네덜란드의 지속가능한 에너지와 지구 온난화 가스 배출

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- Introduction
- 3-TU theme technologies for sustainable energy
- UT research in this field
- Strategy/Vision/Actions

Sustainable energy and our society

- Security of energy supply for 10 billion people (10×10^9 people * 4×10^3 W/p = 4×10^{13} W)
- Minimize mankind's ecological footprint
- Depletion of fossil fuels
- Very large time scales

We have to take the responsibility for the future now!

nrc May 30, 2006

Vooruitzichten KNMI tot 2050: Nederland wordt warmer en natter

Nederland wordt warmer

KNMI '06 klimaatscenario's, verandering in 2050 ten opzichte van 1990

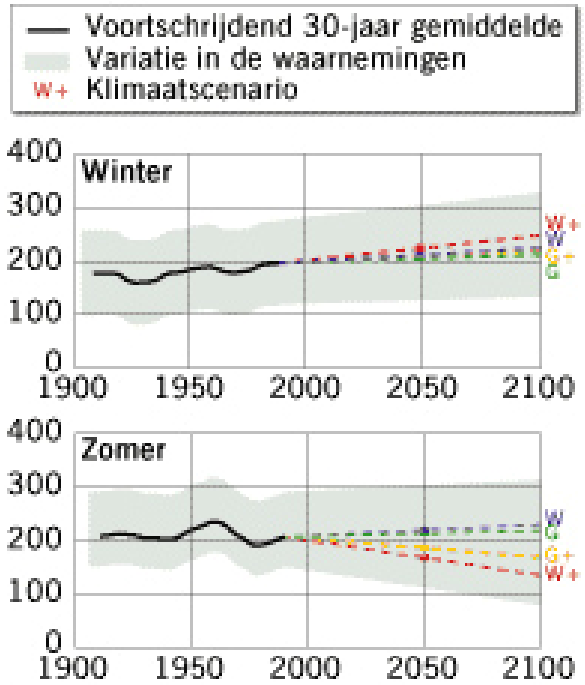
Gematigd (G)
Wereldwijde temperatuurstijging 1°C
geen verandering in luchtstromings-patronen in West-Europa

Gematigd + (G+)
Wereldwijde temperatuurstijging 1°C
winters zachter en natter door meer westenwind
zomers warmer en droger door meer oostenwind

Warm (W)
Wereldwijde temperatuurstijging 2°C
geen verandering in luchtstromings-patronen in West-Europa

Warm + (W+)
Wereldwijde temperatuurstijging 2°C
winters zachter en natter door meer westenwind
zomers warmer en droger door meer oostenwind

Neerslag in Nederland (in mm)



Gevolgen klimaatscenario's voor Nederland in 2050 veranderingen ten opzichte van basisjaar 1990

