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Poland's Energy Strategy: Clean Coal and Renewables

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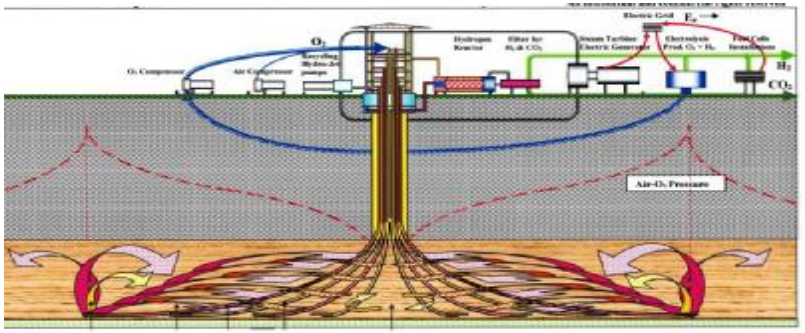
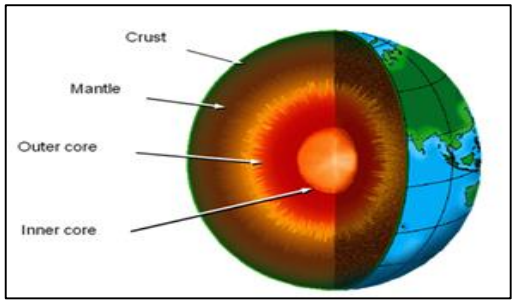
The Electricity Age for Passenger Vehicles





New Sources of Electricity?

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Electricity Production from Fossil Fuels

Coal/peat	TWh
People's Rep. of China	2 656
United States	2 118
India	549
Japan	311
Germany	311
South Africa	247
Australia	194
Korea	171
Russian Federation	170
Poland	148
Rest of the world	1 353
World	**8 228**

61%

Oil	TWh
Japan	156
Saudi Arabia	104
United States	78
Mexico	52
Indonesia	38
Italy	35
Kuwait	35
People's Rep. of China	34
India	33
Iraq	33
Rest of the world	516
World	**1 114**

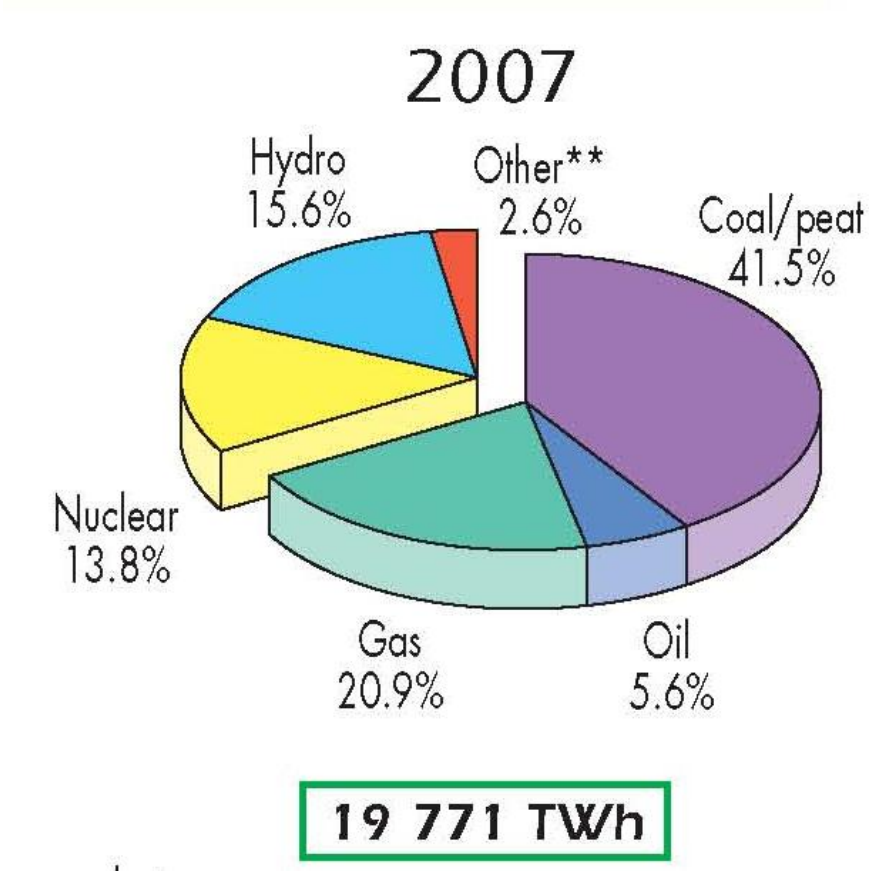
8%

Gas	TWh
United States	915
Russian Federation	487
Japan	290
Italy	173
United Kingdom	164
Islamic Rep. of Iran	160
Mexico	126
Thailand	97
Turkey	95
Spain	93
Rest of the world	1 527
World	**4 127**

