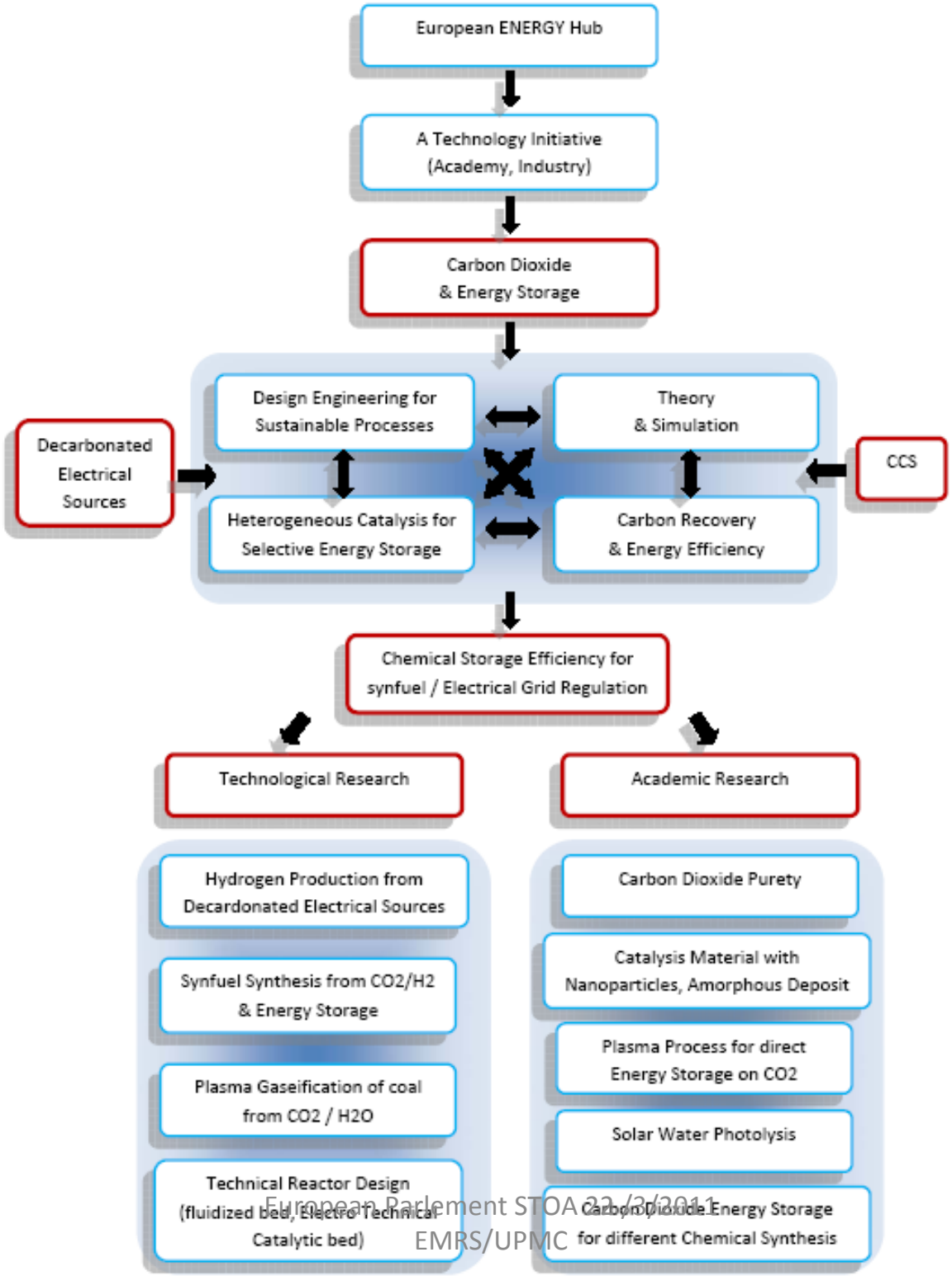
11- an international roadmap


European ENERGY Hub
A Technology Initiative
(Academy, Industry)
Carbon Dioxide
& Energy Storage
Design Engineering for
Sustainable Processes
Theory
& Simulation
Decarbonated
Electrical
Sources
CCS
Heterogeneous Catalysis for
Selective Energy Storage
Carbon Recovery
& Energy Efficiency
Chemical Storage Efficiency for
synfuel / Electrical Grid Regulation
Technological Research
Academic Research
Hydrogen Production from
Decardonated Electrical Sources
Synfuel Synthesis from CO2/H2
& Energy Storage
Plasma Gaseification of coal
from CO2 / H2O
Technical Reactor Design
(fluidized bed, Electro Technical
Catalytic bed)
Carbon Dioxide Purety
Catalysis Material with
Nanoparticles, Amorphous Deposit
Plasma Process for direct
Energy Storage on CO2
Solar Water Photolysis
Carbon Dioxide Energy Storage
for different Chemical Synthesis

Existing Pilot plants in operation or under development :

Synfuel : Board Energy Corp.(Vancouver) : 5 109 $ at walls hill (OHIO)
Power : 50.000b/day

Rentech Inc (Los Angeles), Plant Natchez (Mississippi) :
30.000b/day starting 2011

Methanol : Mitsui Che : mitsui ceramic inc 1.5 109 yen

Methanol to olefin (USA - China) 1.6 109 T/Year to 60.000T/Year of C2H4,C3H6

Synfuel : *to Fisher Tropsch* (gasification of coal and waste (South Africa, US)

Syngas from high power arc plasma : 10 to 20 megawatt (Russia,Tech Rep, CEA)
in an *Huaneng Group* :China biggest electricity provider :scale up its Shidongkou n°2 to capture existing coal plant in Shanghai :3000T/Y
Shanhua Group :China biggest coal producer :IGCC process for coal to liquid
1 million ton of diesel per year in Mongolia

GreenGen :an integrated gasification combined cycle (IGCC) **in China**

- **IGCC plant was approved by the Chinese government last june 2009**
- **Construction in Tianjin**
- **IGCC turns coal into gas which allows easy separation of CO2 from combustible gases**
- **This project is the leading carbon capture for coal fired power**

- Science 25 sept 2009 VOL 325 p 1646

This opportunity needs a value chain

Petroleum Value Chain:

Exploration → Production → Transport → Refining → Blending

CO_2/CH_4 Value Chain:

Recycle	Collection	Transport	Electrolysis/ Methanation	CH_4 for power
•No hurdles	•Infrastructure •Scale •Stack recovery	•Transport cost •Vessel compatibility •Storage	•Electrode system •Catalyst system •Heat provision •Oxygen management •Water management	•No hurdles