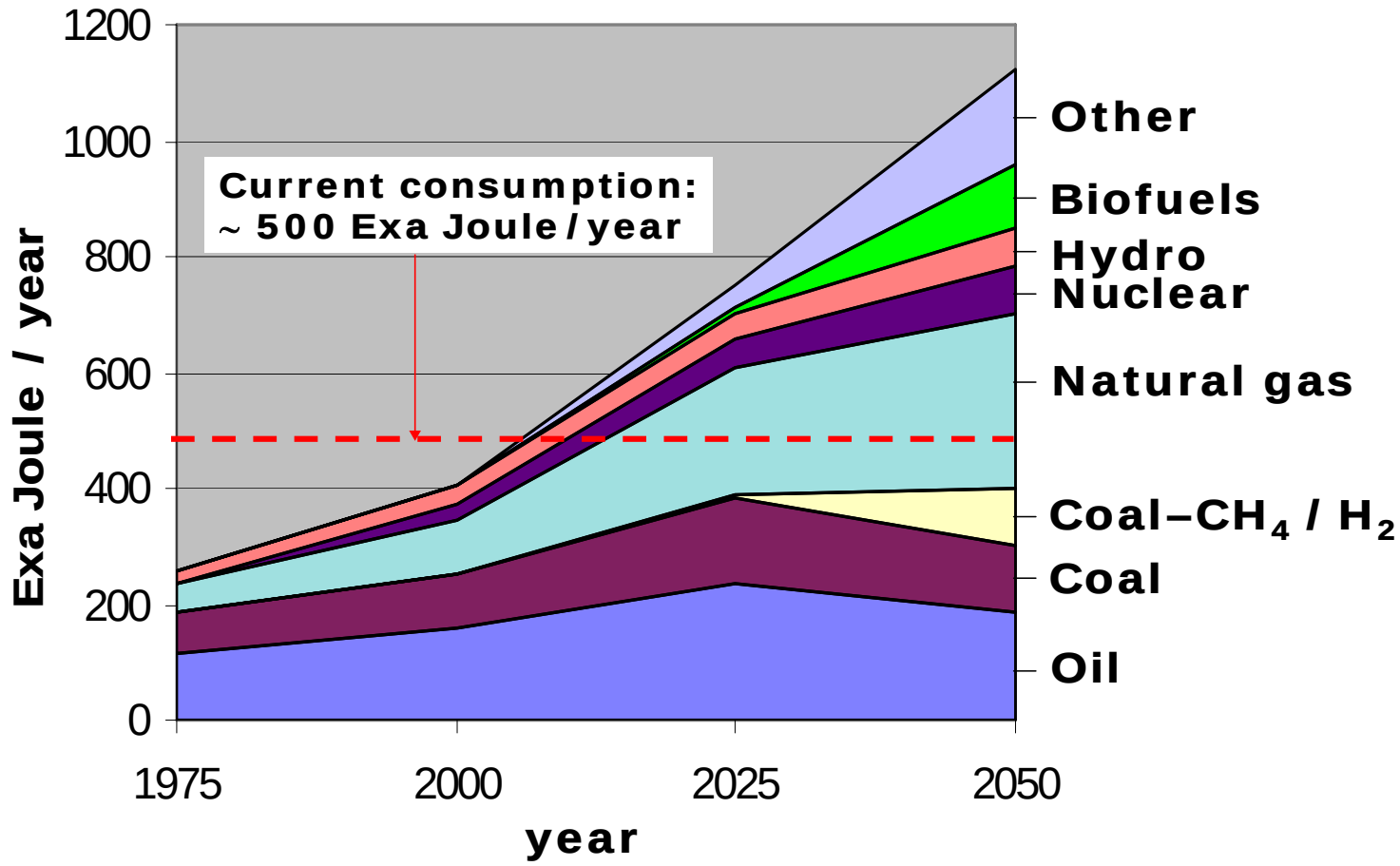
		G	G+	W	W+
Winter	Gem. temperatuur	+0,9°C	+1,1°C	+1,8°C	+2,3°C
(dec, jan, feb)	Gem. neerslaghoeveelheid	+4%	+7%	+7%	+14%
Zomer	Gem. temperatuur	+0,9°C	+1,4°C	+1,7°C	+2,8°C
(jun, jul, aug)	Gem. neerslaghoeveelheid	+3%	-10%	+6%	-19%
	Absolute zeespiegelstijging	15-25 cm	15-25 cm	20-35 cm	20-35 cm

Het klimaat in het basisjaar 1990 is gebaseerd op gegevens van 1976 tot en met 2005

NRC Handelsblad 300506 / JF, RL / Bron: KNMI

Energy scenarios

(Shell's "spirit of the coming age" scenario)



EU directives for Fuels

	2000	2005	2010	2020
Biofuels Natural gas Hydrogen		2%	6% 2%	8% 10% 5%
Total, alternative motor fuels	0%	2%	8%	23%

