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SMART ENERGY SYSTEMS — DECOUPLING FROM RESOURCE BASED ENERGY

Abstract: European Union has started the transition of energy systems to energy sources with lower environmental impact due to conventional resource being scarce and controversial. The transition is becoming more attractive with fall of investment costs of renewables and volatile prices and political insecurity of fossil fuels. The resources are bountiful, especially wind and solar, while integrating them into current energy systems is proving to be a challenge. The limit of cheap and easy integration for wind is 20% of yearly electricity generation, while a combined wind and solar may reach 30%. Going any further asks for implementation of really free energy markets (involving day ahead, intraday and various reserve and ancillary services markets), and it involves integration between electricity, heat, water and transport systems. The cheapest and simplest way of increasing further the penetration of renewables is integrating power and heat systems through the use of district heating and cooling (which may be centrally controlled and may have significant heat storage capacity). In countries with low heat demand water supply system may be used to increase the penetration of renewables, by using water at higher potential energy as storage media, or in dry climates desalination and stored water may be used for those purposes, and reversible hydro may be used as balancing technology. Electrification of personal car transport allows not only for huge increase of energy efficiency, but also, electric cars due to low daily use may be excellent for demand side management and even storage potential. That will allow reaching 80% renewable in energy system, but the remaining 20% may be more an uphill battle without technology breakthrough. Long haul freight road transport, aviation and ship transport, as well as high temperature industrial processes, cannot currently be easily electrified. Biomass, if not used for producing electricity and heat, may cover half of those needs, but the rest will have to come from some other technology.

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EU energy context

- **Security of energy supply**
 - Import dependence from 50% to 70% by 2030
- **Employment and regional development policies**
 - Deindustrialization and trade liberalization
 - “Boosting growth and jobs by meeting our climate change commitments”
- **Mitigation of global warming**
- **Environmental protection**
- **Sustainable development**

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Rapidly closing window of opportunity

65% of our carbon budget compatible with a 2°C goal already used

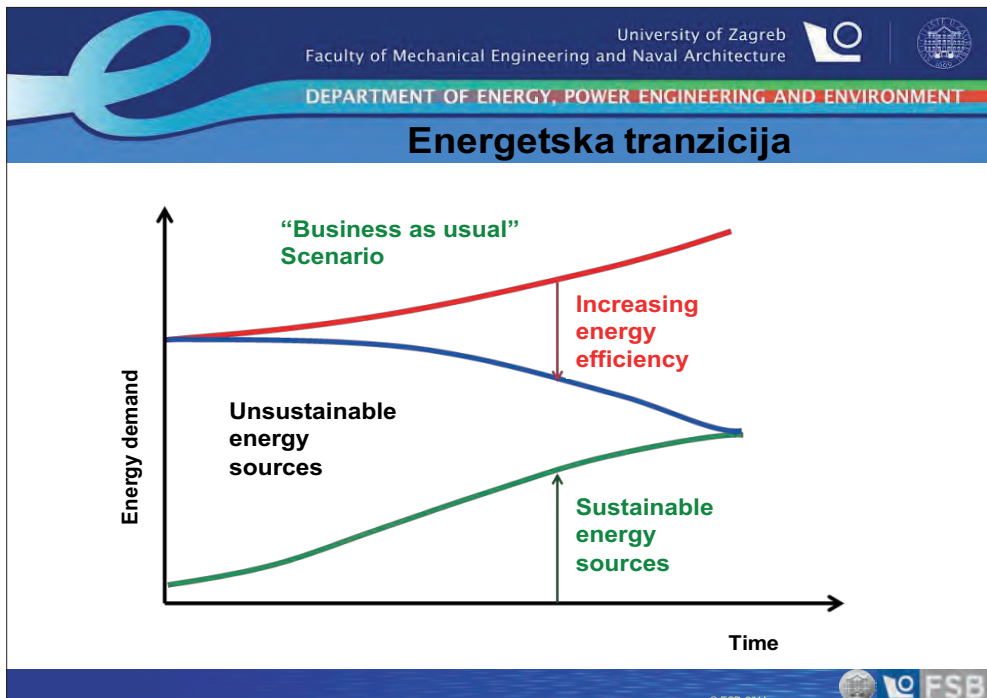
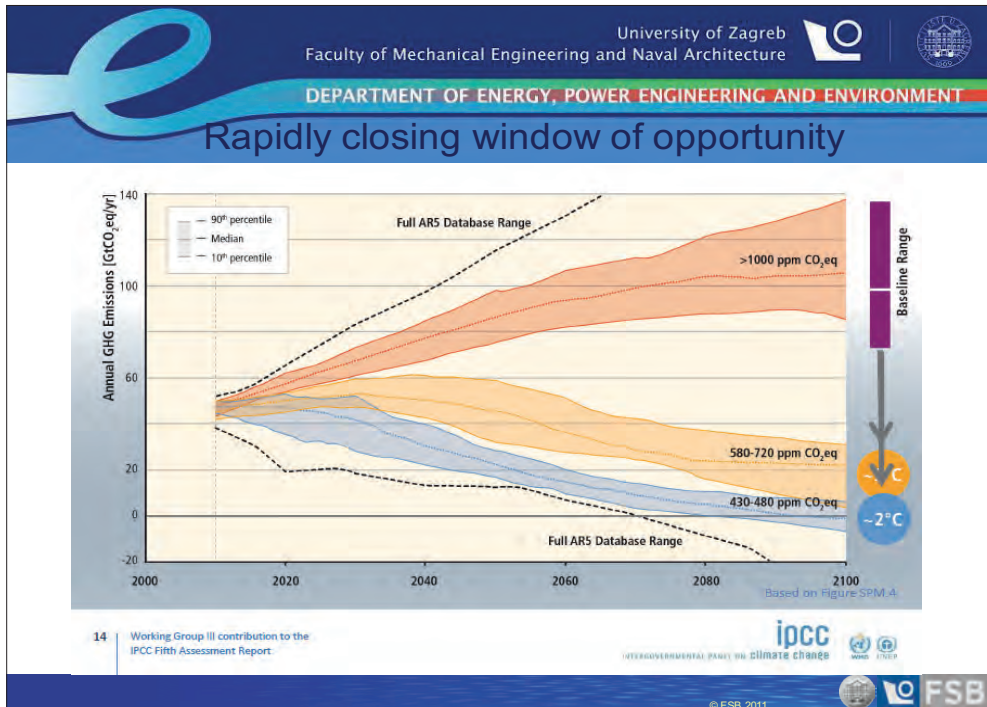
Category	Amount (GtCO ₂)
Total Carbon Budget	2900
Amount Used (1870-2011)	1900
Amount Remaining	1000


