The Future of Coal use

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Production of major fuels and chemical raw material in the world

CRUDE OIL PRODUCTION: DAILY 94 M BARRELS, 204 B GJ ANNUALLY (11.473 USD/GJ)
(PRICE: 11,4 USD /GJ PEAK 2X)
NATURAL GAS PRODUCTION: 3500 B M^3 184 B GJ
(3 USD/GJ(US), 5.7 USD GJ EU, 9.52 USD/GJ CHINA, PEAK 2 X)
COAL PRODUCTION 8 B TONNES ~119 B GJ
GERMAN OPEN PIT < 2,30 USD/GJ , 2.9 USD/GJ POLISH UNDERGROUND
2.8 USD/GJ ARA, 3.3 USD/GJ CHINA)(PEAK 1,5 X)
RENEWABLE ENERGY RESOURCES: ESTIMATED 76 B GJ (~15% OF THE TOTAL)

AROUND 80-90% MONOPOLY REGARDING HYDROCARBONS
COMMERCIAL TRADE AND COMMERCIAL PRICES

LESS THAN 40% MONOPOLY REGARDING COAL
COMMERCIAL TRADE IS LOW AND PRODUCER PRICES DOMINATE

RENEWABLES EQUIPMENT PRODUCERS (AVAILIBILTY SUN:15 % WIND 21 %)

CONCENTRATION

Comparison of Coal production prices in the world

Coal prices	USD/GJ	Correction for the energy efficiency gas/coal 55/43% 1,27 x	Price of natural gas USD/GJ /LNG ca. +70%/
USA Powder River Wyoming	0,4722	0,6	3(102 USD/1000 m3)
USA Illinois	1,372	1,74	3
USA Northern Appalache	1,638	2,08	3
USA Rocky mountains	1,638	2,08	3
USA Middle Appalache	1,638	2,08	3
China Shenhua at mine mouth	1,375	1,746	9,5(324 USD/1000 m3)
China Shenhua transported	2,06	2,61	9,5
China CECO purchase	3,41	(4,33) + only for chemicals	9,5
India	0,44	0,56	4,55
Europe ARA	3,71	7,71	6 (22 Euro/MWh)
Europe German open pit	1,72- 2,3	2,18- 2,92	6
Europe Polish deep mine	2,9	3,68	6 + no public data available
Hungarian open pit	< 2,29	< 2,90	6+ no public data available
Hungarian deep mine new opening estimate	3,44- 4,60	4,367- 5,84	6 + no public data available
Australia Victoria open pit	0,44	0,56	4,55

Comparison of coal prices with that of other fossil fuels
(1 Euro = 322 HUF, 1 USD = 280 HUF)
Source: EEX webpage

	energy content	Rough original price	USD/GJ	In 1998
1 barrel oil	6,1 Gjoule	70 USD/barrel	11,47 3213 HUF	**700 HUF/GJ**
1000 m^3 gas import	34 Gjoule	265 USD (24 €/MWh)	7.79 2182 HUF	**600 HUF/GJ**
Price of 1 tonne coal on ARA parity	**25 Gjoule**	**90 USD**	**3.6** **1008 HUF** **+ 342 HUF delivery**	**428 HUF/GJ**

A politicised product: electric energy

- Price level of electric energy on the stock exchange in Europe: 45-50 €/MWh
- 9GJ coal is required for producing 1 MWh electric energy at 40% efficiency
- (9x3.43 Euros) 30.78 € /MWh fuel cost.
- 6.54 GJ natural gas is required for producing 1 MWh electric energy at 55% efficiency: 43.63 €/MWh
- Guaranteed priority dispatched wind power in Germany: 60 €/MWh
- Guaranteed priority dispatched solar power in Germany: 120 €/MWh
- Available wind and solar power plant capacities are under 15 %
- Wind and solar prices contain no loss reserve or other reserves therefore their quality is not the same
- The way is good but the spreading of an experimental technology is financed by tax payers
- Voting on the use of renewable energy resources is practically voting on natural gas

Carbon dioxide: resources or enemy of the environment?