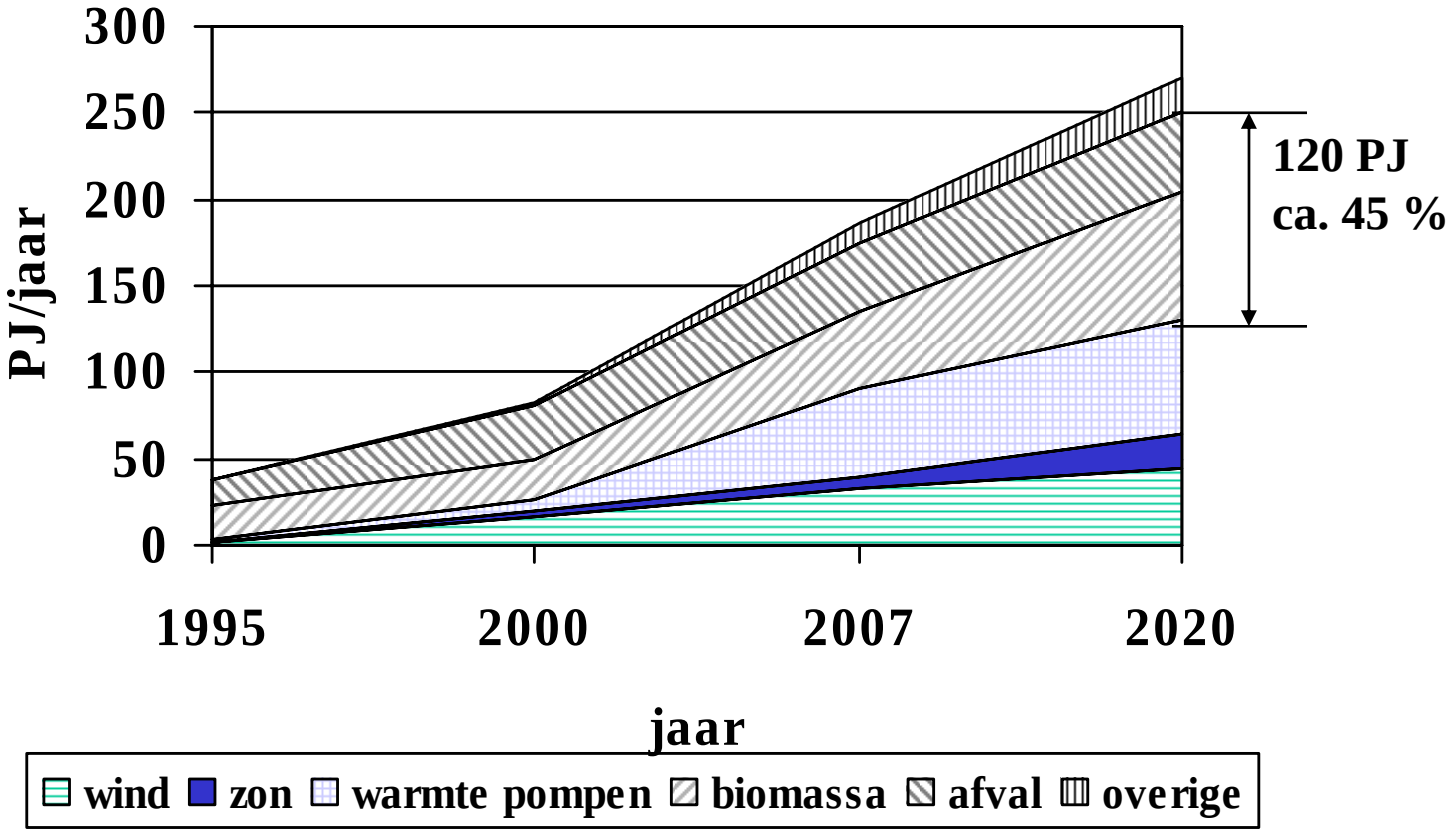
- Extra diesel / gasoline required in 2010 :
  83 million barrels ~ full scale refinery

Sustainable energy in the Netherlands

- The Dutch targets
  - 3 % in 2000
  - 10 % in 2020

- Policy
  - Stimulate technological developments
  - Give subsidies for:
    - Energy savings
    - Green investments
  - Forcing the electricity suppliers to deliver green electricity

Sustainable energy in the Netherlands



Sustainable Energy: Definition

- EZ : “Duurzame energie staat in het Nederlandse beleid voor elektriciteit, warmte of brandstof uit hernieuwbare (onuitputtelijke) bronnen”

  (Too restricted for IMPACT)

- Brundtland: “Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”

  (Much broader, better for IMPACT)

Themes in 3TU TSE (CoC / CoE)

- **Solar Cells**
- **Photo-catalysis**
- **Energy Storage**
- **Fuel Cells**
- **Biomass conversion**
- **Biofuel utilization**

} Center of Excellence

- Wind Energy
- Nuclear Energy
- Clean Fossil Energy
- Electricity Distribution
- Environmental and transition studies

Solar Cells

- **Integrated design of products and in the building environment** (Van Houten (Reinders), De Wulf (Brouwers))
- **Materials** (Elwenspoek)