EMRS Fall Meeting
Warsaw 13-15 sept 2010
Symposium A

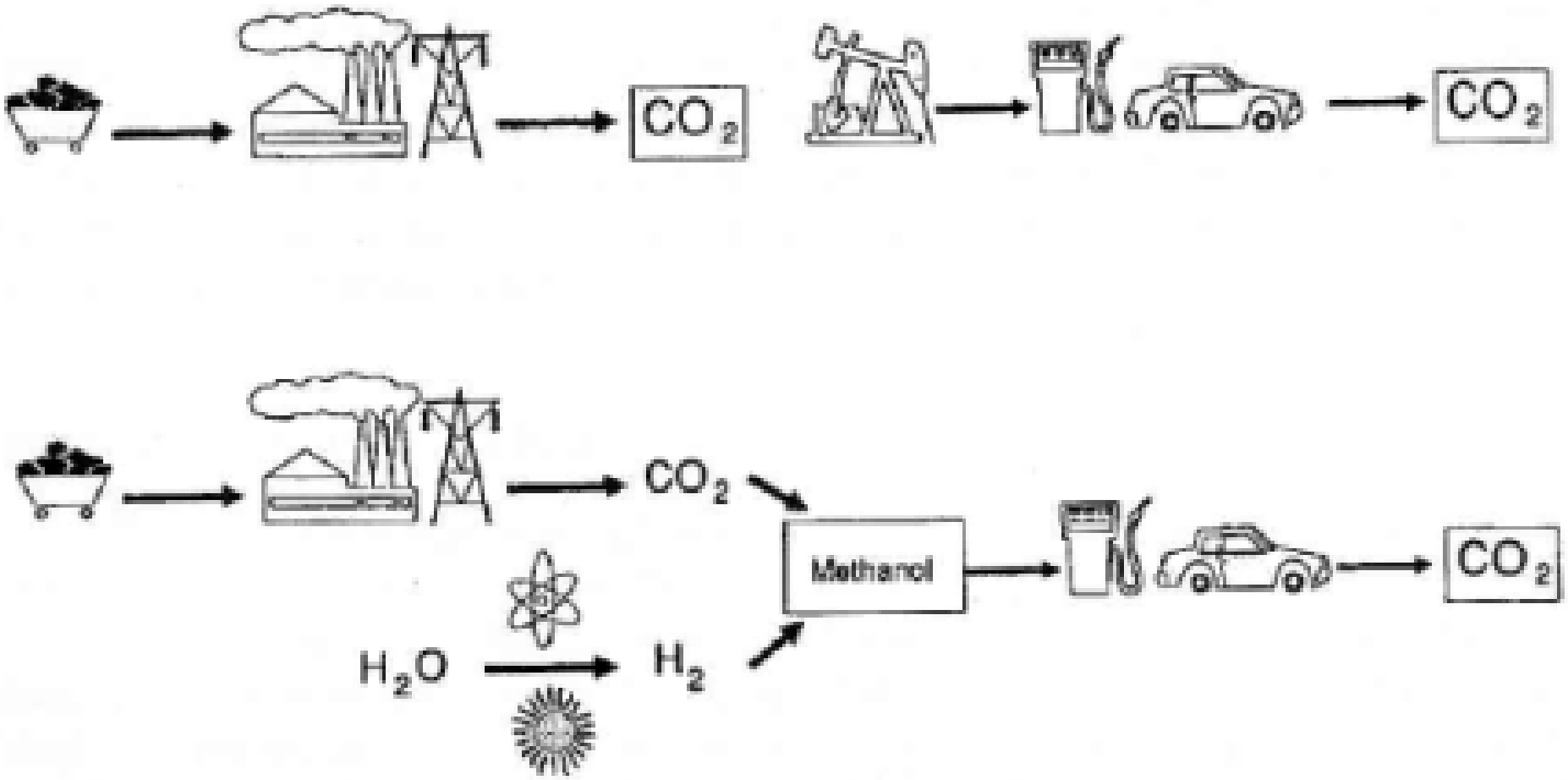
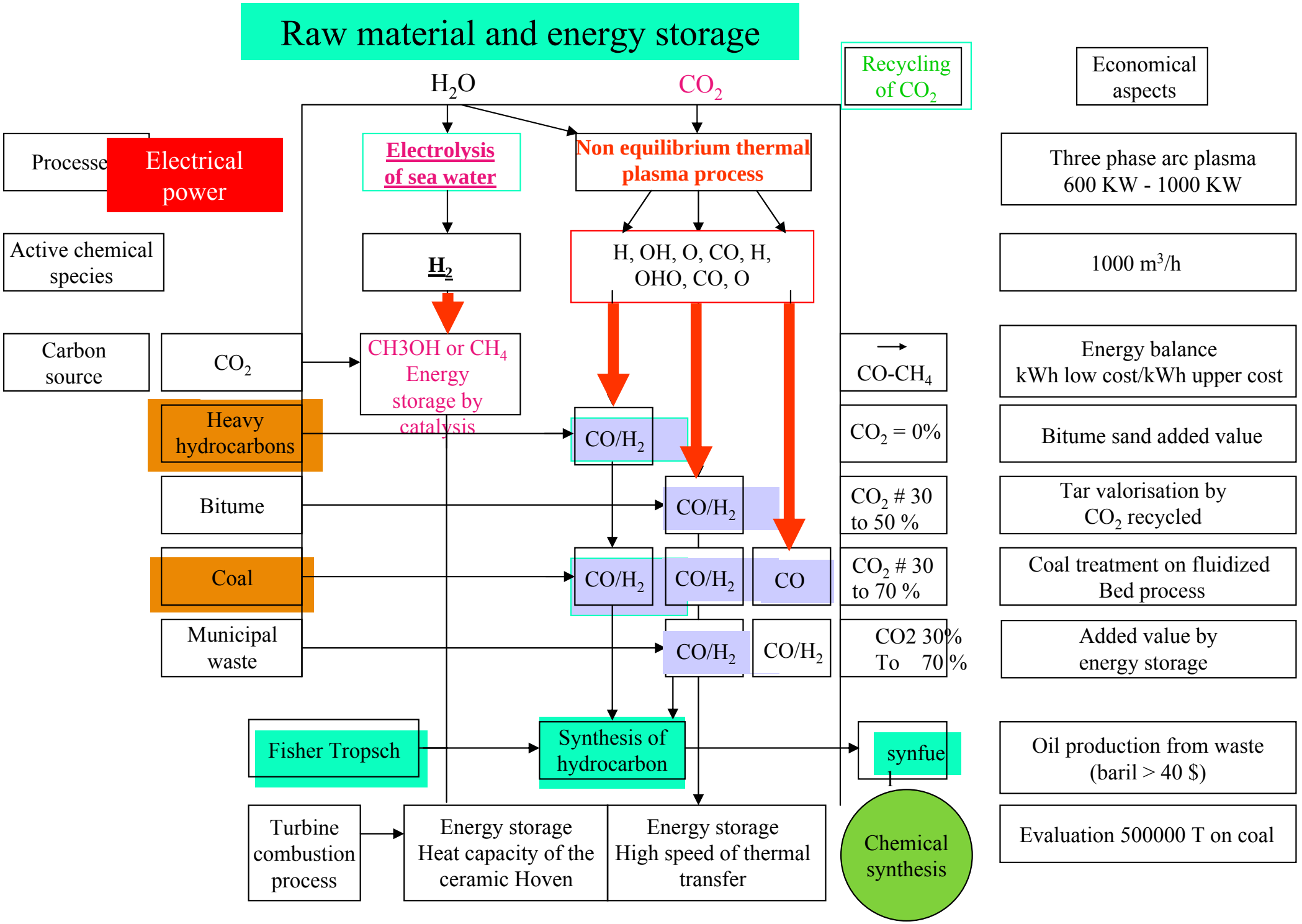