31%

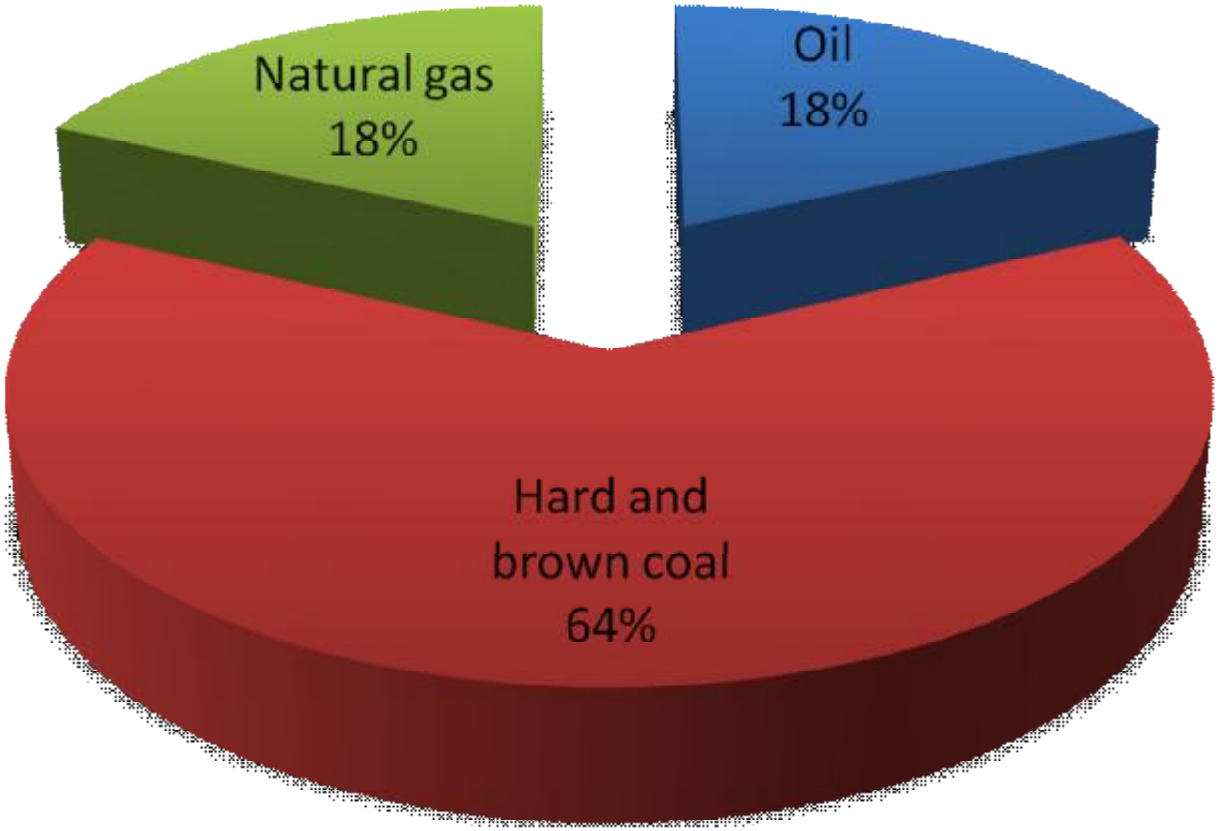
International Energy Agency
2007 data

Fuel Shares of Electricity Generation



International Energy Agency

World's Fossil Fuel Reserves



Countries with Primarily Coal-Dependant Electricity

Country	% of coal based electricity generation
Germany	49%
USA	50%
Greece	59%
Czech Rep.	61%
Maroco	67%
India	69%
Kazachstan	70%
Israel	76%
China	78%
Australia	79%
South Africa	92%
Poland	95%

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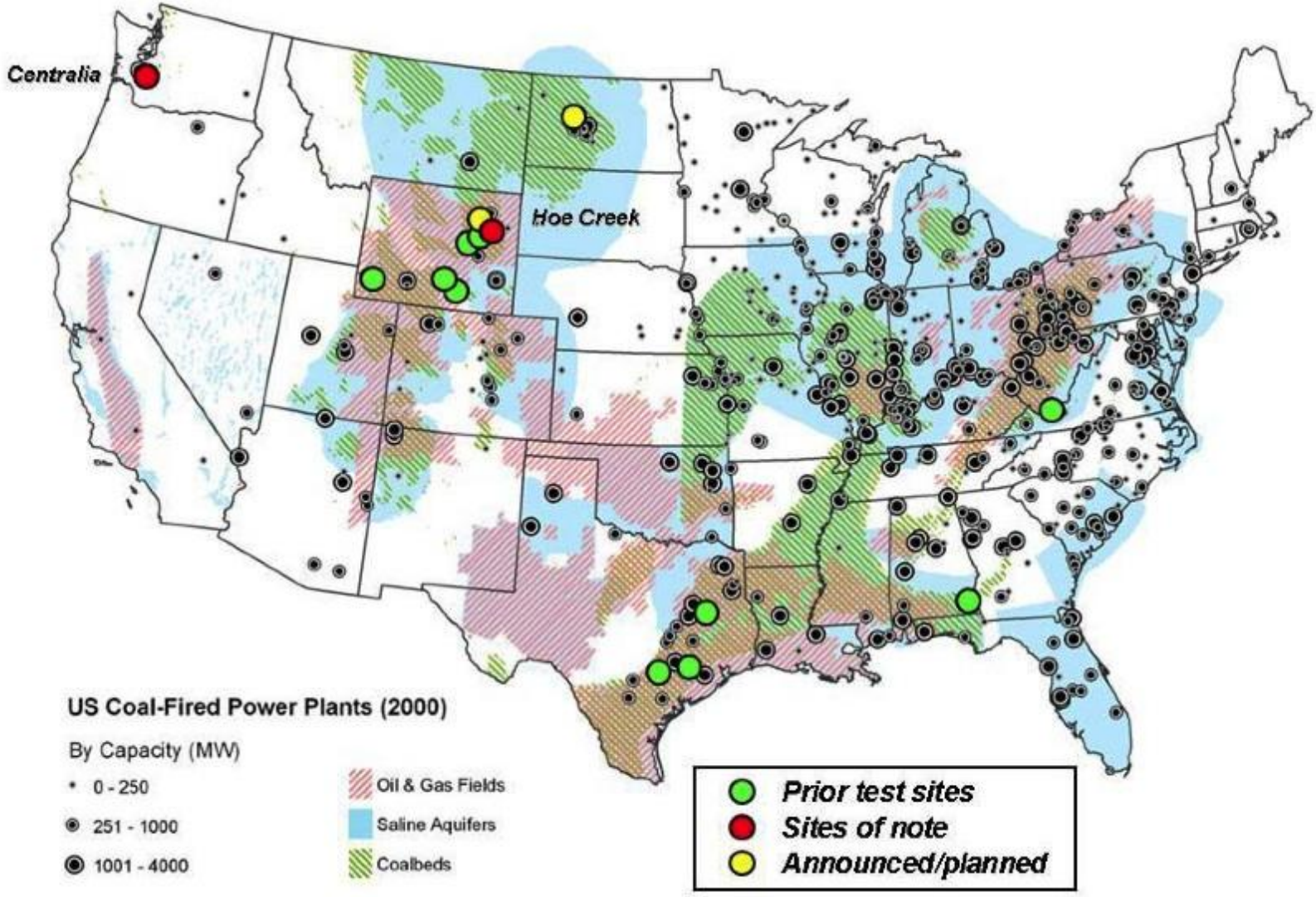
Coal in US Electrical Energy Production



Bradshaw & Dance, 2005

Electrical Energy Demand of Poland by 2030

Annual rate of increase	3%
Generation capacity	**35 GW**
Need to be retired by 2030	**15 GW**
Generation capacity required in 2030	**65 GW**
New capacity needed by 2030*	**45 GW**