AR5 WG1 SPM

ipcc
INTERGOVERNMENTAL PANEL ON climate change



WMO UNEP

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Sustainable energy resources - electricity

- **Security of energy supply**
 - Nuclear is environmentally sound but quite expensive (110 EUR/MWh), politically difficult in some countries, additionally expensive for small countries, even more for new entrants, and too late too little
 - Therefore only renewables are available to increase security of energy supply

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Sustainable energy resources - electricity

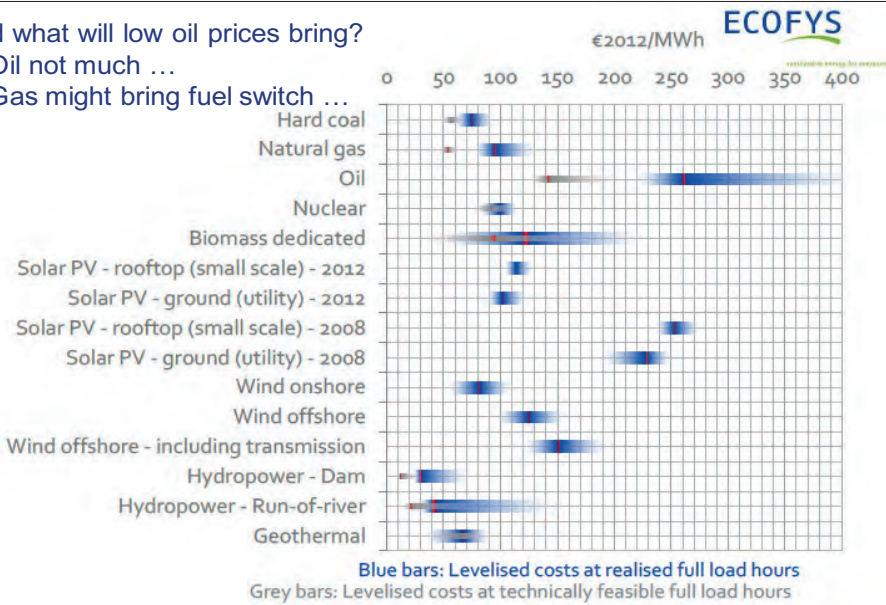
- **Security of energy supply - renewables**
 - Hydro – excellent but all viable projects have been built long time ago
 - Biomass – excellent but also already too much used in EU, any further increase risks food production and environment
 - Low solar to electricity efficiency ($2\% * 20\% = 0,4\%$)
 - Only waste biomass and biomass from co-production is sustainable
 - Geothermal – complicated and only available in some places
 - Wind – available everywhere and cheap
 - Solar – available everywhere and now cheap

