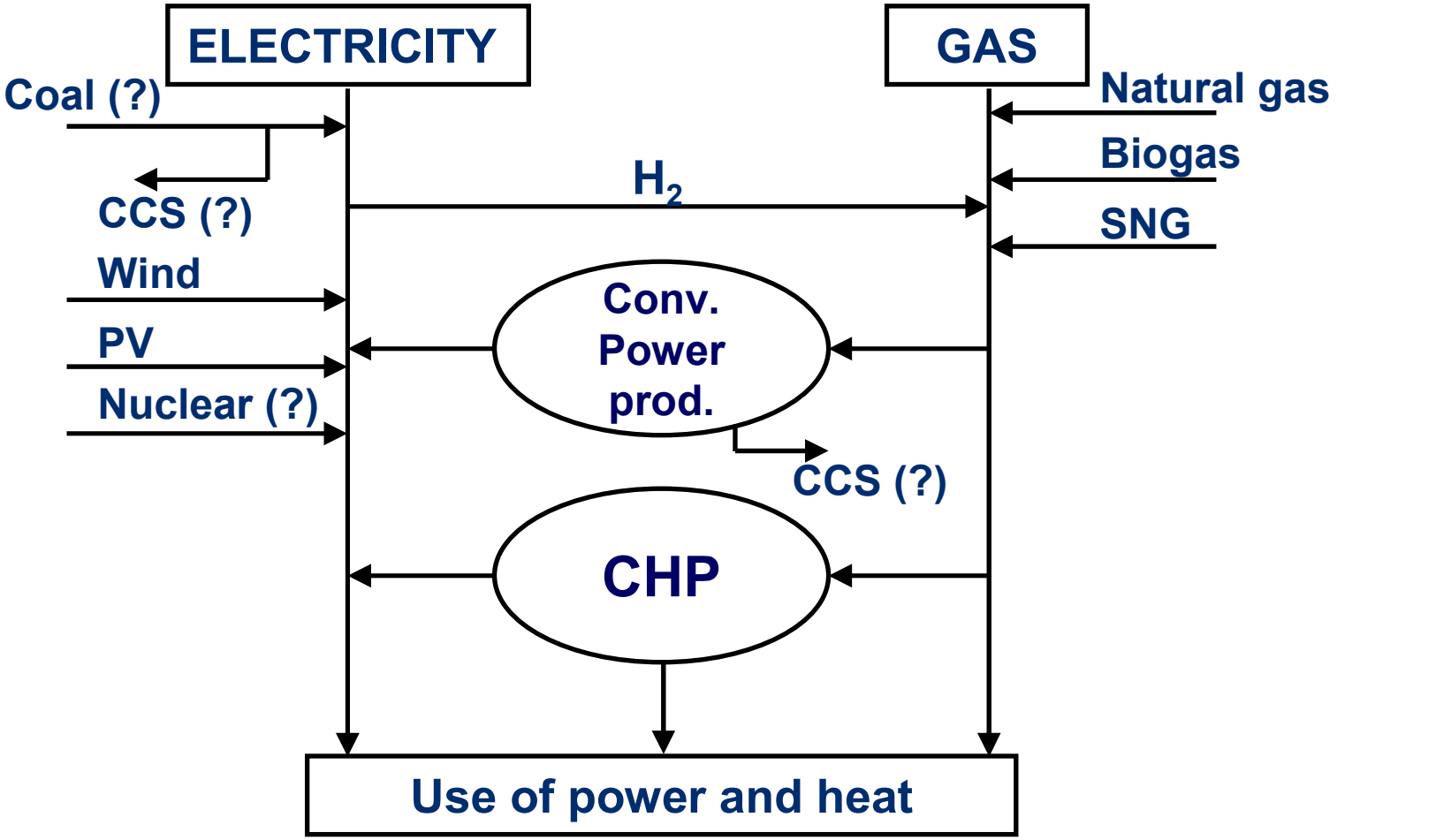
# Foreseen changes in the gas distribution grids

| Current situation | Future situation |
|---|---|
| Negligable green gas share: 0.1% in 2010 | Increased green gas share: 12% in 2020 |
| One type of gas in the gas distribution grid | Multiple types of gases in the gas distribution grid |
| Uni-directional gas supply chain | Bi-directional gas supply chain |
| No interaction with other energy distribution grids | Increased interaction with electricity distribution grid and local heat grids |
| Passive gas grid | Smart gas grid, monitoring and control of gas quality, pressure, and flow |



Source: TU Twente

# Possible role of GAS in future energy supply systems



# Strong position of gas supply/infrastructure (1)

- A full infrastructure is already in operation (production, storage, transport, gas appliances)
- Needed adaptions for future gas (energy) supply are limited and foreseeable: restricted investments
- Gas is the cleanest fossil fuel with the potential becoming “green” (biogas, SNG)
- (Natural) gas remains a low cost and secure source of energy
- Maintaining gas infrastructure is inexpensive compared to costs associated with other system evolutions
- Gas is a strong option for balancing energy demand and supply

# Strong position of gas supply/infrastructure (2)

- However, research should be encouraged to maximize the value of the full gas chain: EDGaR research program

EDGaR
Energy Delta Gas Research

# How can the value of the gas chain be maximized?

- Go for more sustainability (e.g. biogas, H2 made from renewables)
- Use innovative technologies to generate heat and power (e.g. gas heat pumps, micro-chp, fuel cells)
- Optimize the use of the current gas infrastructure (capacity, flexibility, availability)