Solar car

Electronic book

Photo-catalysis

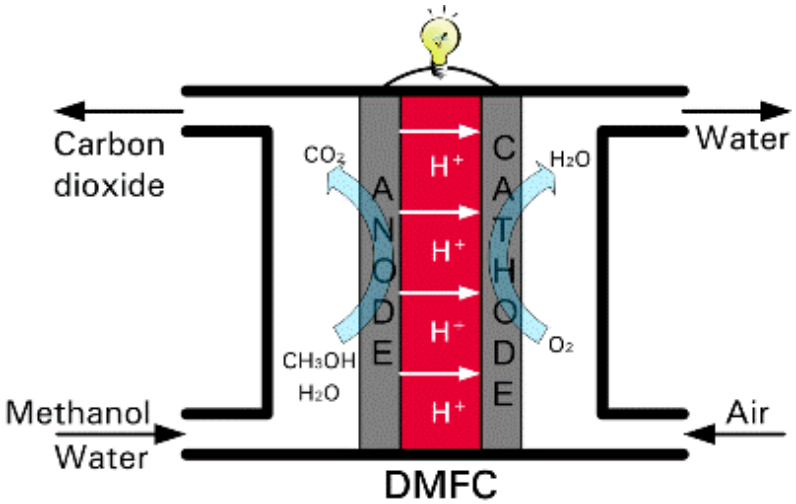
- **Not in IMPACT** (Delft & Eindhoven)

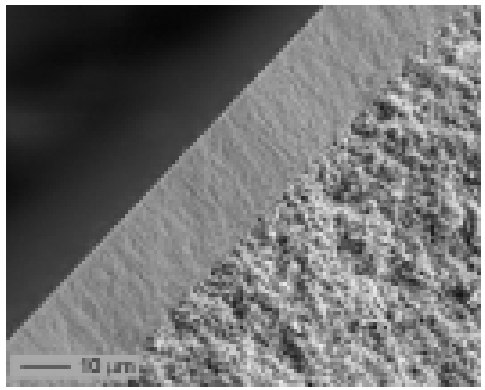
Energy Storage

- **Superconducting Magnetic Energy Storage** (Ten Kate)

Fuel Cells

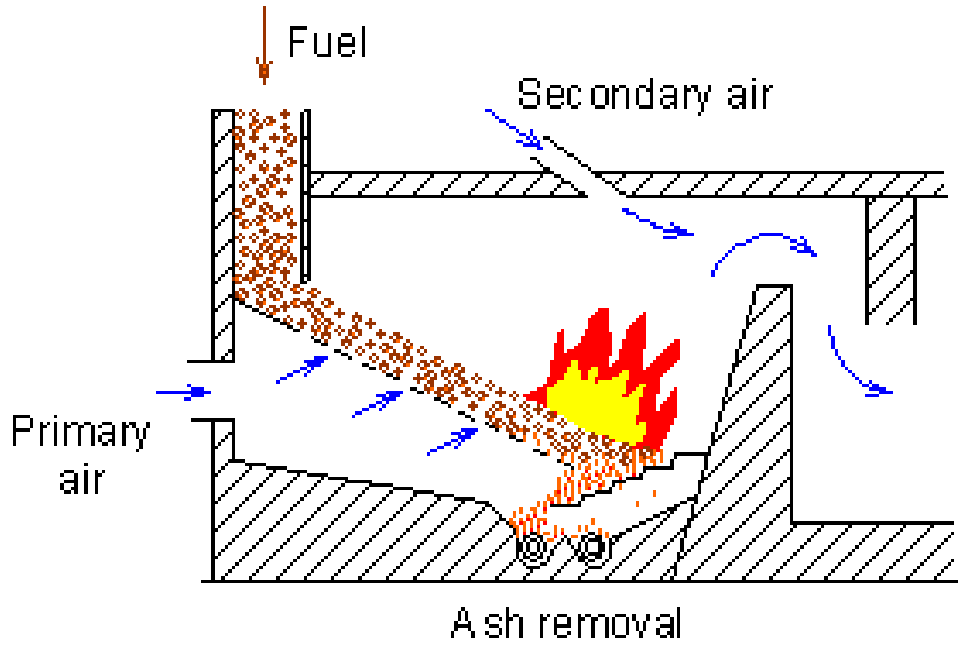
- **Direct Methanol Fuel Cells (**Wessling, Nijmeyer)
- **Solid Oxide Fuel cell** (Wessling, Bouwmeester)
- **A miniature solic-acid fuel cell** (Elwenspoek, Bouwmeester, Bouwkamp)
- **Integrated design of fuel cells in products** (van Houten, Reinders)