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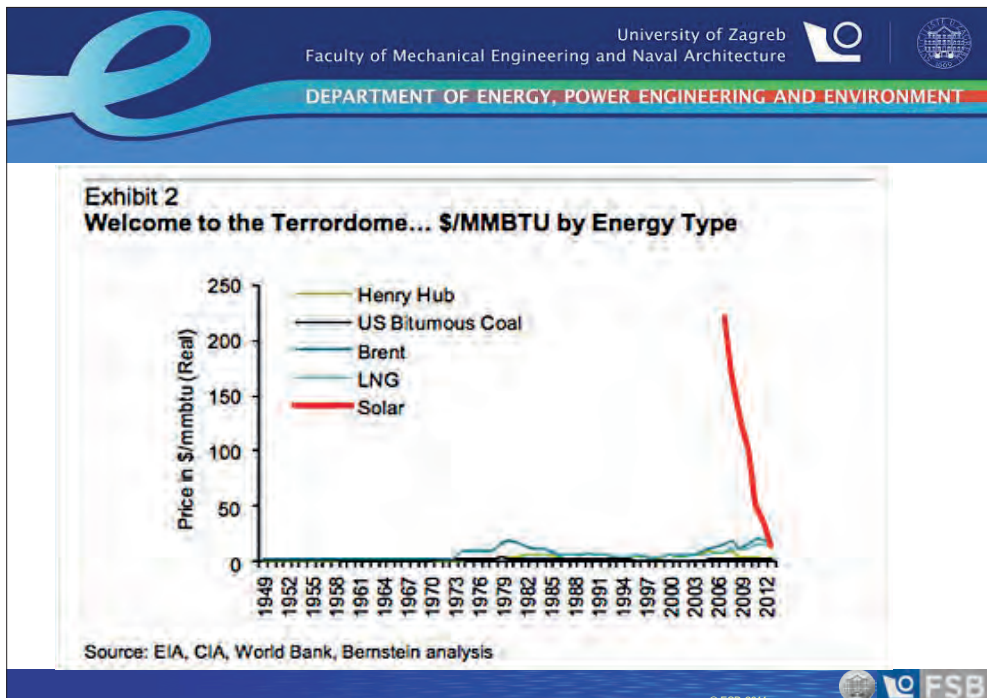


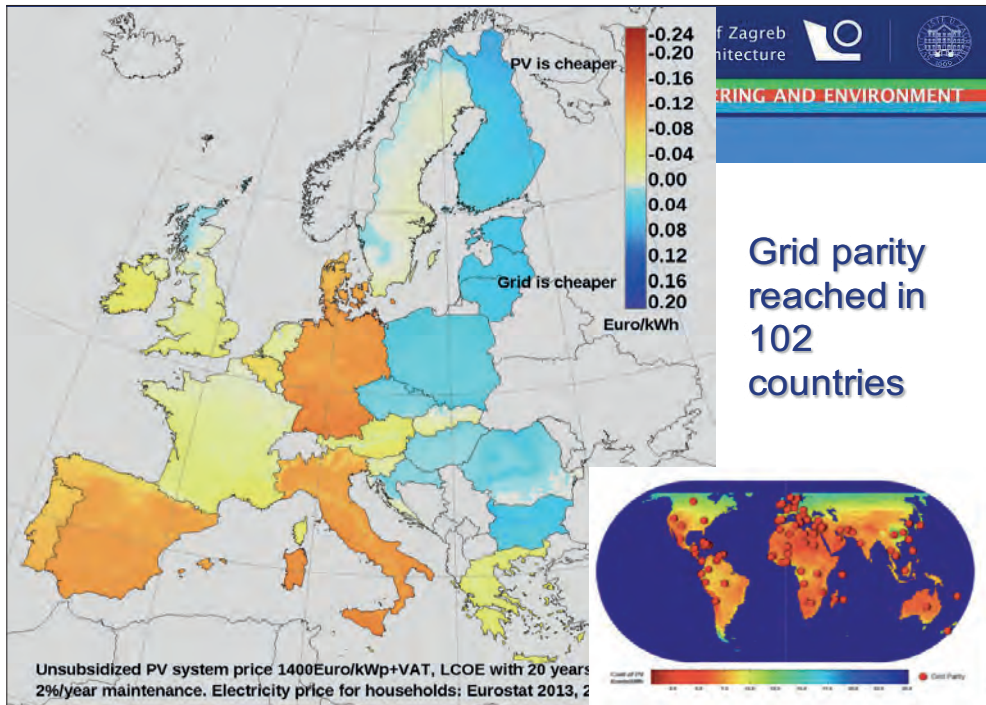
And what will low oil prices bring?

