Liquid
Coal

10030 Amberwood Road
Fort Myers, Florida 33913
(239) 561-1561
www.liquidcoal.com

Liquid
Coal

Enabling free men to resolve our country's addiction to imported oil

Bonne Posma
Liquid Coal Inc

01 May 2008

Our increasing addiction to imported oil since 1973

Liquid Coal

Echoing the nation's deep concern about our growing reliance on imported oil, President Bush has frequently stated that we must end our addiction to imported oil.

Going back to the 70's , the Nixon, Ford and Carter administrations and their successors have, over the past 35 years, initiated many "**Alternative Energy**" proposals to counter our growing foreign energy dependency.

These Alternative Energy Schemes have cost us hundreds of billions of dollars and include Solar, Wind, Tidal, Ethanol and Biomass energy sources as well as Hydrogen, and Advanced Battery energy storage projects.

Our increasing addiction to imported oil since 1973

Liquid
Coal

Over the past 25 years, we have not constructed a single new nuclear reactor, nor built a single new refinery, hobbled our coal industry with ill-conceived environmental laws , banned drilling for oil in Alaska and placed our Federal lands off-limit to oil and natural gas exploration.

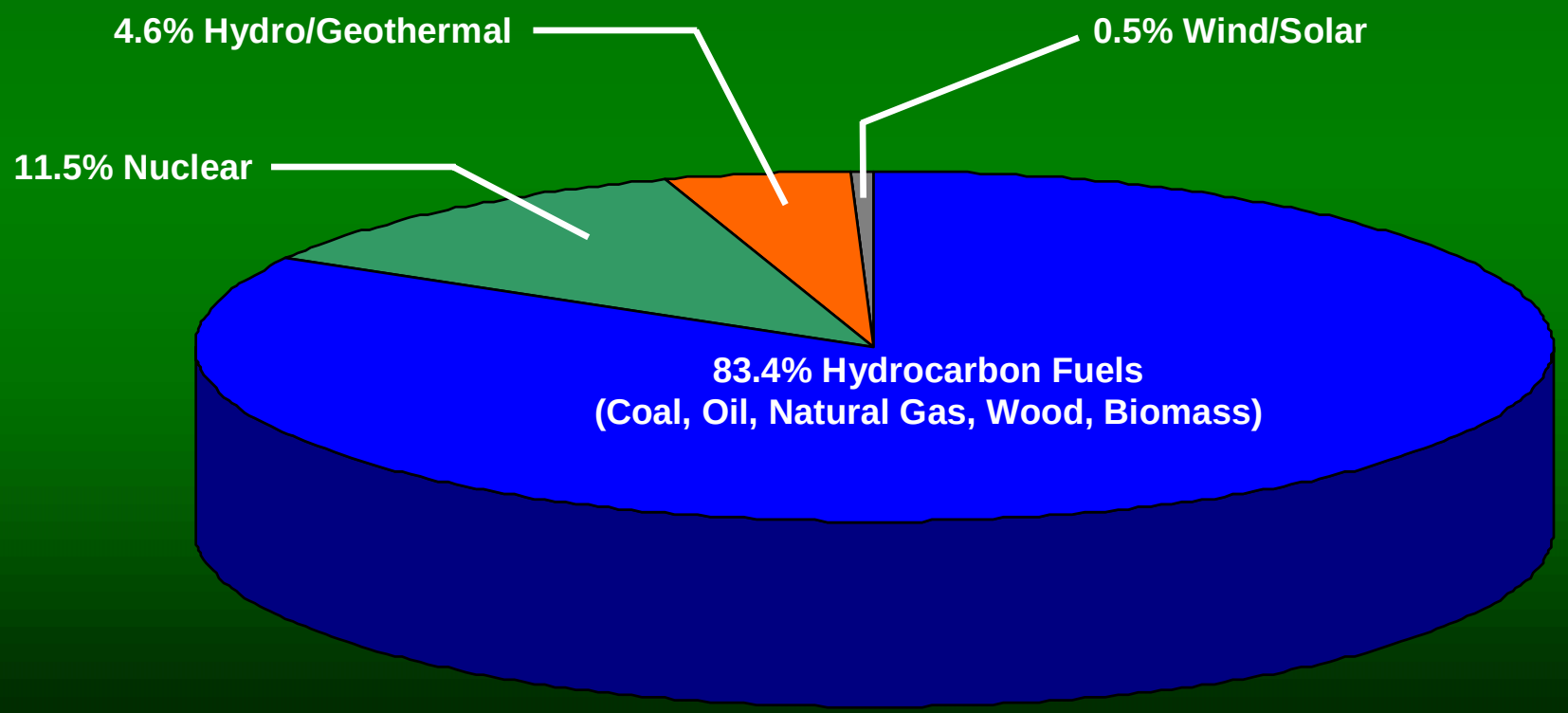
After all this huge expenditure on Alternative Energy, and legislation to hinder the growth of proven energy resources, where does our country gets its energy from **today**?