- Arguments on its effects on climate resemble war in the dugout
- The carbon cycle is the basis of life and can be utilised as a primary commodity as well
- Technological advancement makes the use of coal as a basic material more economical. CCR (Carbon Capture and Reuse) instead of CCS (Carbon Capture and Storage). EOR is the traditional application, Polyoils mean short return rate, greenhouses, hydrogenation are unlimited but currently not economical alternative, realisation of methanol economy, hydrogen economy
- CO_2 calculation anomalies partly due to the life cycle
- CO_2 as a basic weapon in the economic war
- Paradoxes of research financing

Major fields of CO_2 research (Source: E-MRS)

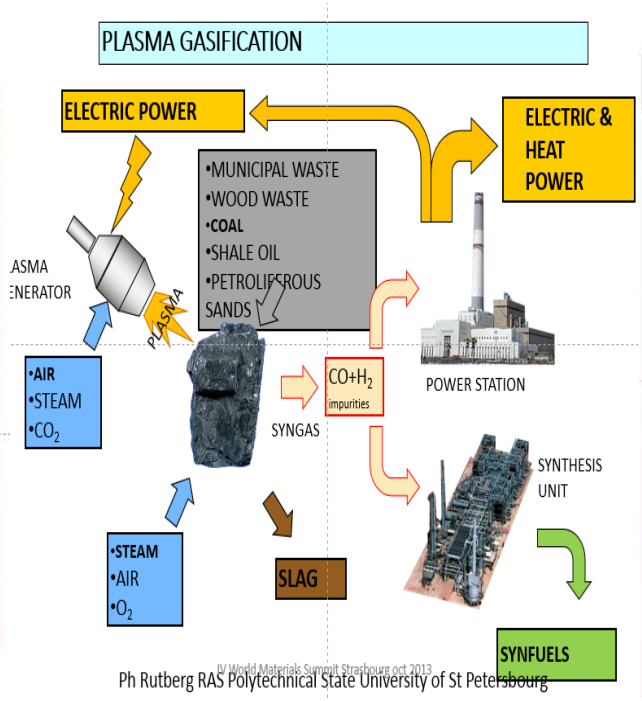
Carbon dioxide emission and processes innovation

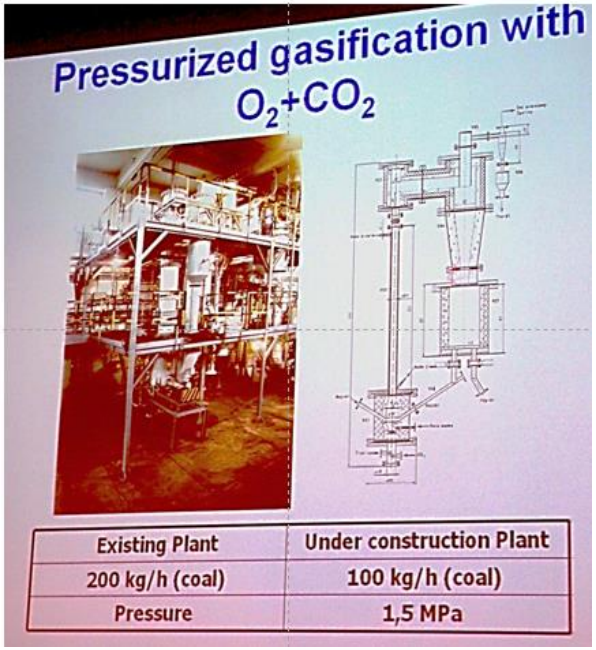
1. classical turbine : 30 % efficiency and water consumption Or Allam turbine with CO_2: supercritical CO_2 : 50% Efficiency, recycling of CO_2 and water consumption elimination (starting Texas US)
2. Coal extraction by bacteria: coal to methane (Starting US)
3. CO_2 recycling by cyanobacteria (energy and water from the sea) starting for industrial development Mitsui Japan)
4. Micro algea and CO_2 for food production (fish farm) starting Almeria epain and China with Australia)
5. sea algea farm on sea field for sun energy extraction and phosphate fertiliser recycling
6. CO_2 to cellulose to methane by bacteria and by products of phosphate compouds (a challenge)

CO_2 for coal gasification and energy storage few TERRAWATTh (source: E-MRS)

Pictures: CO_2 from air Climeworks Switzerland, Plasma gasification with CO_2 Russia gasification with O_2 and CO_2 Poland

First world commercial capture plant from Climeworks Zurich





For all industrial units as required:
- Electric energy supply
- Water supply/Water treatment
- Catalyser supply

Unused carbonium sources

- Agricultural biomass
- Sewage sludge
- Manure
- Waste
- Coal
- CO_2

Unused energy and water sources

- Power plant/industrial waste heat
- Solar/wind/geothermal energy
- Rivers
- Off- peak electricity

