

SUSTAINABLE ENERGY SYSTEMS: BARRIERS AND SOLUTIONS

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BACKGROUND

- Global warming developing faster, CO₂ absorption in nature is smaller and global societal costs are higher than anticipated by IPCC in 2007: *all news seem to go in the wrong direction.*
- Preparation for COP15 in Copenhagen is developing very slowly: few and insufficient commitments for GHG reduction and lack of economic commitments from industrial nations.
- Controversies between industrial and developing countries concerning responsibility for global warming and the necessary commitments for GHG reduction.
- COP15 risks to end up as a flop.
- Need for professional analysis of barriers and solutions.

MAIN INTERNATIONAL ACTIVITIES IN 2009 (1)

- Bonn (1-12 June): *Proposed GHG reductions from 50-95 % by 2050. Global warming less than 2 degrees centigrade with at least 50 % certainty. Proposed Funds for for developing countries: 70 to 140 billion US dollars/year – but no commitment from EU and the US. No agreement on principles for providing the funds, nor on reduction targets for 2020.*
- G8 in Italy (8-10 July): *80 % GHG reduction for G8 by 2050 to support 50 % global reduction. Major Economies Forum (MEF): Global warming less than 2 degrees, but no ambitious targets for 2020.*
- Bonn (10-14 August): *No progress worth mentioning.*

MAIN INTERNATIONAL ACTIVITIES IN 2009 (2)

- Bangkok (28 September – 9 October): *Maybe end of poker game and start of concrete commitments?*
- Barcelona (2-6 November): *Last chance for a manageable text for COP15.*

MAIN INTERNATIONAL ACTIVITIES IN 2009 (3)

- Copenhagen, COP 15 (7-18 December): *Official message from most nations is that they support preventive actions and goals – especially for year 2050 when most of the present decision makers will be dead. Reality is that if president Obama does not get his mandate from the US Congress, and if the US and China (and India) do not establish joint agreement concerning efficient goals and commitments – then COP15 will be an empty showcase, or more honestly a serious "flop".*
- Copenhagen, ClimateForum09 (7-18 December): *NGO forum with expected 20.000 participants. Open for program proposals (nim@byg.dtu.dk).*

CONTROVERSIAL ISSUES BEFORE COP15 (1)

- Balance between mitigation of global warming and adaptation to global warming. *Fear that too much attention to adaptation shall delay or prevent the necessary attention to mitigation.*
- Balance between interests of present generations and future generations. *Present generations tend to think that their privileges and their welfare should have first priority as future generations will be smart enough to find new solutions.*
- Balance between market systems and state regulation. *Markets usually have short time horizons + profit first.*
- Wildly different cost estimates for mitigation. *The Stern Report (2007) has been drowned in narrow discussions of discount rates in spite of clear and serious conclusions.*

CONTROVERSIAL ISSUES BEFORE COP 15 (2)

- Balance between free choice of lifestyle and state regulation of life style, *e.g. through personal carbon allowances.*
- Balance between biomass for food and biomass for energy (*e.g. fuel for cars and airplanes*).
- Should nuclear power be one of the main transition technologies? *Strong ngo-opposition (Finnish problems).*
- Should Carbon Capture and Storage (CCS) be accepted as one of the new technologies for sustainable energy development? *Strong ngo opposition (e.g.in Denmark): many uncertainties.*
- Geo-engineering? *Warnings from Royal Society and ngo side.*
- First priority to Cap and Trade systems or other schemes?

SUSTAINABLE SCENARIOS: DANISH EXAMPLE

- Technology is not the problem. *Most are already available.*
- Sustainable energy scenarios by the Danish Engineering Society (IDA, June 2009) and Coherent Energy and Environmental System Analysis (CEESA, 2009), partly financed by The Danish Council for Strategic Research.
- *IDA: reduction of Danish CO₂-emission of 60 % by 2030 and of 90 % by 2050 compared to 1990.*
- *CEESA: reduction of 60 % by 2030 and of 100 % by 2050.*
- Both scenarios rely on renewable energy sources and energy conservation with continued growth in welfare and production.
- Also "Future Climate", Sept. 3, 2009, www.futureclimate.info

MAIN TECHNOLOGIES IN IDA SCENARIO

- Wind turbines: *70 % of Danish electricity by wind in 2050 (20 % in 2008). 4,500 MW on-shore and 4,600 MW off-shore.*
- Biomass for energy sector and transportation: *Total around 225 PJ/y used in co-generation and biogas plants.*
- Solar voltaics: *Covering 10 % of Danish electricity by 2050.*
- Wave energy: *Covering 5 % of Danish electricity by 2050.*
- Electrolysis and fuel cells: *Used for new types of cogeneration plants (30 % in 2030), especially when surplus of wind power.*
- Heat pumps and heat storage: *Both for individual houses and in connection with co-generation plants.*
- Low temperature district heating: *low heat losses.*

DEMAND FOR NEW SYSTEMS THINKING

- Energy supply systems dominated by fluctuating renewables demand new systems thinking especially for electricity: *flexible systems on national and local scale including heat pumps, heat storage, electrolysis, fuel cells, demand side management, integration of electric cars, battery storage etc.*
- Demonstration projects on local flexible electricity systems are carried out by Danish utilities (www.energinet.dk).
- Supplementary solutions: Expansion of long range transmission lines to take advantage of time differences in fluctuation of wind and sun – and co-operation with hydropower systems. *Discussions about economy.*