Liquid
Coal

Liquid
Coal

Present Sources for US energy Consumption

Source: Energy Information Administration / Annual Energy Review 2006



Liquid
Coal

What the present energy sourcing facts tell us

It is sad to say that the hundreds of billions of dollars taken out of our economy by way of grants, subsidies, tariffs, regulations and tax incentives have done nothing to lessen our dependence on imported oil – instead, they have made us more dependent.

As the facts clearly show, heavily subsidized "Alternative " energy sources only amount to an miniscule 0.2% of our total energy supply.

Without subsidies this number would be close to zero.

Liquid
Coal

What the present energy sourcing facts tell us

It is indisputable that Hydrocarbon Fuels and Nuclear Energy will continue to provide more than 96% of our country's energy for the foreseeable future (at least for the next 50 years).

Liquid
Coal

What about Coal to Liquid (CTL) and "Clean Coal" Technologies ?

A number of coal companies are presently involved in establishing CTL pilot plants using Fischer-Tropsch and Bergius Liquefaction processes.

Several power companies, including our local Tampa Electric Company are in the process of building "clean" coal-powered plants using IGCC (Integrated Gasification Combined Cycle) and SPC (Supercritical) technologies.

Liquid
Coal

What about Coal to Liquid (CTL) and "Clean Coal" Technologies ?

Several states are vying to build the flagship DOE clean coal "FutureGen" plant which will feature CCS (Carbon Capture and Sequester) technology.

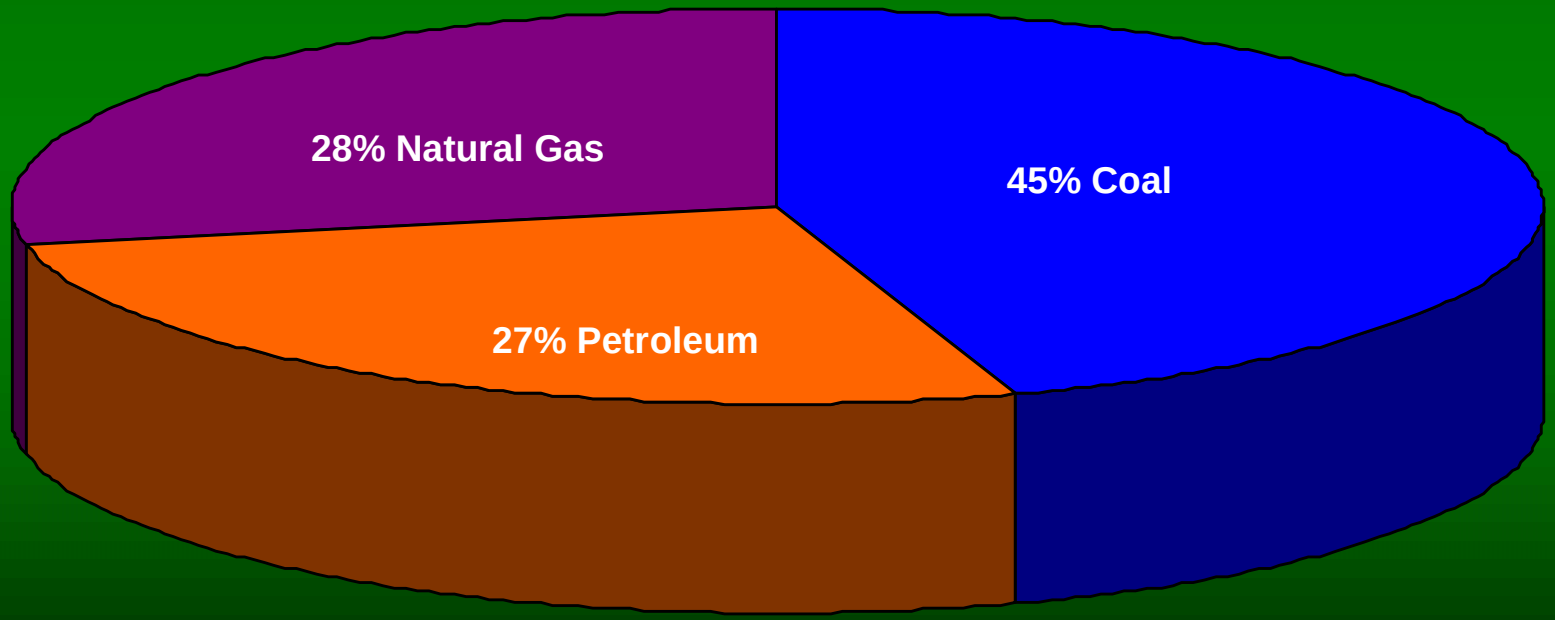
All of these schemes will be very costly, and waste tremendous amounts of energy when they will be forced to implement CCS.