Biomass

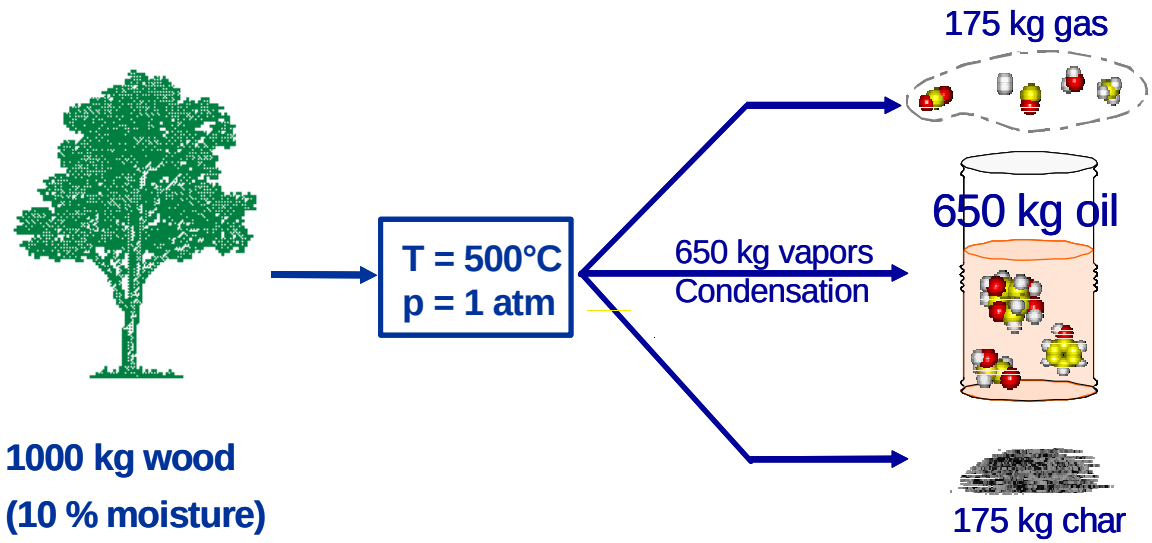
- **Combustion of waste and biomass** (Brem)



Sloping grate combustion system

Biomass pyrolysis

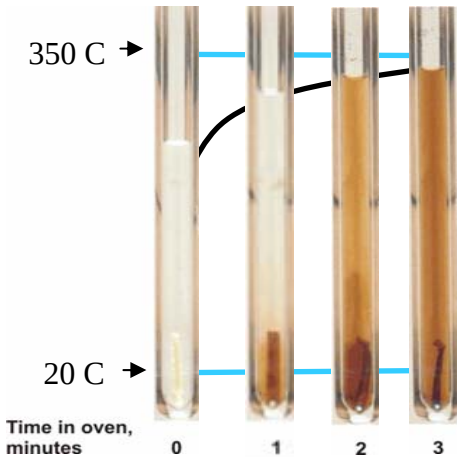
- Van Swaaij (rotating cone reactor)
- Brem (pyros reactor)
- Lefferts (use of catalysts)