* 2 GW /year

Coal – a Principal Energy Source for Poland and for the USA

- Energy independance cannot be achieved solely by the use of currently under development “green” energy sources
- Fossil fuel resources have to be mobilized with greater efficiency, higher recovery rate, and “greener” technologies
- Coal used “as-usual” becomes unacceptable to environment-conscious nations

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Poland Actively Pursuing Green Coal Technologies

- Polygeneration plant in Kędzierzyn with CO2 sequestration

PKE
GRUPA TAURON
ZIELONA ENERGIA

Production Capacity:	**283 MWe; 125 MW_t**
Syn-Gas Production:	**1,42 blm Nm^3/year**
CO_2 sequestration:	3 100 000 Tonn/year
Ograniczenie emisji CO_2 :	**92%**
Investment:	**2 bln USD**

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Underground Coal Gasification

- Coal processed underground produces gases which provide hydrogen, synthetic gases, and heat
- Underground coal gasification has been studied in-situ since 1940's in all corners of the world
- More then 160 plants worldwide produce 50,000 MWt of syngas (Simbeck, 2002)

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Why UCG?

- Lower operational costs then conventional mining
  - Mining cost
  - Surface area
  - Transportation and storage
  - Refuse disposal
  - No surface gasification
- Safety issues in mining
- Unminable coal deposits
- Environmental advantages (controlled CO_2 ,NO_x, SO_x)

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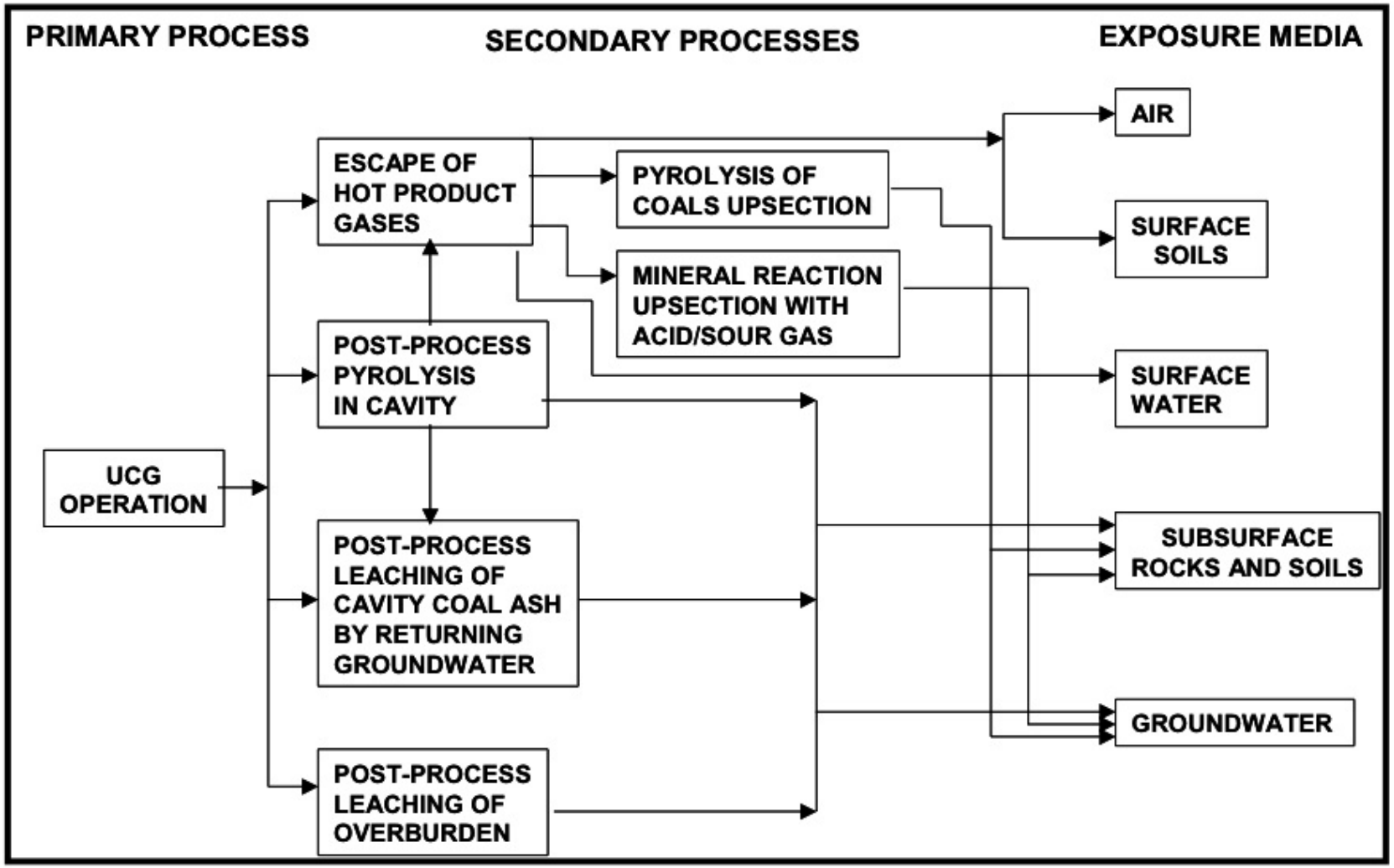
Risk Based Decision Making in UCG



LLNL Best Practice in UCG

PLRT and Pol-Tex Methan

- Principal elements of radical coal processing (Zakiewicz Method):
  - Super Daisy Shaft
  - Jet Stingers
  - Uniform, fine crushing (“rubblization”) propellant technology
  - Constant and progressive re-agitation
  - Process controls
- Principal advantages
  - Process CO_2 utilization and sequestration
  - Elimination of NOx and 80% of the energy needed for air injection
  - To-date unattainable coal seam extraction rate (over 80%)

