SYDDANSK UNIVERSITET
UNIVERSITY OF SOUTHERN DENMARK

Prioritising carbon in the fossil-free society

– global perspective and national implications

Henrik Wenzel, University of Southern Denmark,

Contact: henrik.wenzel@kbm.sdu.dk

CEESA annual meeting
June 2nd 2009
Hotel Haraldskær, Vejle, denmark

Presentation overview

- Proportions in demand and supply
  - of biomass
  - of priority customers
- Environmental assessment concept
- Environmental assessment
- Interpretation
- Boosting techno-sphere’s carbon cycle
- Conclusion
- Recommendations

SYDDANSK UNIVERSITET
UNIVERSITY OF SOUTHERN DENMARK

Proportions in demand and supply

- of biomass

Earth land area: 15 Gha; global agricultural area: 5 Gha
– of which 1.5 Gha arable land and 3.5 Gha grassland

How big are the new customers for biomass?

World average food intake: 2700 kcal/pers/day	≈	25 EJ/year
Agricultural biomass today	≈	100-150 EJ/year
Fossil energy consumption today	≈	400 EJ/year
Biomass for full fossil substitution today	≈	500-600 EJ/year

Can agricultural yield increases reduce the gap?

Yield increase in agriculture	≈	1% per year
		→ 0.8 %
Consumption growth (GDP/capita)	≈	5% per year
		→ ?? %

Proportions in demand and supply

- of biomass

How much new land can be cultivated?

New cultivable land: Biophysical maximum ≈ 2 Gha more
– most of which is in South America and Africa (Ramancutty et al., 2002).

BUT: cultivating new land can imply a 2-9 times higher release of CO_2 bound in soil and vegetation than energy crops can save over 30 years by substitution of fossil fuels (Righelato and Spracklen, Science 2007) – meaning pay back of 60 – 300 years.

Sustainable new land cultivation

30-40% more (Danish Ministry for Food and Agriculture, 2008)
- and we need 500% more if biomass should fully substitute fossil fuels

Proportions in demand and supply

- of biomass

Study	Scope	Time	Supply	Demand	Scenario	Biomass potential (EJ/y)				
						Residue	Crops	Total	EJ/y	%
(*26*)	EU25	2030	X			6.7	5.2	11.9	79-90	16-18%
(*27*)	EU27	2015-2025	X			2.8	1.8	4.6	89-102	4-5%
	EU27	2025-2045	X		Low	2.9	5.6	8.5	89-102	8-9%
	EU27	2025-2045	X		High	3.5	7.2	10.7	89-102	10-12%
	EU27	>2040	X		Low	2.5	15.4	17.9	89-102	17-19%
	EU27	>2040	X		High	3.1	19.9	23	89-102	21-25%
(*22*)	Global	2030	X		Low	96	219	315	631-716	42-48%
	Global		X		High	96	315	411	631-716	55-62%
(*28*)	Global	2030	X			87	151	238	631-716	32-36%
(*29*)	Global	2025-2050	X			31	267	298	631-716	40-45%
(*30*)	Global	2020	X			15	112	127	631-716	17-19%
(*31*)	Global	2025		X				74	631-716	10-11%
(*35*)	Global	2025	n.d	n.d				85	631-716	11-13%
(*32*)	Global	2025	X[b]	X[b]	BI	56	17	74	631-716	10-11%
(*33*)	Global	2030		X	FFES			91	631-716	12-14%
(*34*)	Global	2025	X[b]	X[b]	RIGES	65	80	145	631-716	19-22%

Proportions in demand and supply

- of priority customers

Jet-fuels in 2006:	10 EJ/y
Jet-fuels in 2030:	25 EJ/y
Biomass for jet-fuels in 2030:	50 EJ/y
Biomass for chemical feedstock in 2030 (23 EJ/y non-fuel oil in 2006 projected to 32 EJ/y in 2030):	60 EJ/y
Biomass for road transport in 2030 (80 EJ/y in 2006 projected to 100 EJ/y in 2030)	200 EJ/y
Biomass for 20% of road transport in 2030:	40 EJ/y