However, if implemented, they will work.

Liquid
Coal

US Fossil Energy – 2004

(Howard Hayden, US Energy Facts – July 2006)



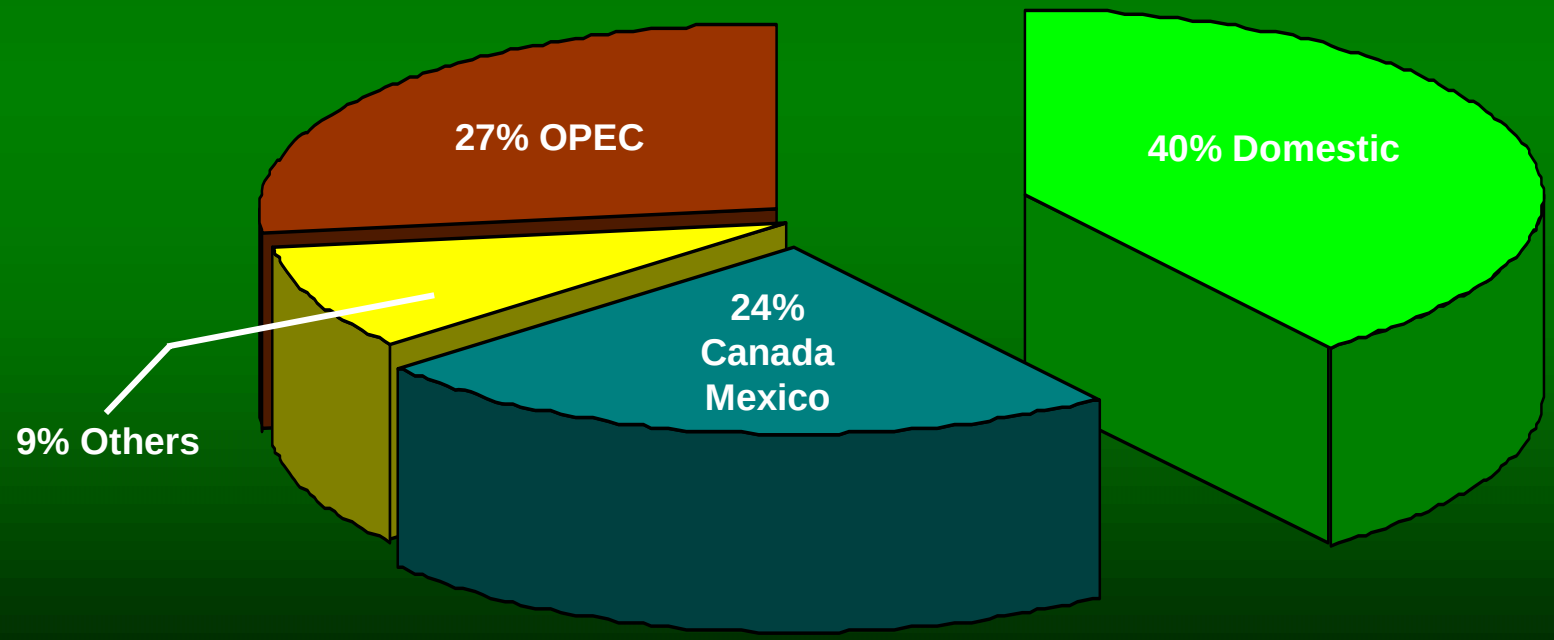
Note: 90% of our coal is used to generate electricity