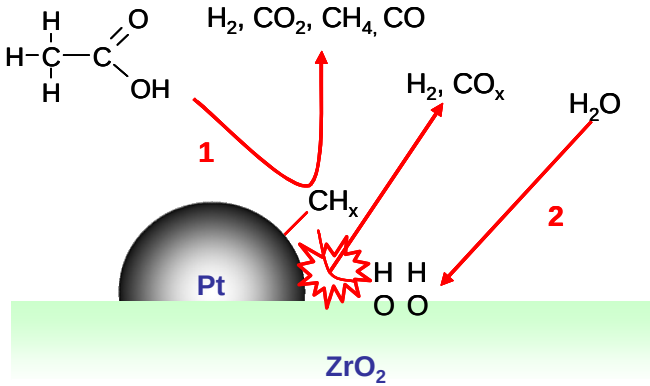
Both 1 MJ

Biomass gasification

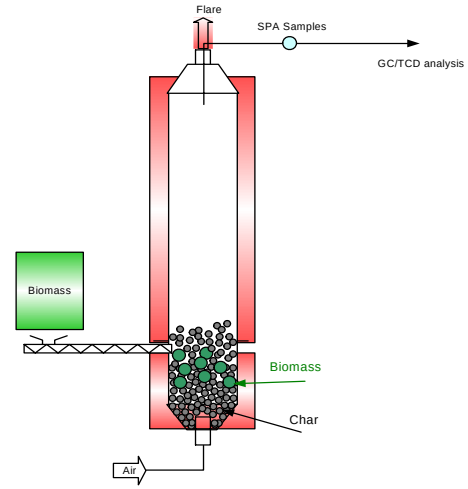
Van Swaaij, Lefferts, Brem



Supercritical gasification



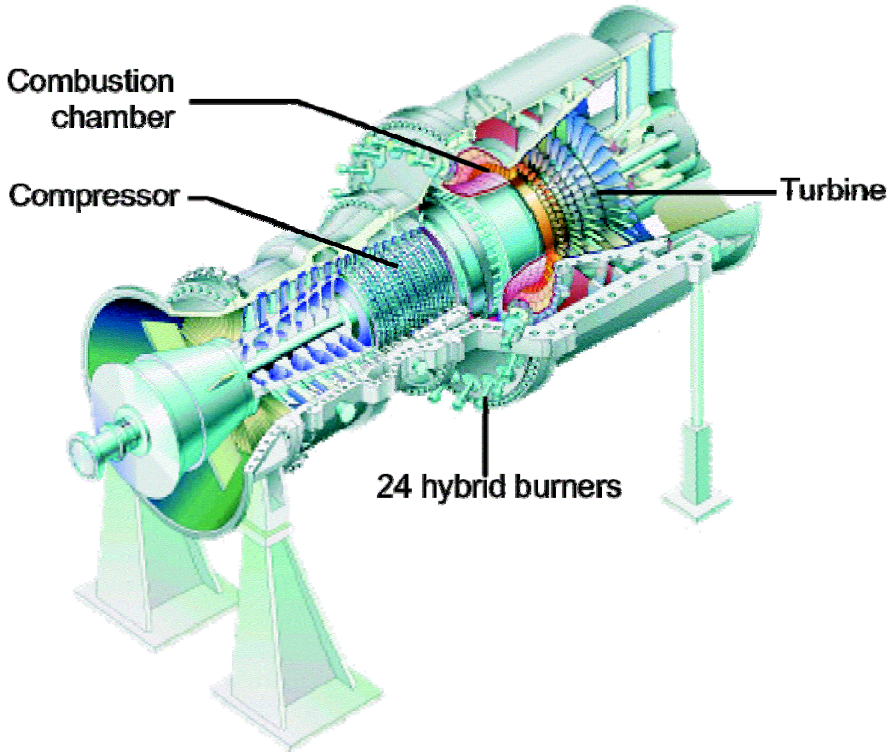
Catalytic gasification of pyrolysis oil



Tar free gasification

Biofuel utilization

- **Gaseous and liquid combustion in gas turbines** (Van der Meer)
- **Piston lubrication and biofuels** (Schipper)
- **Turbulence, RANS, DNS and LES in combustion (**Van der Vegt, Geurts, Lohse, en Van der Meer**)**



Wind Energy

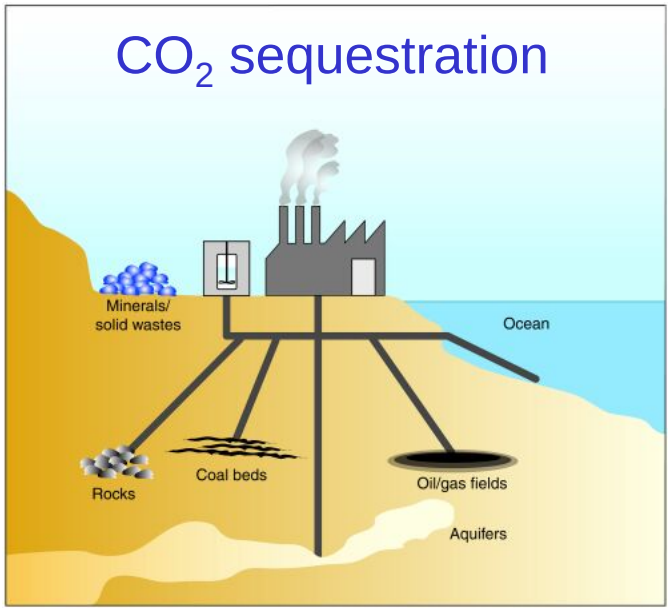
- **CFD of flow around wind turbines** (Hoeijmakers)
- **Environmental aspects of wind parks at sea** (Hulscher)
- **Materials for turbine blades** (Akkerman)