Preparation plant

- Separation/Con-centration
- Cutting/Grinding
- Homogenisation
- Watering/Drying
- Torrefaction
- Bacteria/enzymes

Energy use / storage

- Heat storage, heat pumps, ORC
- CHP
- Thermal max
- Hydropower use
- Accumulator farms

Electric energy
District heating
Agriculture

Processing plants

Production of chemical products
- Gasification, CO_2 sequest, crude gas cleaning
- Crude oil cleaning with solvent procedure
- Synthesisprocedure

Bacteria/enzyme processing
- Biogas production, CO_2 sequestration

CO_2 utilisation
- Chemical processing
- Fireproof material cells

H_2 production, O_2 production
- Hydrolisis
- Natural gas decompos.
- Carbon reduction
- Air decomposition

Waste material, slag use
- Chemically bound construction material
- Chemical extraction

Energy use
- Renewables, collectors
- Catalytic oxidation

MeOH, Further chemical compounds Sulfur, Soil improving Fertiliser

Biogas

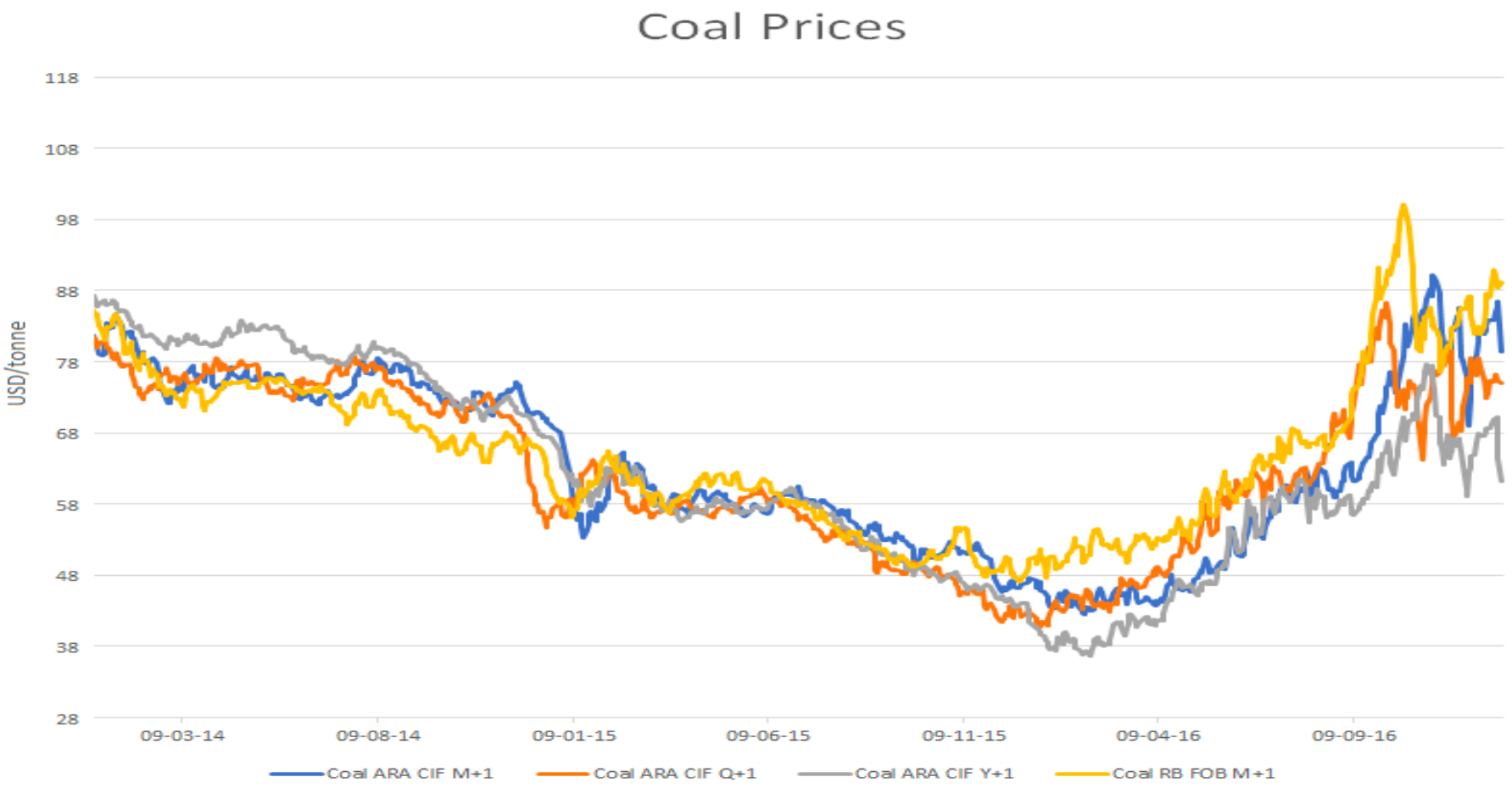
Polyols, Hydrocarbons

H_2, O_2, N_2 H_2 chemical storage

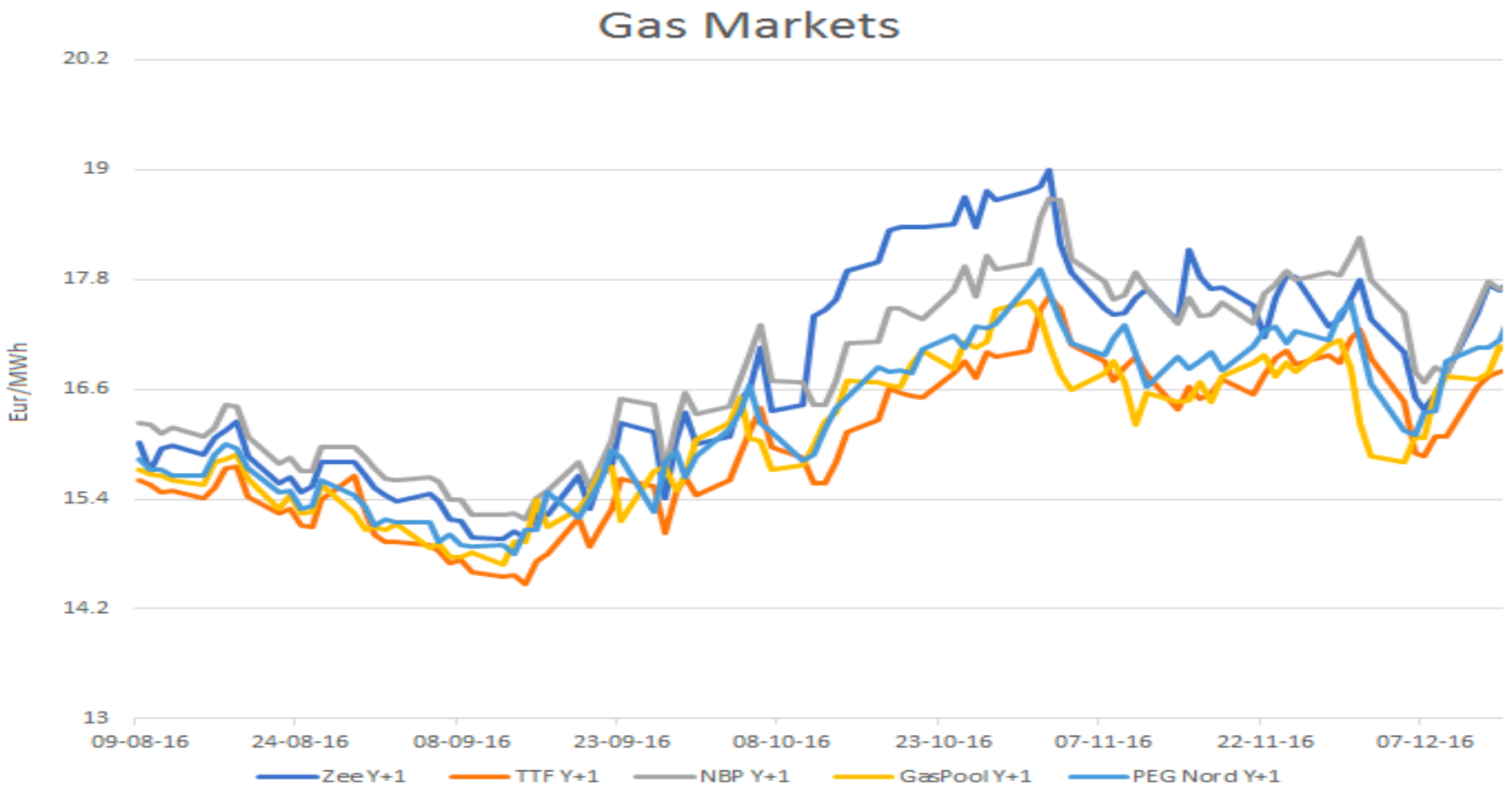
Construction material, Rare Earth Element