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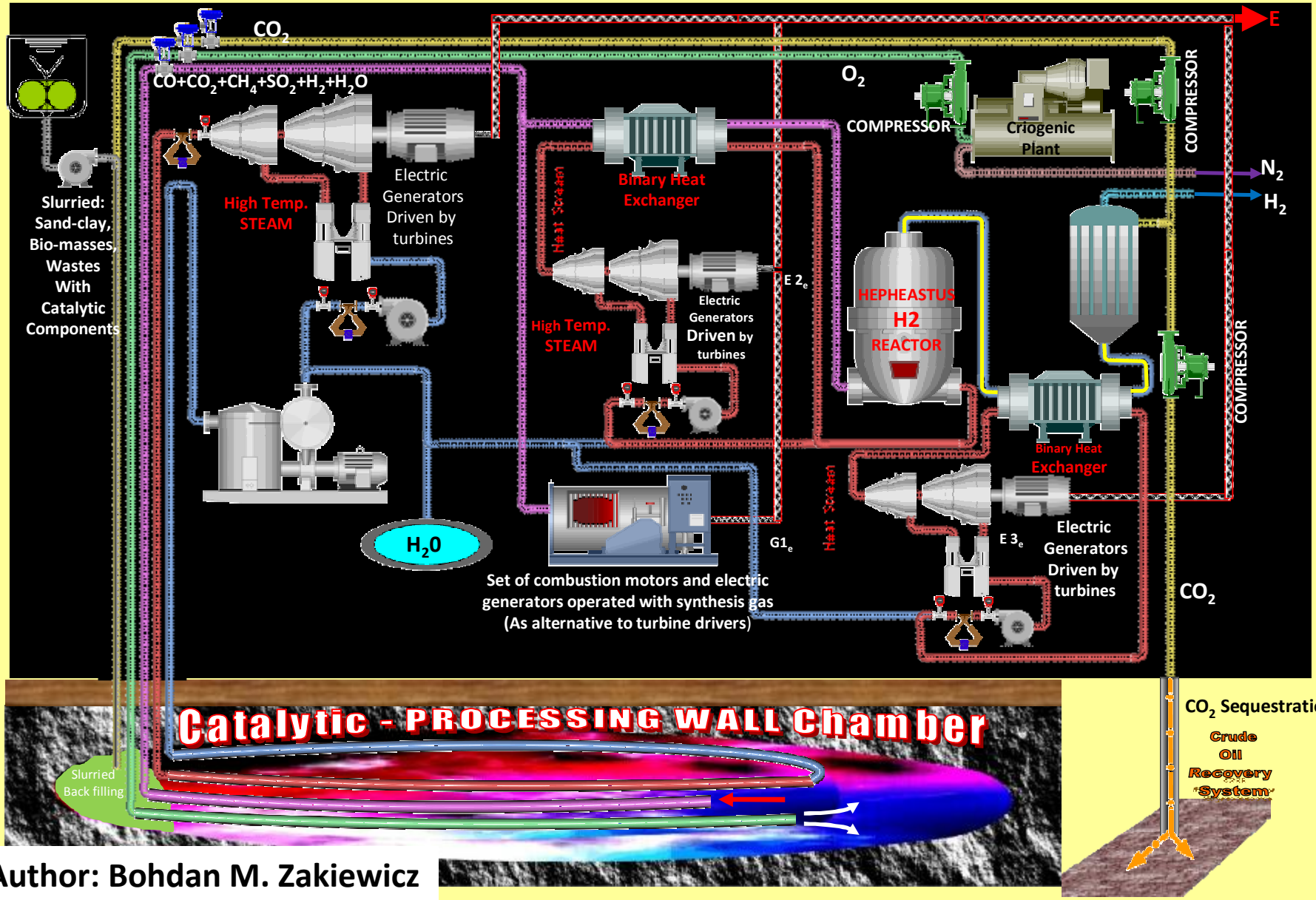
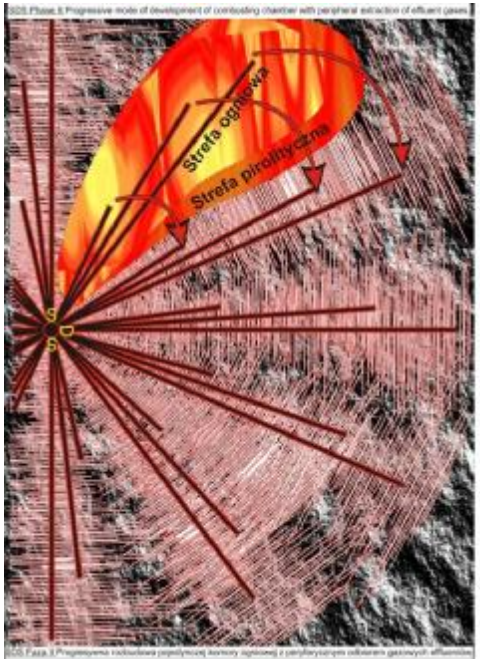
POLISH LABORATORY OF RADICAL TECHNOLOGIES