Biomass for electricity and heat in 2030: only residuals from fuel production

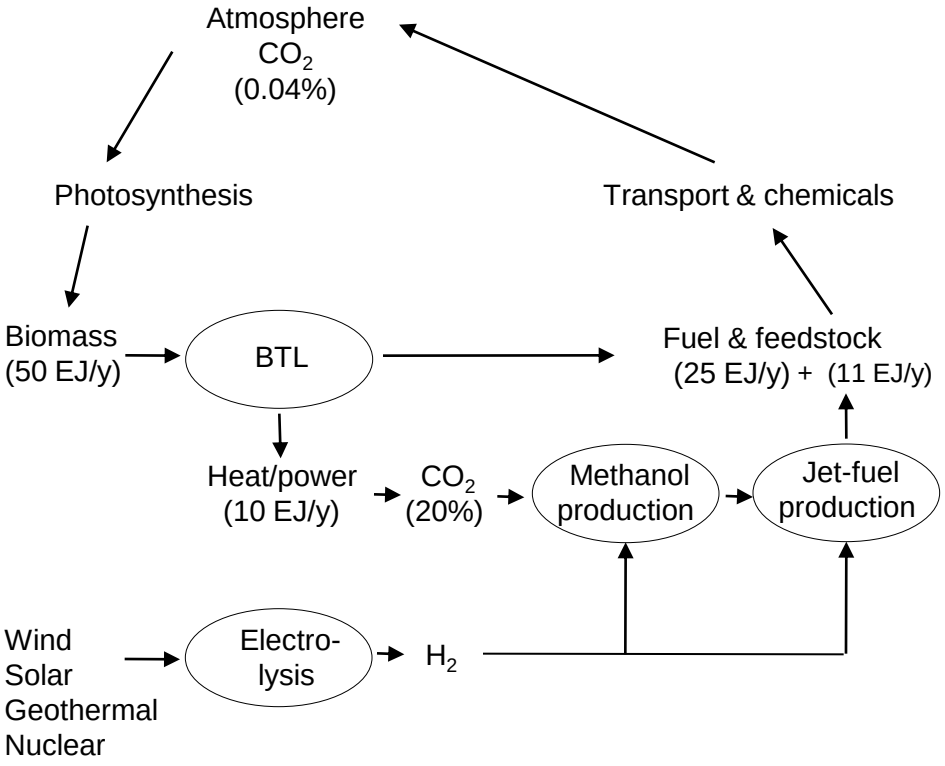
Total aviation, chemicals and long distance road:	**150 EJ/y**
Available non-food biomass in 2030:	**15-96 EJ/y**
Micro-algae 2030:	???? EJ/y