Figure 1. Possible route of production and usage of methanol.

B. Eliasson, F. G. Simon, and W. Egli

Asea Brown Boveri
Corporate Research Center
Baden, Switzerland


Raw material and energy storage
H_2O
CO_2
Recycling of CO_2
Economical aspects
Processe
Electrical power
Electrolysis of sea water
Non equilibrium thermal plasma process
Three phase arc plasma 600 KW - 1000 KW
Active chemical species
H_2
H, OH, O, CO, H, OHO, CO, O
1000 m^3/h
Carbon source
CO_2
CH3OH or CH_4 Energy storage by catalysis
$CO-CH_4$
Energy balance kWh low cost/kWh upper cost
Heavy hydrocarbons
CO/H_2
CO_2 = 0%
Bitume sand added value
Bitume
CO/H_2
CO_2 # 30 to 50 %
Tar valorisation by CO_2 recycled
Coal
CO/H_2
CO/H_2
CO
CO_2 # 30 to 70 %
Coal treatment on fluidized Bed process
Municipal waste
CO/H_2
CO/H_2
CO2 30% To 70 %
Added value by energy storage
Fisher Tropsch
Synthesis of hydrocarbon
synfuel
Oil production from waste (baril > 40 $)
Turbine combustion process
Energy storage Heat capacity of the ceramic Hoven
Energy storage High speed of thermal transfer
Chemical synthesis
Evaluation 500000 T on coal