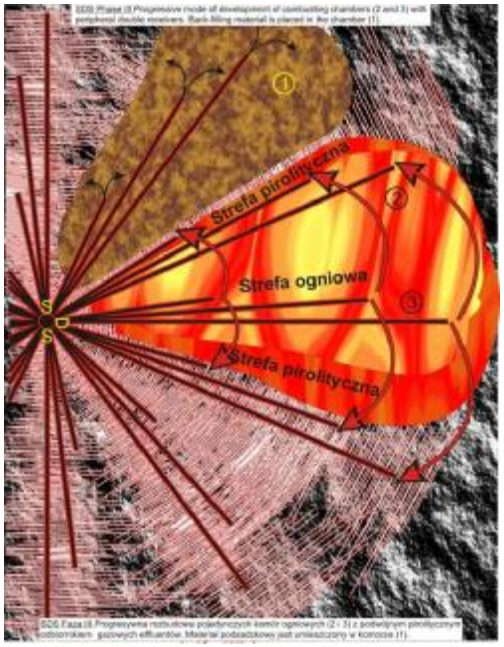
CEEC & Hydrogenium Suprematio Project

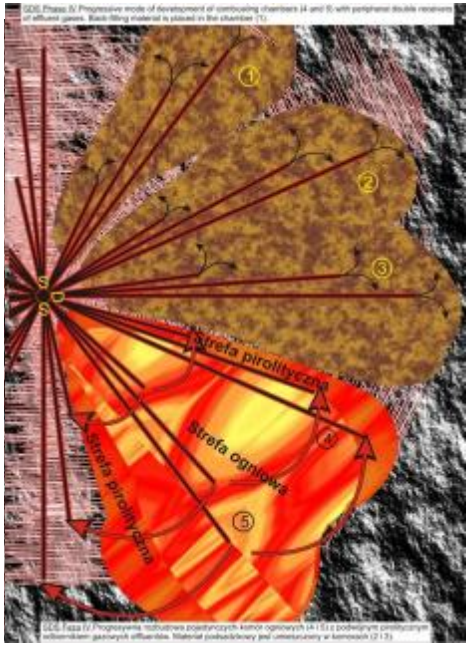


Author: Bohdan M. Zakiewicz

Integration of Mining and Pyrolisis Technologies







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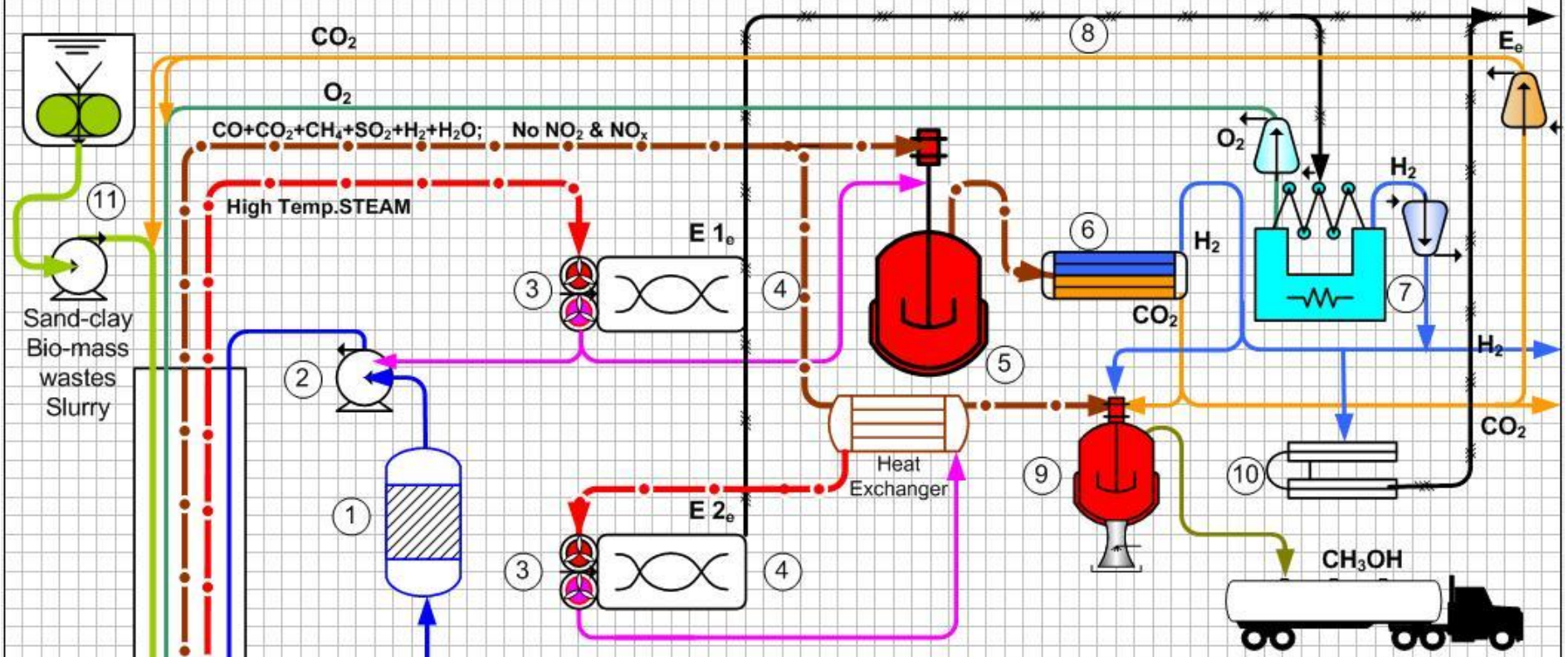
Consolidated Seven Rocks Mining, Ltd.

Hydrogenium Suprematio Project



Equipment List

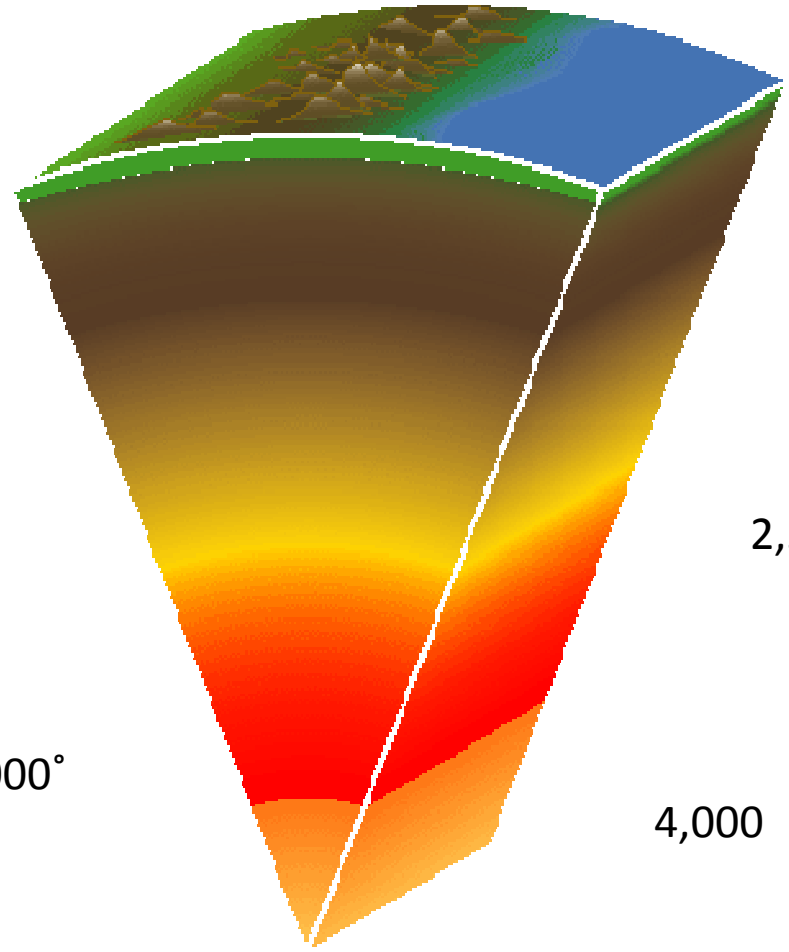
No	Description	Comment	Capacity
1	water conditioner	efluent to pump (2)	N/A
2	water pump	efluent to Jet Stingers and comb. chamber	N/A
3	steam turbine	high temp. high pressure from chamber	N/A
4	electric generator	for running electrolizer and for sale to grid	250 MW
5	hydrogen reactor	processing synthesis gas and steam	1 B cum/y
6	RTI gas separators/filters	separating H2;CO2;SO2;CH4;tail gasses	N/A
7	electrolizer w/ DC/AC conv.	generating H2 and O2 for coal combustion	N/A
8	oxygen compressor	injecting oxygen to combustion chamber	N/A
9	methanol reactor	processing synthesis gas; CO and steam	N/A
10	fuel cells users of hydrogen	generating inexpensive el.power	N/A
11	sand/clay slurry installation	back filling post-combustion chambers	N/A