POLICY MEANS

- Efficient and realistic policies are required in order to promote sustainable scenarios – including changes of lifestyle in the rich countries. *This will not be realised by voluntary means.*
- Industrial cap and trade systems in EU have not been a success, *but could be improved by closing loopholes etc.*
- A sufficiently high CO₂-tax require regional harmonisation, at least at EU-level. Or introduction of national import taxes to compensate for differences. *High CO₂-taxes are socially unbalanced to the disadvantage of low income households. Could be compensated by national income tax schemes.*
- New proposal: *Personal Carbon Allowances (PCA).*

OFFICIAL FORECAST VERSUS IDA SCENARIO

IDA data in italics

- **Primary energy** (PJ/y): 2030 (860/560), 2050 (955/445).
Reduction in energy demand obtained by systematic energy conservation (and improved energy efficiency).
- **GHG emission** (million tons/y): 2030 (62/33), 2050 (71/7).
- **Energy costs** (bill.euro/y): 2030 (15.6/11.9), 2050 (16.6/13.2).
Large investments in RES and energy conservation is more than compensated by avoided fuel costs.
- **Health costs** (bill.euro/y) from emission of SO₂, NO_x, CO, particles, mercury and lead: 2030 (1.9/1.1), 2050 (2.0/0.8).

OTHER ADVANTAGES OF RENEWABLE ENERGY SOURCES (RES)

- Cost security: Once investments are made in wind and solar, the fuel is free. *In contrast, development of fossil fuel costs are very uncertain and could rocket after peak oil.*
- Supply security: Systems based on local resources like wind, solar, hydro, waves and biomass are independent of international conflicts. *In contrast, oil from the Middle East, gas from Russia etc. are sensible to conflicts and politics.*
- Peak oil: Production of oil is expected to peak within 10 to 20 years increasing the competition for the last oil. *Nations with dominating RES systems are independent of this competition.*
- Health externalities: *Much less for RES than for fossil fuels.*
- Conclusion: *RES systems are win-win solutions.*

DESIRED COMMITMENTS BEFORE COP15

- Climate fund for developing countries paid by OECD countries according to their GDP with a total sum of at least 100 billion US dollars per year. *This would correspond to roughly 100 US dollars per OECD person per year – a cheap price to “save the world” and avoid much larger climate costs in the long run.*
- Clear commitments from OECD countries before December 2009 of CO₂ reductions of at least 30 % by 2020, 50 % by 2030 and 90 % by 2050 compared to 1990: *max CO₂ concentration equal to 350 ppm (James Hansen, Rajendra Pachauri).*
- Global agreement on an equity principle where all human beings have the same emission quota in 2050 *(between 1 and 2 tons per person per year. Developing nations may increase their emission up to 2020 but shall end at the equity quota).*

CONCLUSIONS

- The desired commitments are realistic from a technological and economic point of view. Necessary to avoid "tipping points" and keep global warming below 2 degrees centigrade: *max concentration of CO2 equal to 350 ppm.*
- Many (*perhaps most*) politicians in OECD will claim the visionary commitments to be unrealistic and will try to convince their voters about this. *Intense lobbyism in the US against modest, insufficient targets for reduced CO2 emission.*
- As a consequence, COP15 will most likely not be able to reach global agreement on the necessary commitments. Plan B is required (e.g. forerunners) – *but miracles sometimes happen!*

Thank you for your attention

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REFERENCES (2)

- Per Lund: "Cell Controller Pilot Project – Intelligent Mobilization of Distributed Power Generation", International Conf. on Integration of Renewable and Distributed Energy Resources, Nice, France, Dec. 10-12, 2008. www.energinet.dk
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DANISH PRIMARY ENERGY SUPPLY: OFFICIAL FORECAST

with data from IDA scenario in parentheses

Type of energy	2008	2015	2030	2050
Coal	175 PJ/y	125 PJ/y (65)	95 PJ/y (15)	150 PJ/y (zero)
Oil	325 PJ/y	330 PJ/y (315)	370 PJ/y (200)	420 PJ/y (zero)
Natural Gas	190 PJ/y	160 PJ/y (110)	150 PJ/y (85)	130 PJ/y (zero)
Biomass	120 PJ/y	165 PJ/y (145)	200 PJ/y (145)	200 PJ/y (285)
Solar heat	5 PJ/y	5 PJ/Y (5)	5 PJ/Y (15)	5 PJ/Y (15)
Electricity from renewables	15 PJ/y	25 PJ/y (60)	40 PJ/y (100)	50 PJ/y (145)
Total	835 PJ/y	815 PJ/y (700)	860 PJ/y (560)	955 PJ/y (445)

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GHG EMISSION

million tons CO2 equivalent (including aviation)

Reference	2008	2015	2030	2050
Official forecast	71	66	62	71
IDA Scenario	71	53	33	7

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DANISH ENERGY COSTS: OFFICIAL FORECAST

with data from IDA scenario in parentheses

All costs in million euros per year (rounded numbers)

Type of cost	2008	2015	2030	2050
Investments	1,600	1,750 (2,500)	1,600 (4,500)	1,600 (8,200)
Maintenance + operation	450	530 (500)	660 (1,300)	700 (2,600)
Fuel	11,500	11,000 (9,300)	12,000 (5,700)	12,200 (2,400)
CO2 cost	2,000	1,400 (1,000)	1,300 (400)	2,100 (zero)
Total	15,550	14,680 (13,300)	15,560 (11,900)	16,600 (13,200)

HEALTH COSTS (billion euros per year) from emission of SO₂,NO_x,CO, particles, mercury and lead.

Reference	2015	2030	2050
Official forecast	2.0	1.9	2.0
IDA scenario	1.6	1.1	0.8