Liquid
Coal

US Oil Consumption – 2005

(http://www.eia.doe.gov/neic/quickfacts/quickoil.html)

Total US Oil consumption: 21 million barrels / day



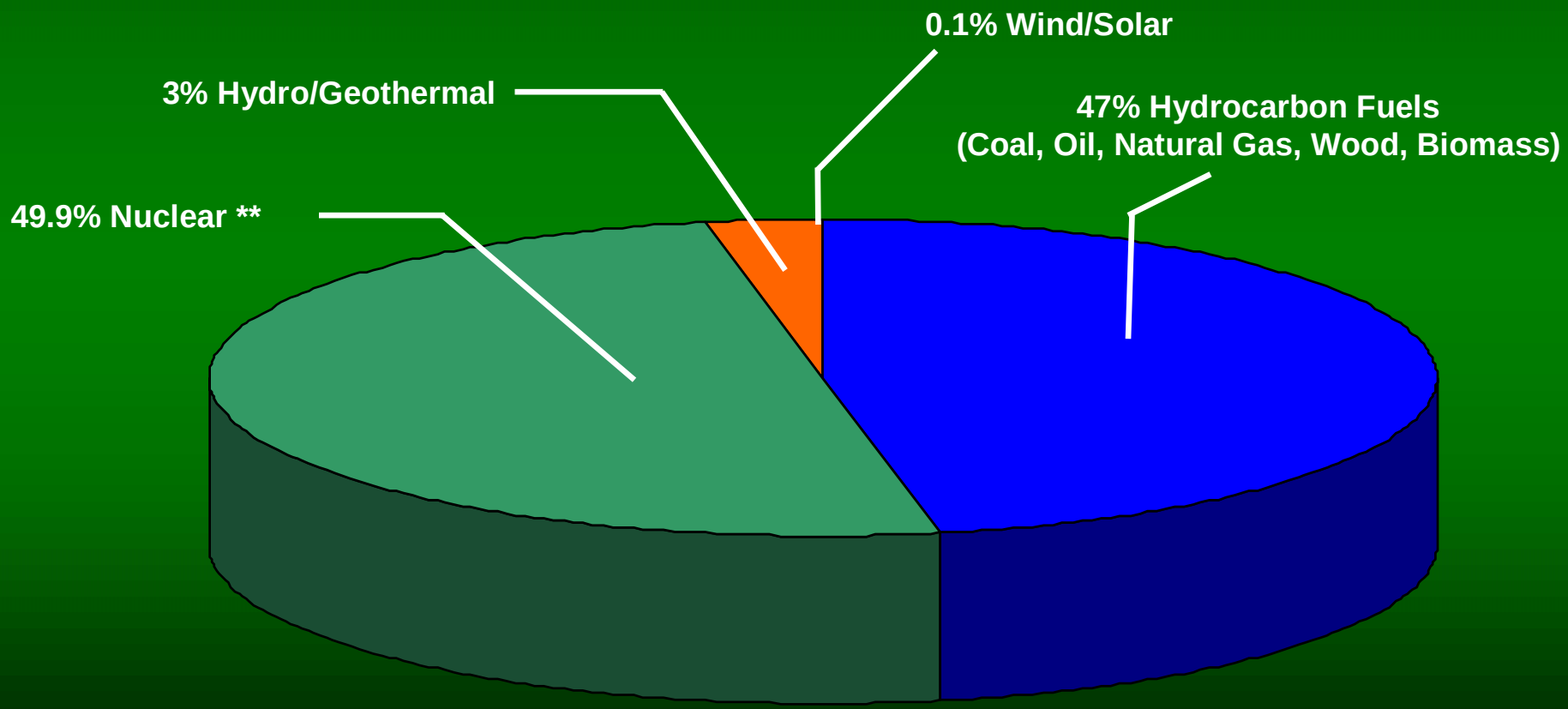
Liquid
Coal

Based on existing technology, Liquid Coal Inc advocates the following possible energy sourcing for the immediate future