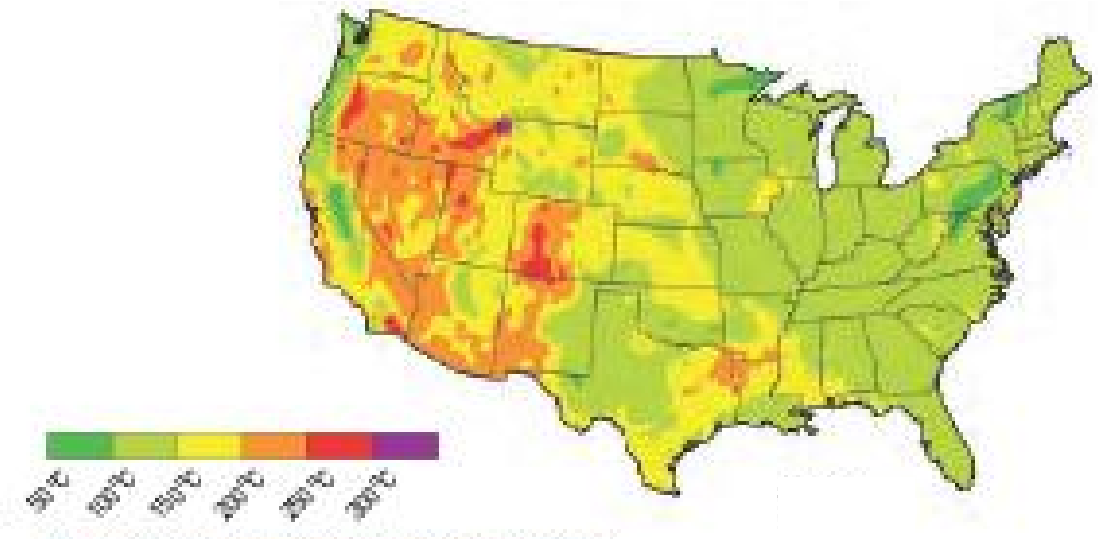
Author: Dipl.Eng. Bohdan M. ZAKIEWICZ, PhD