KBFI

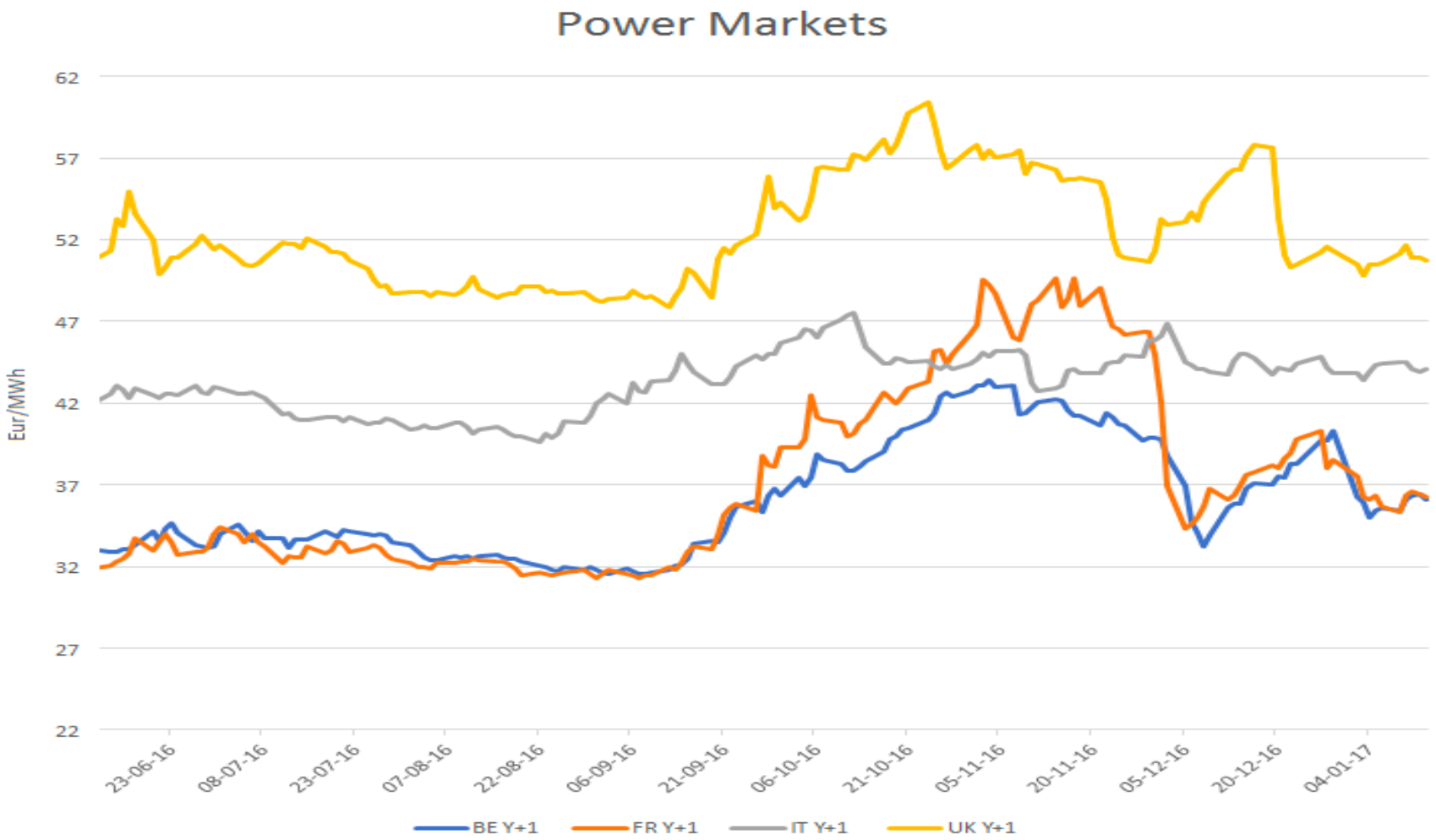
Tendencies in coal prices (source:Energy Market price)



Tendencies in gas prices (source: Energy Market pice)



Electric energy markets (source Energy Market Price)



Clean coal technologies and their possible application in existing infrastructure