- Nuclear Energy for generating electricity
- Nuclear Energy for Coal-to-Liquid process heat
- Coal-derived hydrocarbon fuels for transportation
- Home heating by nuclear-generated electricity and hydrocarbon fuels

Liquid
Coal

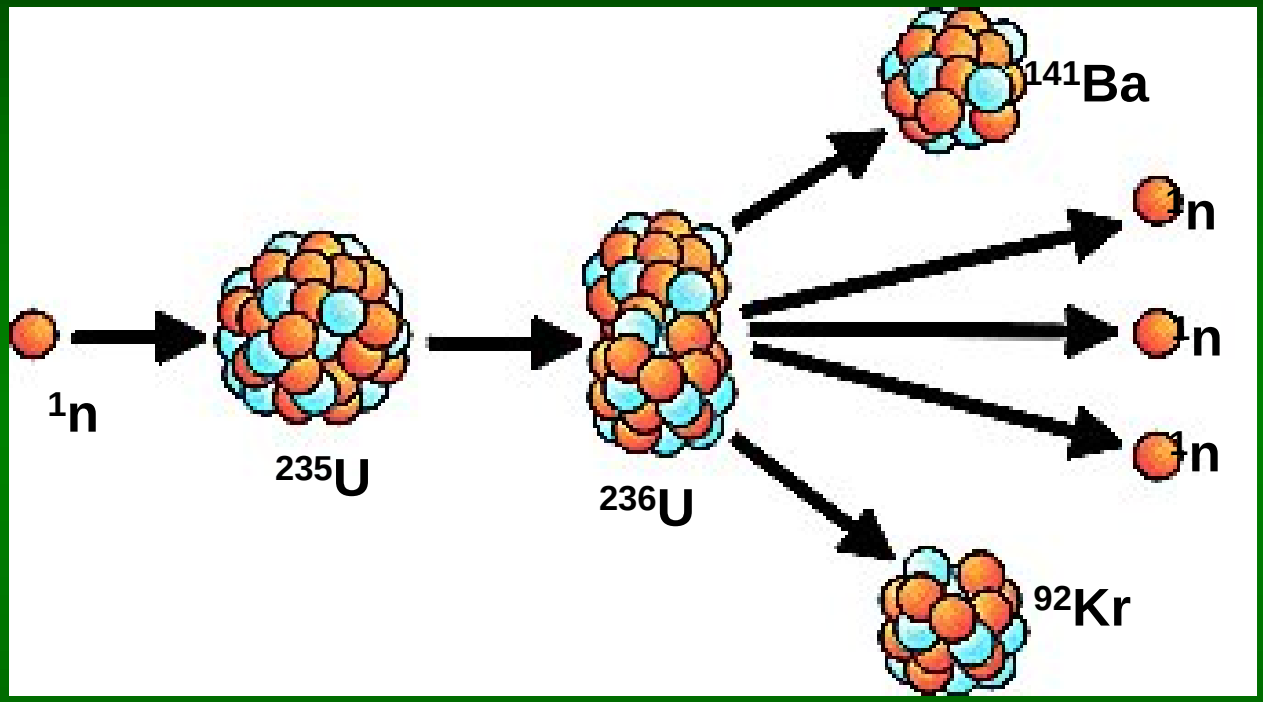
Possible energy sourcing mix for the next 50 years



** Nuclear energy for all of our electricity needs and to provide process heat for 200 CTL nuclear refineries rated at 320 MW each