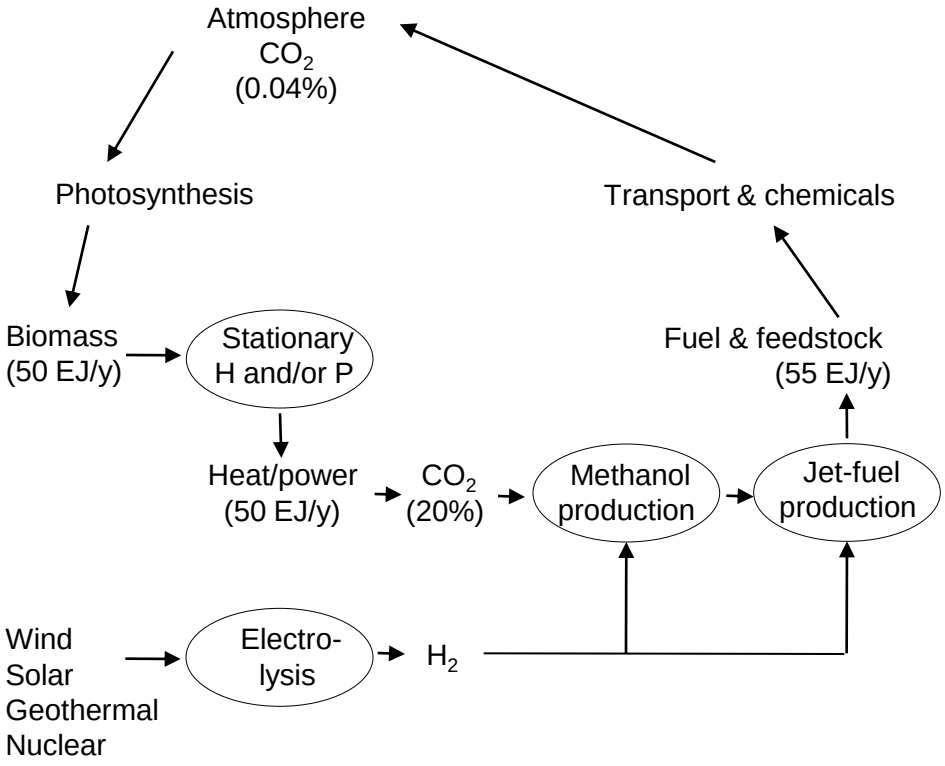
Transport scenario concepts

- All fossil: excessive fossil GHG emissions
- All bio: not enough bio-carbon & excessive biogenic GHG emissions
- Electric: 80% road transport, Bio 20% road, air & sea bio: not enough bio & too high GHG emissions
- Air, sea & long distance road carbon based: we will never reach the IPCC 2 degree C target
- NH3 for long distance road transport?
- Boosting the bio-carbon cycle:
  - Methanol from CO2 & electricity (H2)
  - Biogas from CO2 & electricity (H2)
  - Micro algae oil from CO2 and sunlight