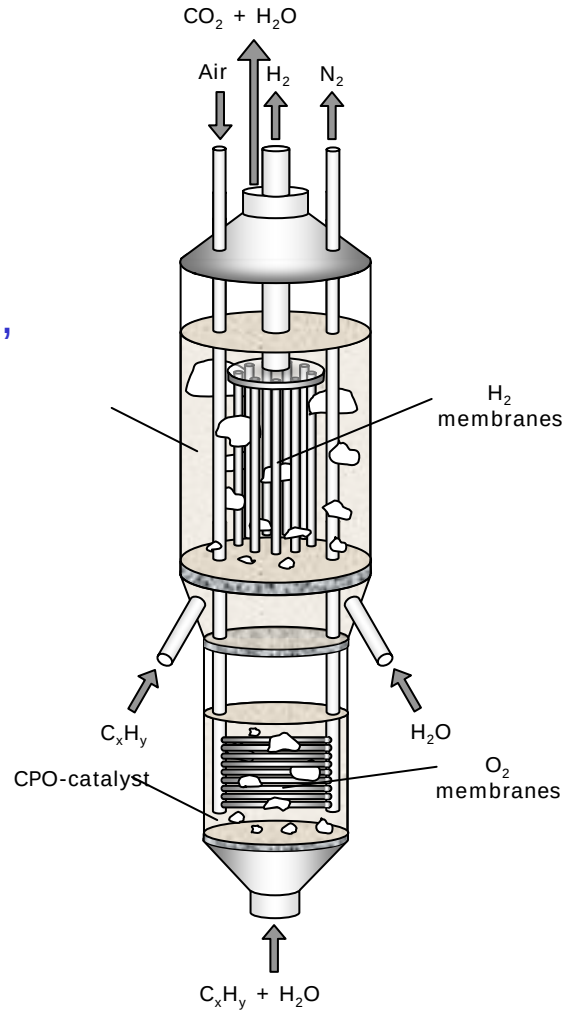
Nuclear Energy

- **Superconductors for superconducting magnets for ITER** (Dhalle, Den Ouden, Nijhuis, Ten Kate)

Clean fossil

- **CO_2 separation and capture** (Versteeg, Van Swaaij)
- **Synthesis gas production** (Kuipers, Van der Meer, Lefferts, Brem)





Integrated CPO reactor

Electricity Distribution

- **High temperature superconducting materials** (Ten Kate)

Environmental and transition studies

- **Environmental aspects of wind parks at sea** (Hulscher)
- **Public policy and the transition towards a less carbon-intensive energy system** (Bressers, BBT)

Master of Science
Sustainable Energy Technology

3TU master starting at September 2006

Participation from CTW, TNW and BBT

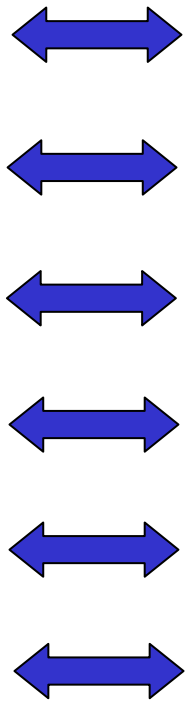
Combination of technical and social courses

First Year: broad field of sustainable energy.

Second year: Master thesis with one of the chairs (in depth)

Research Groups

- Discipline orientated
  - **Heat and flow**
  - **Numerics**
  - **Two phase flows**
  - **Process Technology**
  - **Mechanical Engineering**



- Application oriented
  - **Solar Cells**
  - **Energy Storage**
  - **Fuel Cells**
  - **Biomass conversion**
  - **Biofuel utilization**
  - **Wind Energy**
  - **Clean Fossil Energy**
  - **Electricity Distribution**
  - **Environmental and transition studies**

Research types in Impact SE

Some personal observations:

- **IMPACT focuses now on: Research in large thematic programs**
- Fundamental curiosity driven research is under pressure
- Pure engineering studies for SME’s are under pressure