Nuclear Energy

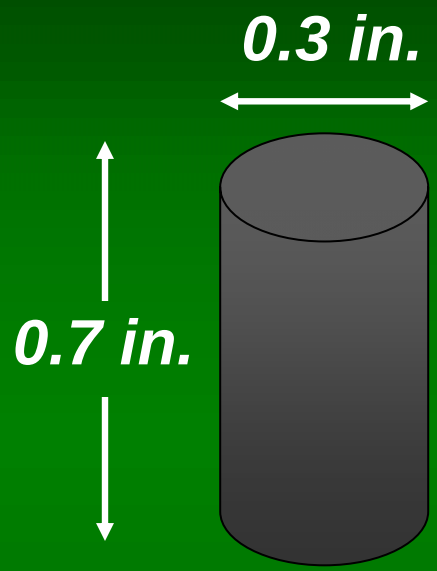
Liquid
Coal



When a slow neutron ^{1}n strikes a ^{235}U nucleus, it changes to ^{236}U which then breaks into smaller nuclei such as ^{92}Kr and ^{141}Ba, releasing 3 more neutrons and a large amount of energy.

Liquid
Coal

Nuclear Energy



One enriched uranium fuel pellet produces as much electricity as:

- 1 Ton of coal

Just 5 fuel pellets can provide the average U.S. household with all its electricity requirements for one year!

Fuel is a relatively small part of output energy costs – therefore nuclear energy costs should remain stable for many years.

Source: NEI

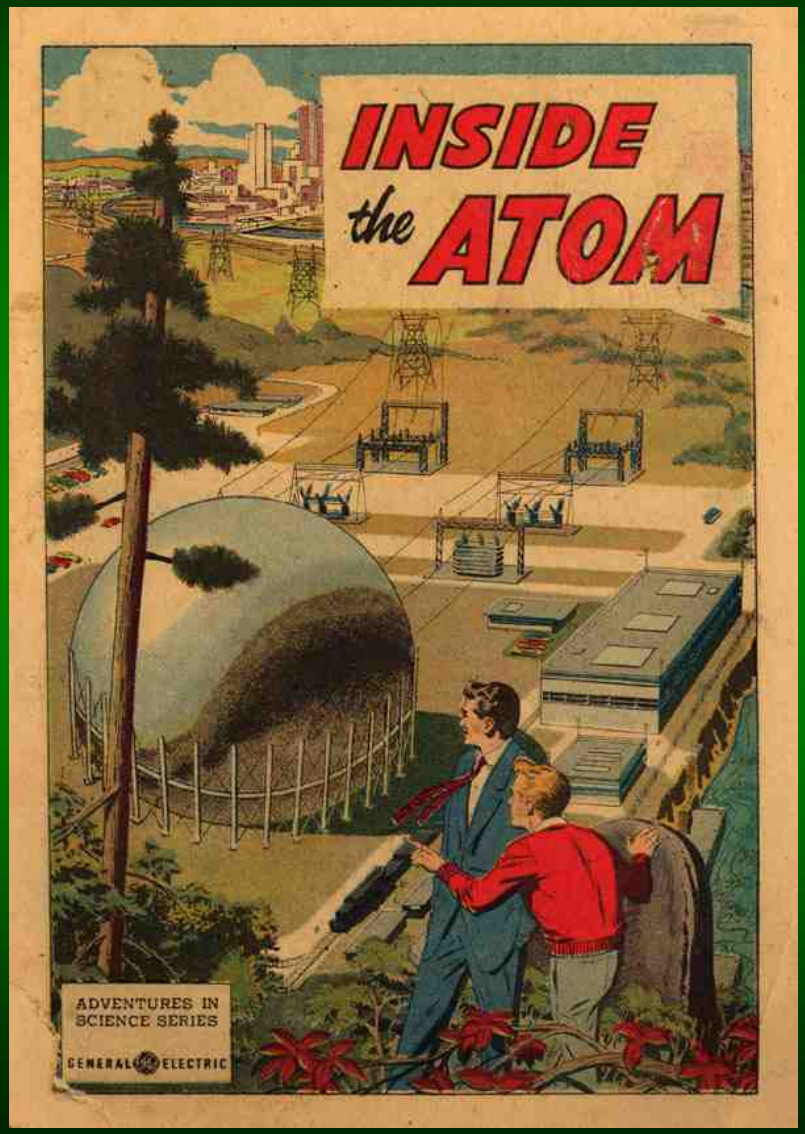
GE Inside the Atom

Liquid Coal

Beginning in 1946, General Electric began publishing what became a series of educational comics.