Temperatures in the Earth

Temperatures in Fahrenheit

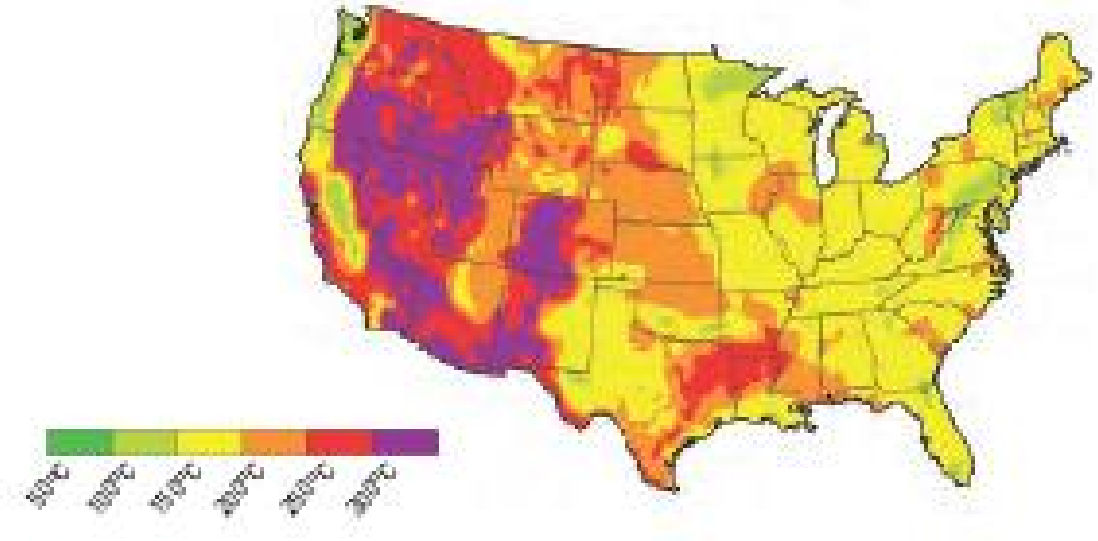
Depth in miles





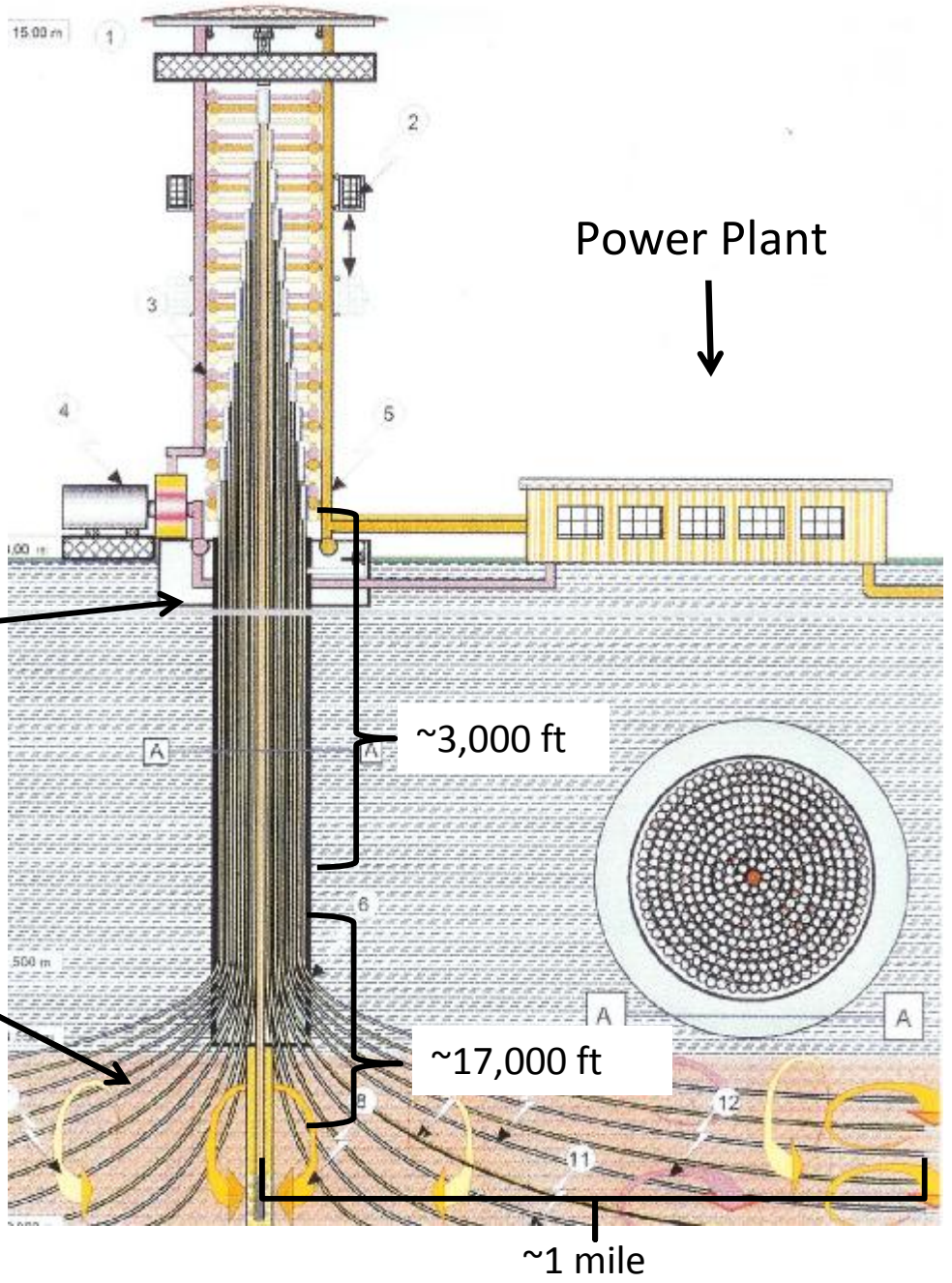
4 miles

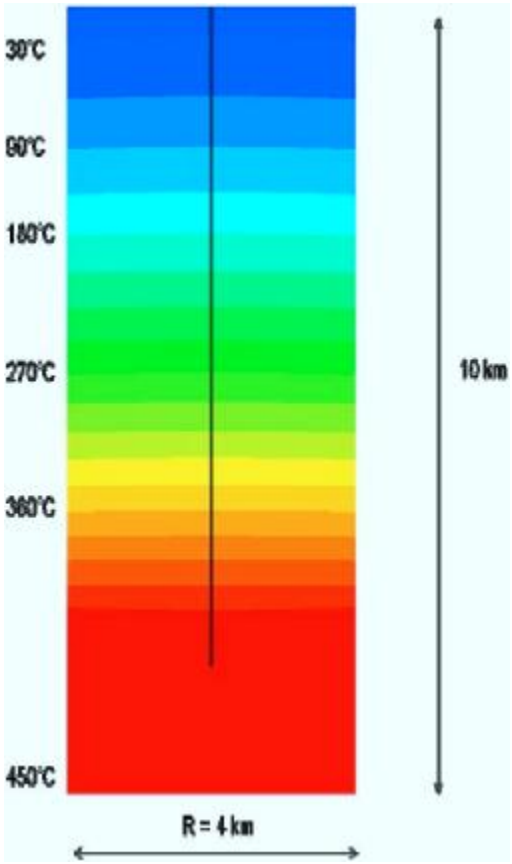
Subsurface Rock Temperatures

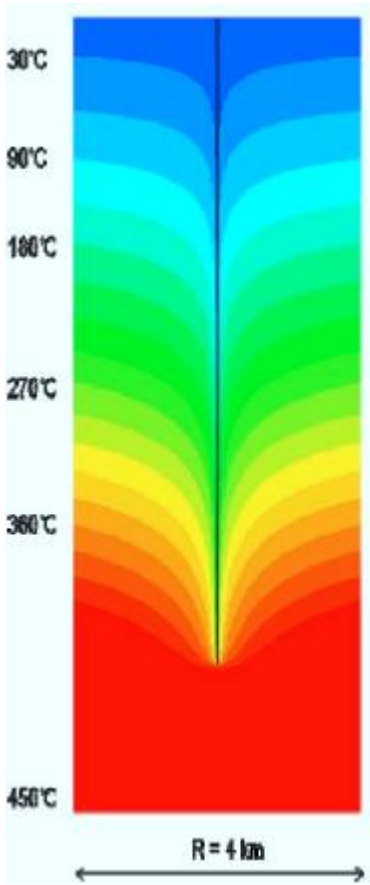


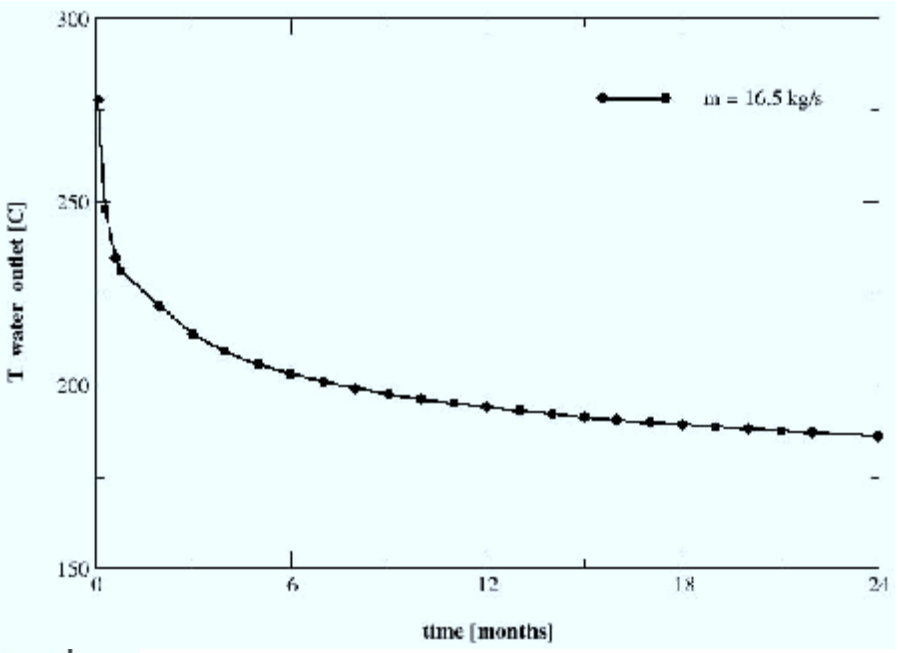
6 miles

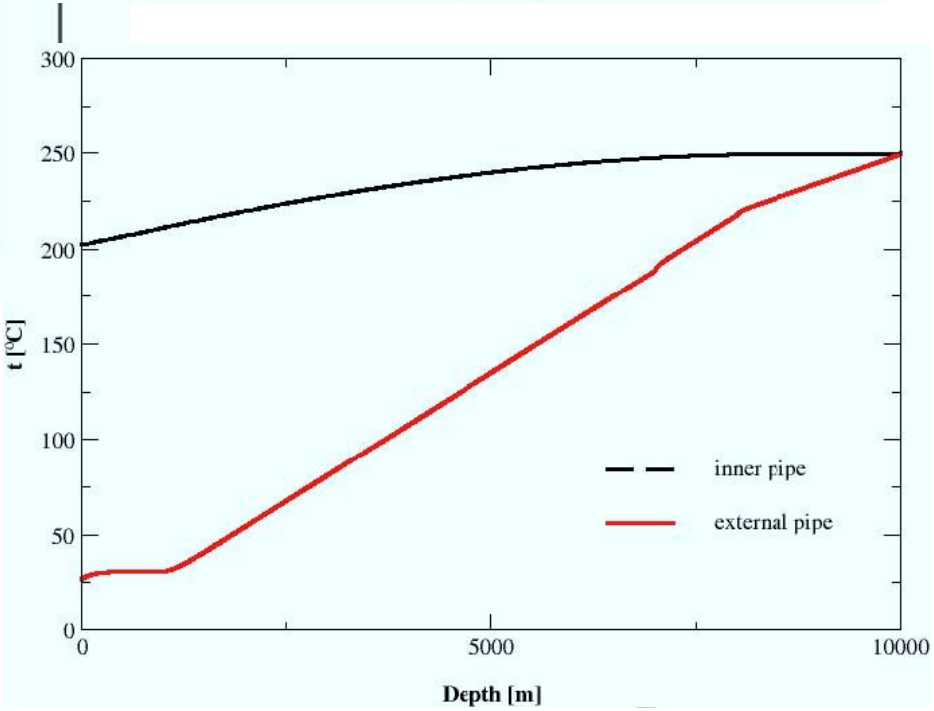
Geothermic Solution Technology



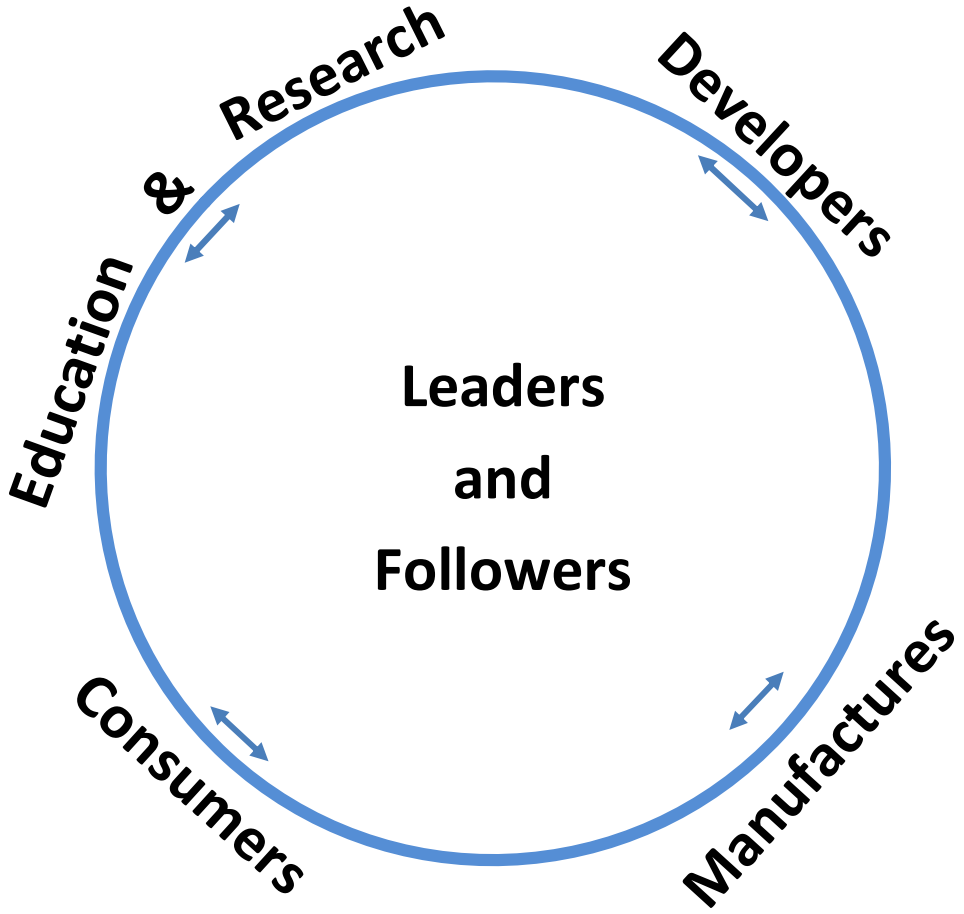

30°C
90°C
180°C
270°C
360°C
450°C
10 km
R = 4 km


30°C
90°C
180°C
270°C
360°C
450°C
R = 4 km


300
250
200
150
T water outlet [C]
m = 16.5 kg/s
0
6
12
18
24
time [months]


300
250
200
150
100
50
0
t [°C]
inner pipe
external pipe
0
5000
10000
Depth [m]

Challenges and Opportunities in Technology Transfer



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Conclusions & Recommendations

- Coal is, and will remain, an important element of Poland and U.S. energy and chemical sectors
- U.S. National Laboratories and corporations have a significant body of research in the area of underground coal processing; Poland is on the verge of implementing pilot UCP programs
- A joint effort between U.S. and Polish scientist/researchers should be carried out to develop *disruptive technologies* in order to harvest calorific and chemical value from coal
- Cooperation between U.S. and Polish scientists and technologists in the area of other renewable energies, i.e. EGS, should be stimulated

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Thank you!

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