- All technologies of coal use either as material direct dissolution or indirect gasification with subsequent cleaning and transformation
- Also technologies for CO_2 capture and sequestration CCS or reuse CCR
- Selected technologies of the toolbox can be used to clean coal retrofit of existing infrastructure, hence strategy for CTC and coal to power overlapping
- Example: Gasification outside of the existing boiler than catalytic glowing of the gas instead of burning and transformation of the CO_2 in the exhaust with the help of waste heat into alcohols (common research areas)

Methanol prices (source: Methanex)

Current Posted Prices

Europe

(Valid October 1, 2018 - December 31, 2018)
Methanex European Posted Contract Price
Posted September 27, 2018
Euro 428/MT

North America

(Valid November 1, 2018 - November 30, 2018)
Methanex Non-Discounted Reference Price
Posted October 26, 2018
USD 1.56/Gal*
USD 519/MT

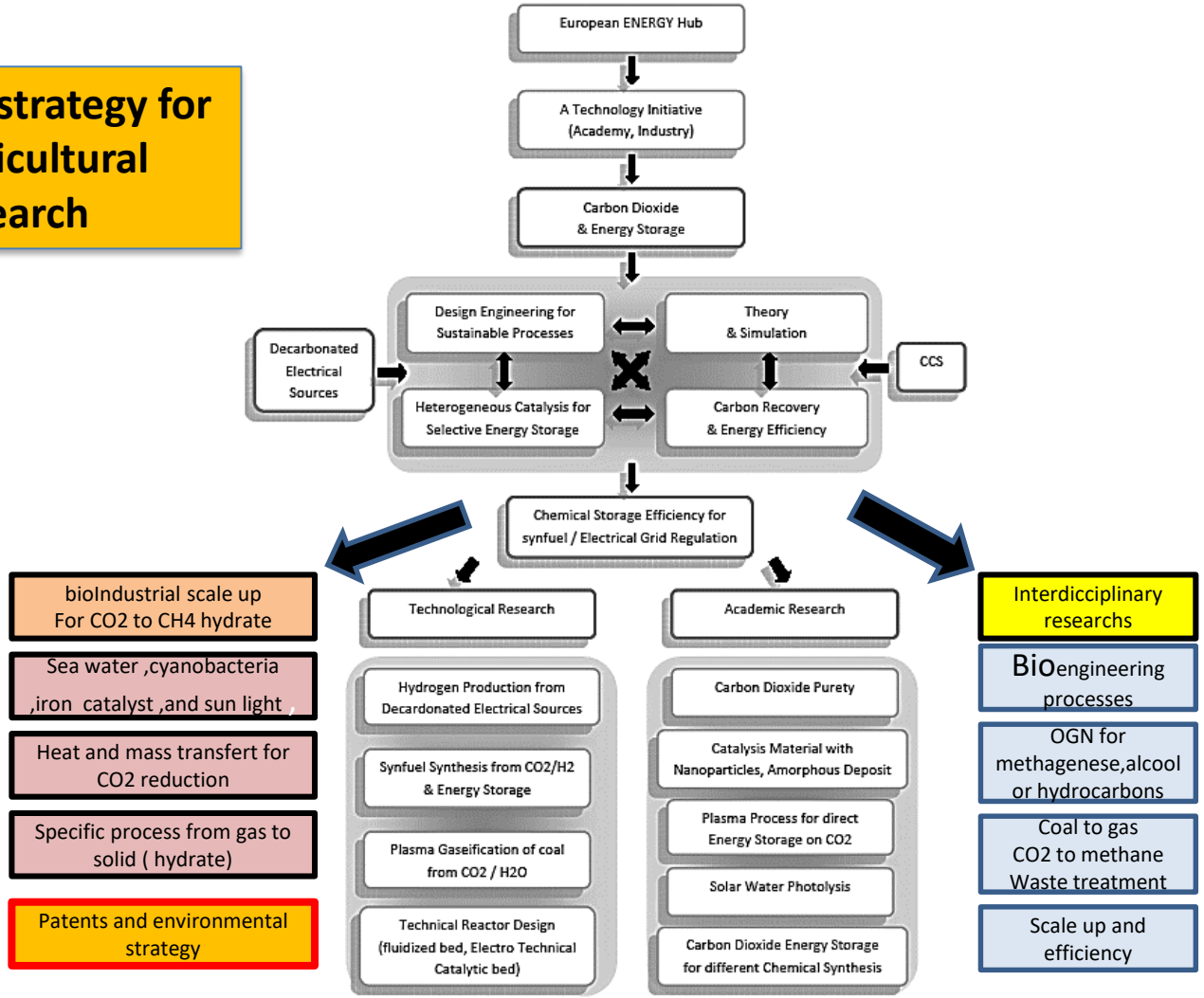
Asia Pacific

(Valid November 1, 2018 - November 30, 2018)
Asian Posted Contract Price
Posted October 31, 2018
USD 510/MT