- Oil not much ...
- Gas might bring fuel switch ...



LCOE – various technologies





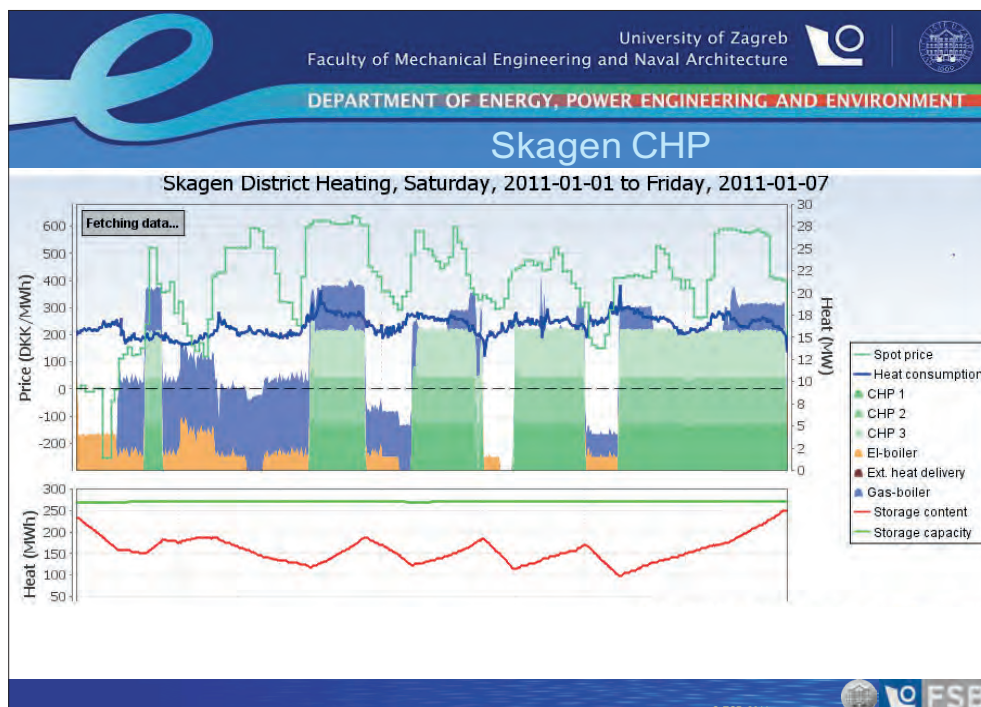
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Markets and RES

➤ Consequences of market liberalisation:

- Demission of base load
- The importance of balancing power (**gas, hydro**)
- Cycling of old coal power plants (4000 hours by 2020)
- Market arbitrage (time delay, power-to-heat, power-to-water, e-mobility, demand management, power-to-e-fuels)
- XX century energy systems: supply follows demand
- XXI century energy systems: demand follows supply -> smart energy systems