A vision

- a long term point of reference – the point of carbon availability



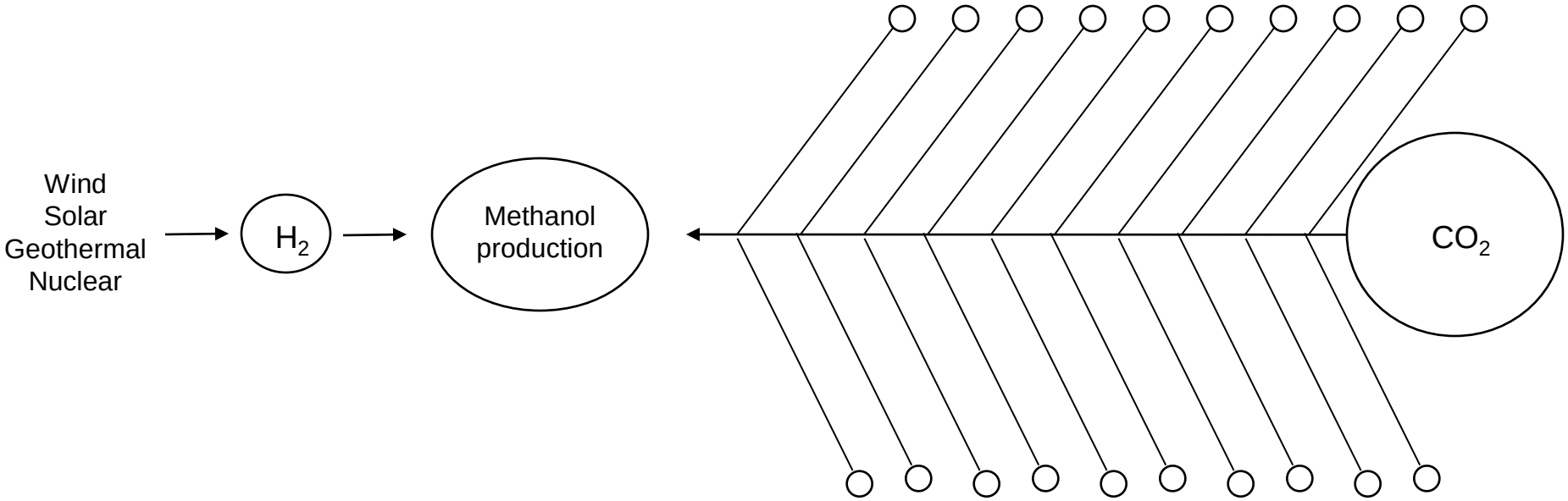


Fuel & feedstock:	36 EJ/y
Heat & power:	10 EJ/y
Total:	46 EJ/y

Fuel & feedstock:	55 EJ/y
Heat & power:	50 EJ/y
Total:	105 EJ/y

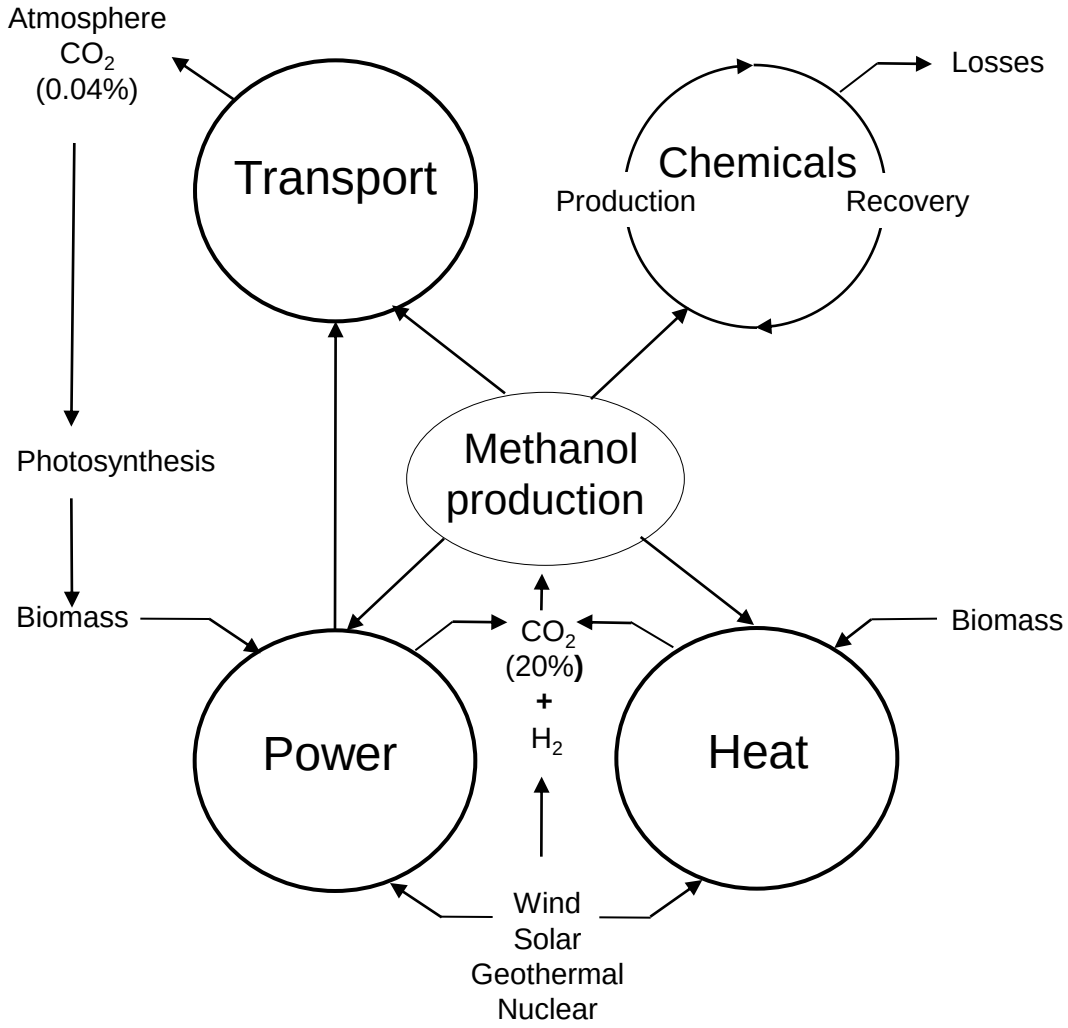
A vision

- a long term point of reference – CO_2 piping and storage



A vision

- a long term point of reference – the methanol society



National implications of global framework conditions

- High on CO2 – fly on CO2
  - If aviation wants bio, it may be able to pay more than other sectors. Due to markets forces, this is where biomass will go then – also in DK
- Same holds true for chemicals
- So global development may override national policies, unless we strongly control the market