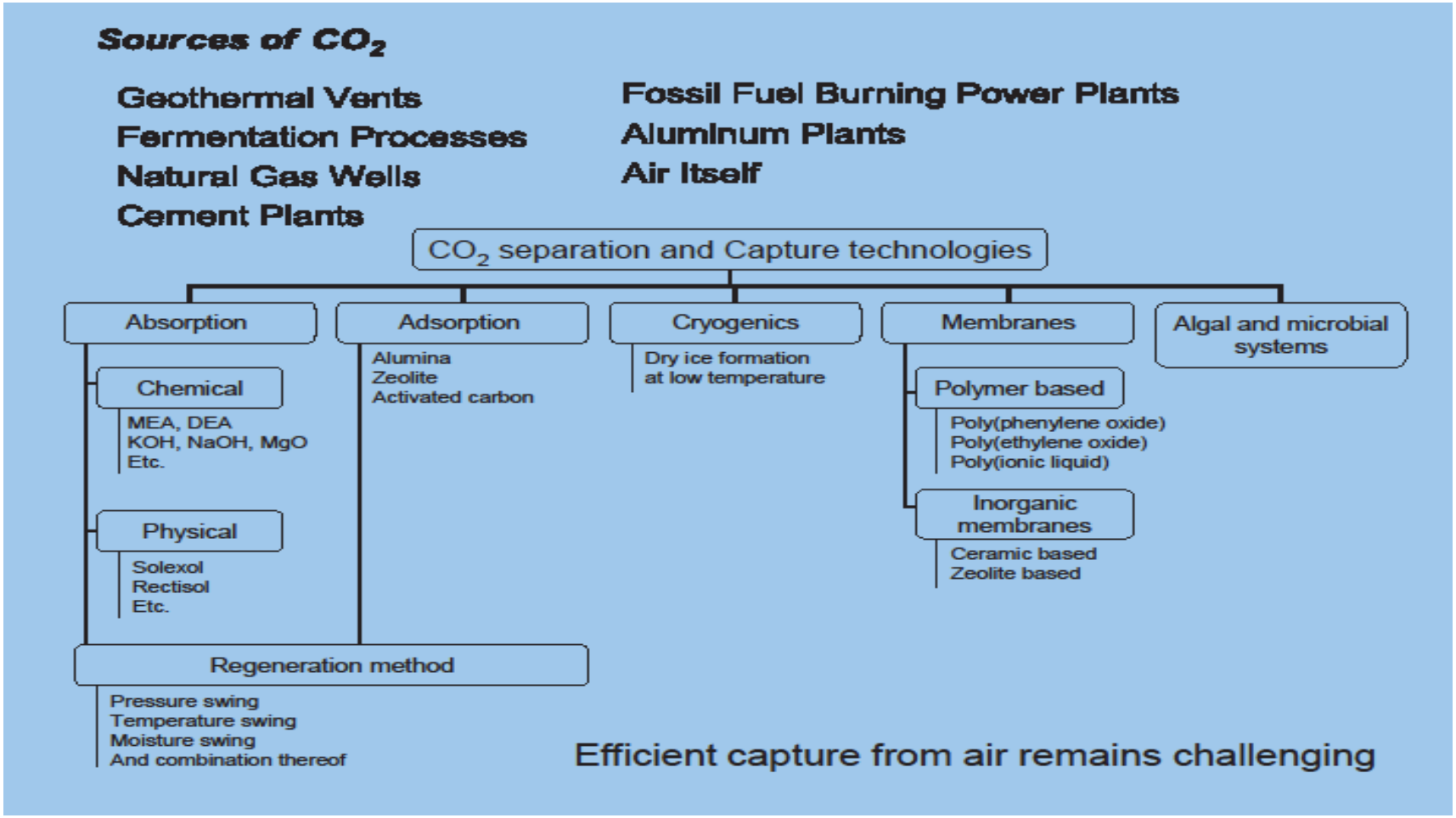
* Convert to $/MT using a conversion rate of 332.6 Gal per MT