Liquid CO_2

Sequestration

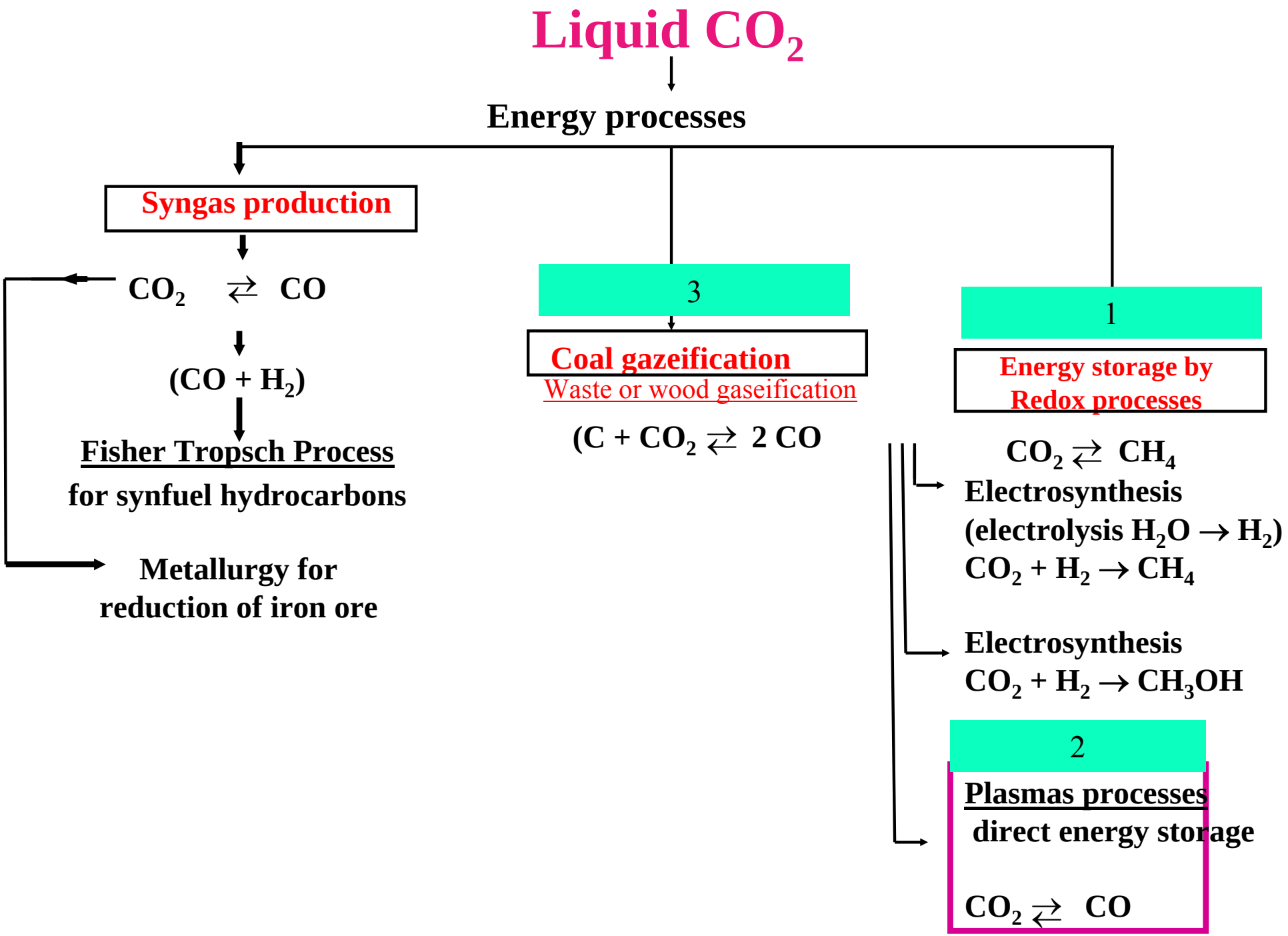
and new ciment for CO_2 storage
(0,6 T/T ciment)
(magnesium silicate)

Solvant properties

Cooling fluid

Chemical synthesis

- Area synthesis (fertilizant)
- HCOOH formic acid (HCOOH)
- H_2O_2 synthesis
- C_2H_5OH synthesis
- Polycarbonate polymer with insulating properties
- Copolymérisation
  epoxide + CO_2 → polycarbonate aliphatique biodégradable properties (30 to 50 % weight CO_2) and good mecanical properties


Liquid CO_2
Energy processes
Syngas production
$CO_2 \rightleftarrows CO$
$(CO + H_2)$
Fisher Tropsch Process
for synfuel hydrocarbons
Metallurgy for
reduction of iron ore
3
Coal gazeification
Waste or wood gaseification
$(C + CO_2 \rightleftarrows 2\,CO$
1
Energy storage by
Redox processes
$CO_2 \rightleftarrows CH_4$
Electrosynthesis
(electrolysis $H_2O \rightarrow H_2$)
$CO_2 + H_2 \rightarrow CH_4$
Electrosynthesis
$CO_2 + H_2 \rightarrow CH_3OH$
2
Plasmas processes
direct energy storage
$CO_2 \rightleftarrows CO$