

#### Energy challenges and sustainable energy solutions

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- Energy evolution and trends
- Energy efficiency
- Substituting oil
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#### The energy challenges ahead

#### Megachallenges ahead !



#### Global Ecosystem under pressure

- destruction pace of species is 1000x
- 6th wave of extinction underway
- ecosystems of 2 billion people destroyed
- 60% of services from ecosystems (water, food, air etc.) are unsustainable



#### **Global Warming**

- man-made emissions disturb the atmosphere's CO<sub>2</sub> balance
- most CO<sub>2</sub> emissions originate from energy
  - fossil fuels 85% of all energy
  - 60-80% reduction by 2060 (UN IPCC)

#### Energy has been essential for development - but all people do not have energy





BP statistical review of world energy 2003

## Energy demand increases with welfare



- Most of the energy and CO<sub>2</sub> increase comes from the developing countries
  - Now 50% of all emissions, growing 3% per year
- Most of the investments in energy is outside OECD
  - Global investment in energy will be 16000 billon € by 2030

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#### Global energy trends



...BAU....if nothing changes...

- Steady growth of energy
- Fossil fuel dominate, oil around 40% of all
- Shift from north to south





#### Cost of climate change mitigation

## Case: How much does it cost to halve the CO2 emissions?

 Assume a price of 30\$/tCO<sub>2</sub>; countries with <2000\$/capita free



Global CO <sub>2</sub> reduction	% of GNP (participant s)	% of world GNP
30%	0.7	0.65
50%	1.2	1.1
70%	1.7	1.5

## The solutions to mitigate climate change are industrially available but need to be scaled up

Global solutions year 2050

- Global  $CO_2$  emissions
  - 7 GtC/p.a. in 2005
  - 14 GtC/p.a. in 2050
- Here 15 technology solutions, each 1 GtC/p.a. (in total≈ 2 × present CO<sub>2</sub> emissions)

Option	Impact	Solution
Energy	4	Traffic
efficiency and	(G†C/a)	Buildings
conservation		Power plants
Low carbon	4	Natural gas
fuels		CO <sub>2</sub> storage
Nuclear	1	Fission reactors
Renewable	4	Wind
energy and		Solar
tuels		Biofuels
Carbon sinks	2	Forestation
		Plantations

Source: Pacala S, Socolow R. Stabilization wedges: solving the climate problem for the next 50 years with current technologies. Science 2004; 305:986-972



#### **Energy efficiency**





#### Changing to energy efficient lighting



- Light = 16% of all electricity= all nuclear world wide
- 30-60% savings possible in a short term

## Technology innovation: Frequency controller

- Customer groups for FC are end-user groups in industry, construction and public sector
- 5% of industries employ FC, potential is 35%
- "Negawatt" costs 1.5-7€/MWh;2-10 €/t CO<sub>2</sub>





A frequency controller helps to save energy and improve process by enabling <u>stepless</u> <u>speed control</u> of pumps, mixers, blowers, etc. in an optimum way.

## Negawatts are an important energy source





# The role of alternative energy and fuel



#### Short and long-term energy issues

CO<sub>2</sub> emissions are increasing (in particular from electricity/coal) Access to easy hydrocarbons is diminishing (in particular oil)



In 10 years we need "Saudi (1) & Russia (2)" equivalent of new oil production

#### OECD/IEA: Oil reserves are adequate and depend on price



lähde: IEA (2005)

#### Options to reduce oil dependence (transport)



Time to widespread deployment		Technology	
Immediate/ Short term		Reduction in demand (smaller engine size; speed limits; transport mode switching)	
		Advanced high-efficiency ICEs	
		Improved hybrid electric designs with petrol, diesel, biodiesel	
		Bio-diesel; bio-ethanol as carriers	
		Co-processing of biomass with fossil fuels	
		Synthetic fuels from gas/ coal/– Fischer-Tropsch	
		Biofuels from ligno-cellulosic feedstocks	
		Electric vehicles (EVs) with advanced battery electricity storage	
		Hydrogen with fuel cells	
Long	term	Air transport: hydrogen/ gas turbine	

## Alternative fuels: bioethanol and biodiesel



Source:JRC/Concawe

Net energy savings: bioethanol -10...40%, biodiesel 50...60%, 2<sup>nd</sup> gen biofuels (syn-diesel, DME and ethanol from wood) 80-90%

Cost of emission reduction with conventional biofuels is high (100-200 €/tCO<sub>2</sub>) but with 2<sup>nd</sup> generation only a fraction of this

Europe's biomass base could provide 10-20% of the transport fuel



#### Land needed for biofuel production

#### • Target is 6% of EU-25 vehicle fuels by 2010

Table 2 Land use requirements for different biofuel-crop combinations

Biofuel-crop combination	EU-15*%	EU-25*%	
All rapeseed	10.0-11.1	8.4-9.4	
Half and half rapeseed and wheat	9.0-15.5	7.6-13.1	
Half and half sugar beet and wheat	5.6-11.8	4.7-10.0	
Half and half sugar beet and woody biomass	4.8-6.4	4.1-5.4	
All woody biomass	6.5-9.1	5.5-7.7	

Lähde: EEA



#### Resource base for biofuels in Europe

- Europe's present biomass base could provide 10-20% of the transport fuel
- EU produces cereals competitively whereas lagging in oilseeds
- Imports of biofuels would be probable
  (e.g. sugarcane based ethanol is very effective)

#### Scenario for biofuels in Europe

Europe road transport PJ/a	2015 need	8% bio target (2020)	Availability of conventional biofuels	Availa of advand biofue	bility ced :Is
Gasoline	3996	320	230	914 - or -	000
Diesel	8794	704	302	000	883
				+ 200 biogas	
Finland's forestry industry ~ 292 PJ (ethanol)					
Finland's all agriculture ~ 65 PJ (ethanol)					
Finland's p	Finland's peat reserves ~ 12000 PJ (FT-diesel)				



#### Sustainable energy systems



#### Shell scenario: Energy market 1860 - 2060





#### Decentralized energy systems



source: ABB

#### Bioenergy is an important local fuel



- Bioenergy 4% of EU energy 69 Mtoe, 2003)
- Potential 15% (295 Mtoe, 2030)
- Enviromental constraints put an upper limit to its use



Figure 1 Environmentally-compatible primary bioenergy potential in the EU

lähde: EEA





## Wind is penetrating into energy production







- Total wind capacity is 60.000 MW and 2005 10.000 MW was added
- Business >10 bill.€, growth >20%/yr
- 2025 >10% of world electricity could be wind power



#### Solar energy = final solution





#### Solar Cells (Photovoltaics)





#### **Off-grid PV** applications

**Stand Alone System** 





#### Stand-alone PV systems









#### Fuel cells and hydrogen

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- Small fuel to electricity converter (1mW-1MW) with high 40-60% efficiency
  - Hydrogen and hybrocarbons as fuel
  - Applications: portable, mobile or stationary energy use
  - Power density 1-4 kW/l





### Thank you for your Attention !

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