# EDGaR Research Programme

- Public – private partnership
- Partners:

  - Energy companies (Gasunie, GasTerra, Enexis, Liander, Stedin)

  - Universities (RU Groningen, TU Delft, Hanzehogeschool)

  - Research institutes (ECN, Kiwa Gas Technology)
- Programme: 5 years; 44 M€
- Central theme: The role of gas in the transition to a sustainable energy supply
- Multi-disciplinary approach: technical, economic, social and legal issues

# Three main themes in EDGaR Programme

- Transition from “mono-gas” to “multi-gas”
- System changes/ integration of energy systems
- Strategic positioning in the international gas (energy) market

EDGaR
Energy Delta Gas Research

# EDGaR Theme 1
# From mono-gas to multi-gas (1)

- To which limits in gas composition are the current gas appliances suitable?
- Do we have to extend our current gas quality management methods?

# EDGaR Theme 1
# From mono-gas to multi-gas (2)

- To which limits in gas composition can the current gas infrastructure (pipelines, etc.) be used?
- Do we have to adapt the current management and maintenance methods of the gas infrastructure?

# EDGaR Theme 1
# From mono-gas to multi-gas (3)

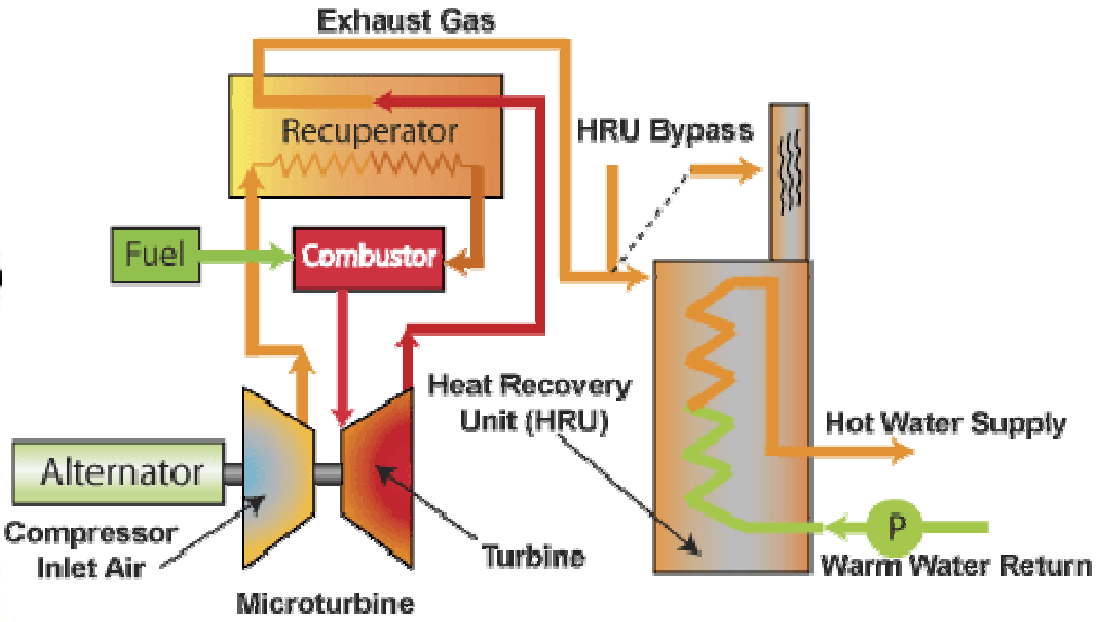
- Development and improvement of technologies to produce “green gas” (SNG)

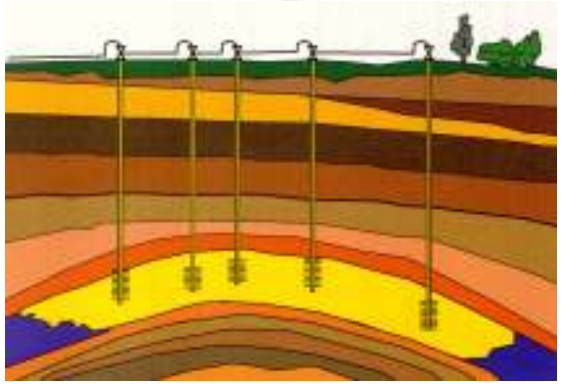
# EDGaR Theme 2
# System changes/integration of energy systems (1)

- Design of future gas networks (more decentral, more balancing, active control, integration with electricity grid, etc.)
- Adaption of institutional framework (regulatory issues, liability, etc.)
- Co-evolution and interaction of technology and regulation

# EDGaR Theme 2
# System changes/integration of energy systems (2)

- Development of future generation of gas appliances
- Local storage methods of energy (gas)



# EDGaR Theme 3
# Strategic positioning in the international gas (energy) market

- Structural changes in international gas (energy) markets
- Understanding the gas sector intra- and inter-market interactions
- Securing gas supply
- Developing strategies for the transition process
- Social acceptance

# Conclusions

- In the next decades gas supply/infrastructure will play an essential role in a reliable, affordable and more sustainable energy supply
- However, innovations over the complete gas chain are necessary to maintain this position
- To this aim the Dutch gas (energy) sector has started the EDGaR Research programme

# Final conclusion

- The GAS INFRASTRUCTURE, an essential part of a future sustainable energy supply!

- Thank you for your attention!