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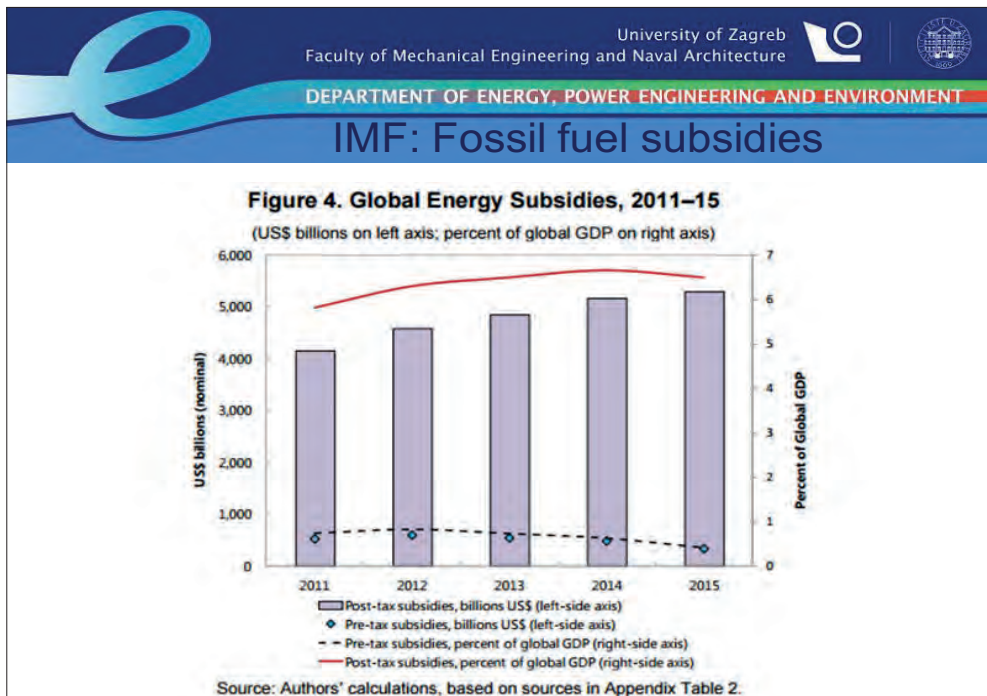
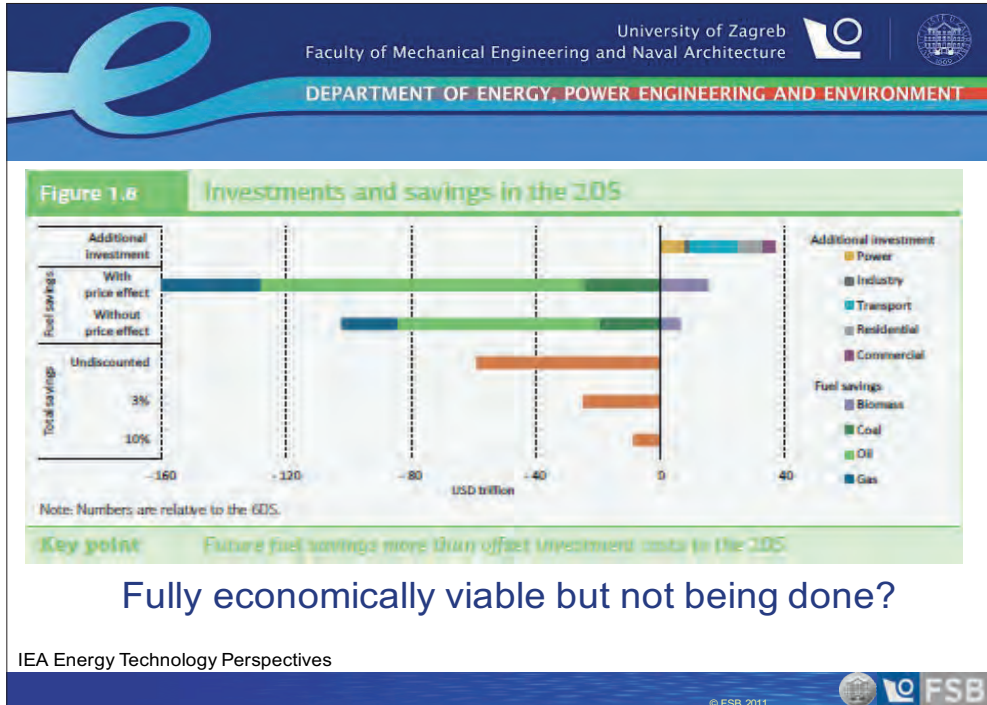
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Demand management

➤ Electromobility



- Only personal cars and short distance utility vehicles - 430000 PEV sold worldwide in 2015
- If RESe 80% reduction of primary energy
- Fast charging 70 kW – huge problem if left uncontrolled, ex AT, 4 mln cars arrives home, plugs in – 280 GW (14 GW installed cap)
- Smart charging – market based, smoothing the demand

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Conclusions - New energy paradigm

- **Phase out of fossil fuel subsidies**
- **More local primary energy**
- **Smart energy systems**
 - **Renewable Energy**
 - **Buildings as Positive Power Plants**
 - **Energy Storage**
 - **Smart grids and Plug-in Vehicles**
- **Resulting in:**
 - **More energy security – more security**
 - **More energy related employment – more equity**
 - **Decoupling the growth from resources**
 - **Putting climate change under control**

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