Leading positions

- Biomass conversion
- Clean fossil
- Fuel utilization
- Fuel Cells

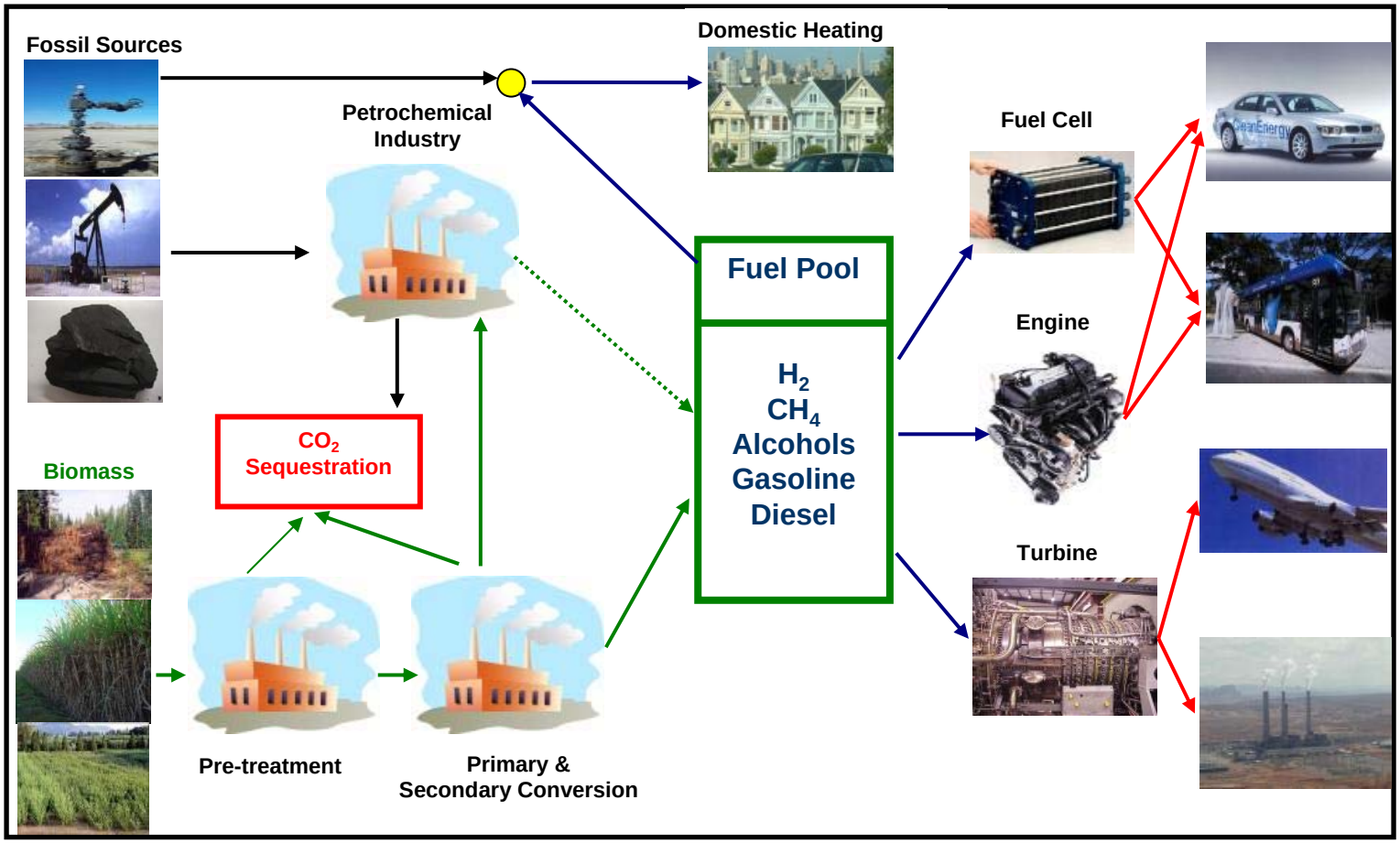
} Initiating & coordination programs & projects

- Other SE work → partnering with other initiatives (of TUD, TU/e, ECN, etc.)

Current activities

- Internal organization of the field
- SmartMix proposal “Sustainable production & utilization of next generation fuels”
  - 6 impact groups, TUD, TU/e, ECN, Shell, Gasunie, …..
- STW program

Smartmix: Sustainable production and utilization of next generation fuels



IMPACT SE Budget (200 k€/annum)

- Visiting researchers (20 k€)
  - Strengthening our international position
- Symposium (15 k€)
  - Visibility, Networks, IMPACT day
- Post-docs (3x = 165 k€)
  - Stimulate corporation between groups
  - More than 2 groups involved
  - Scanning / front end work
  - ….

} New research lines