E-MRS research strategy (source : presentation of Prof Jacques Amouroux)

European strategy for A multicultural research



CO_2 separation and Capture
(source :Prof. Suriya Prakesh)



Direct and indirect GHG emissions from fossil fuels

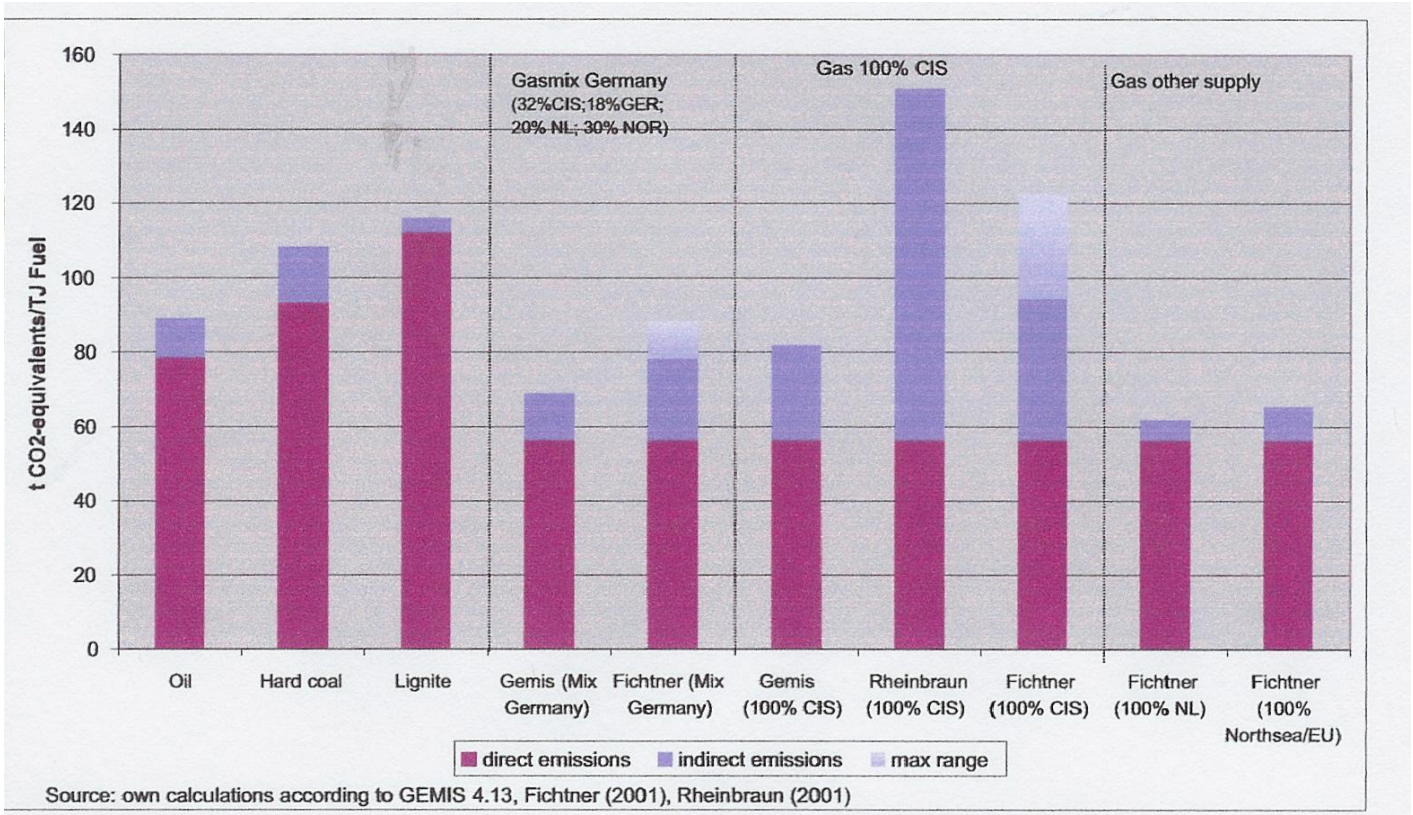


Fig. 2: Direct and indirect GHG-emissions (in CO_2.equivalents) of different fuel-types in comparison with the emissions from the natural gas life cycle under different assumptions and LCA's

Thank you for the attention

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