This issue was published in 1955.

Our country had a positive image about Nuclear Energy at that time. Unfortunately, as a result of misinformation, many people have unfounded concerns about the dangers of Nuclear Energy



Liquid
♦ Coal

Nuclear Process Heat

Pebble Bed Nuclear Reactor

What is a Pebble Bed Reactor?

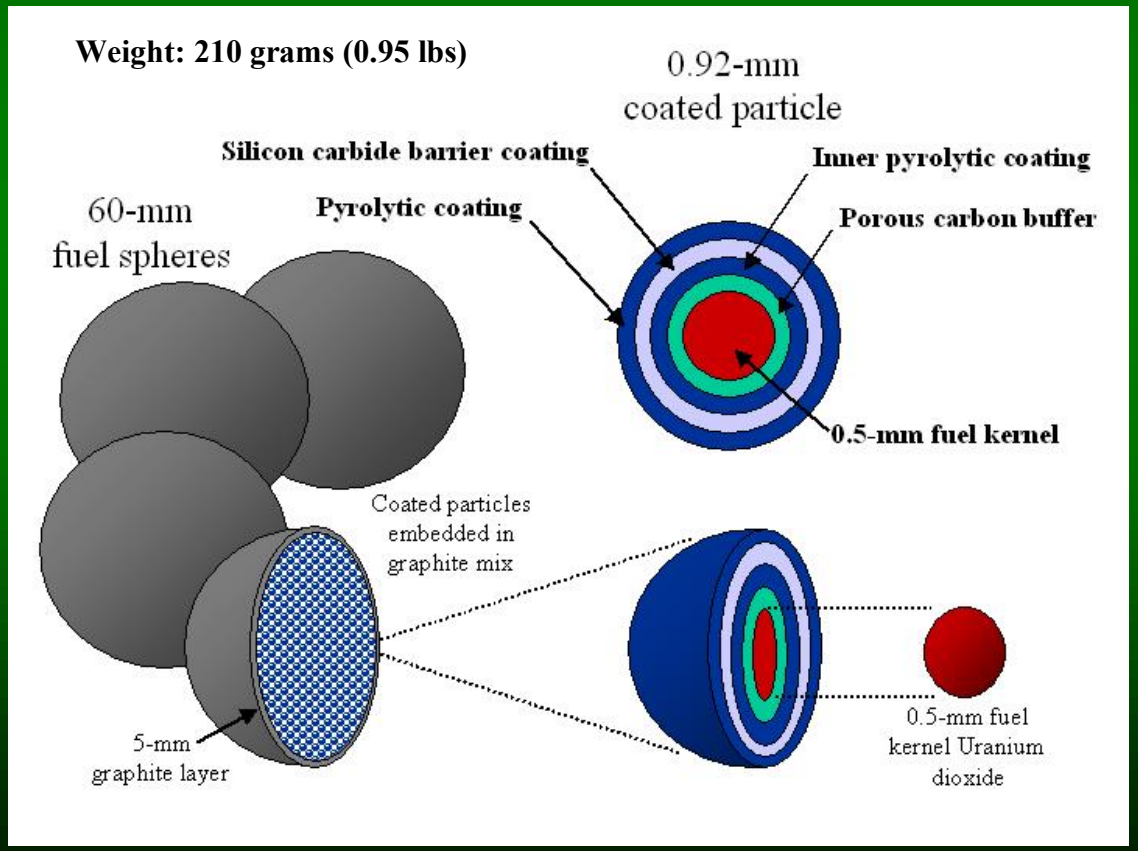
- Passive, inherently safe high temperature helium reactor;
- outlet temperature of 900° C => excellent for process heat uses;
- 450,000 fuel pebbles in core;
- about 2400 pebbles handled by Fuel Handling System each day;
- about 350 spent fuel pebbles discarded daily;
- one fuel pebble recycled every 30 seconds;
- average fuel pebble cycles through core 6 times over 3 years with final burn-up ~50% greater than LWR (light water reactor) fuel.

Liquid
Coal

Nuclear Process Heat

Pebble Bed Nuclear Reactor

Pebble Bed TRISO Fuel Sphere Cross Section

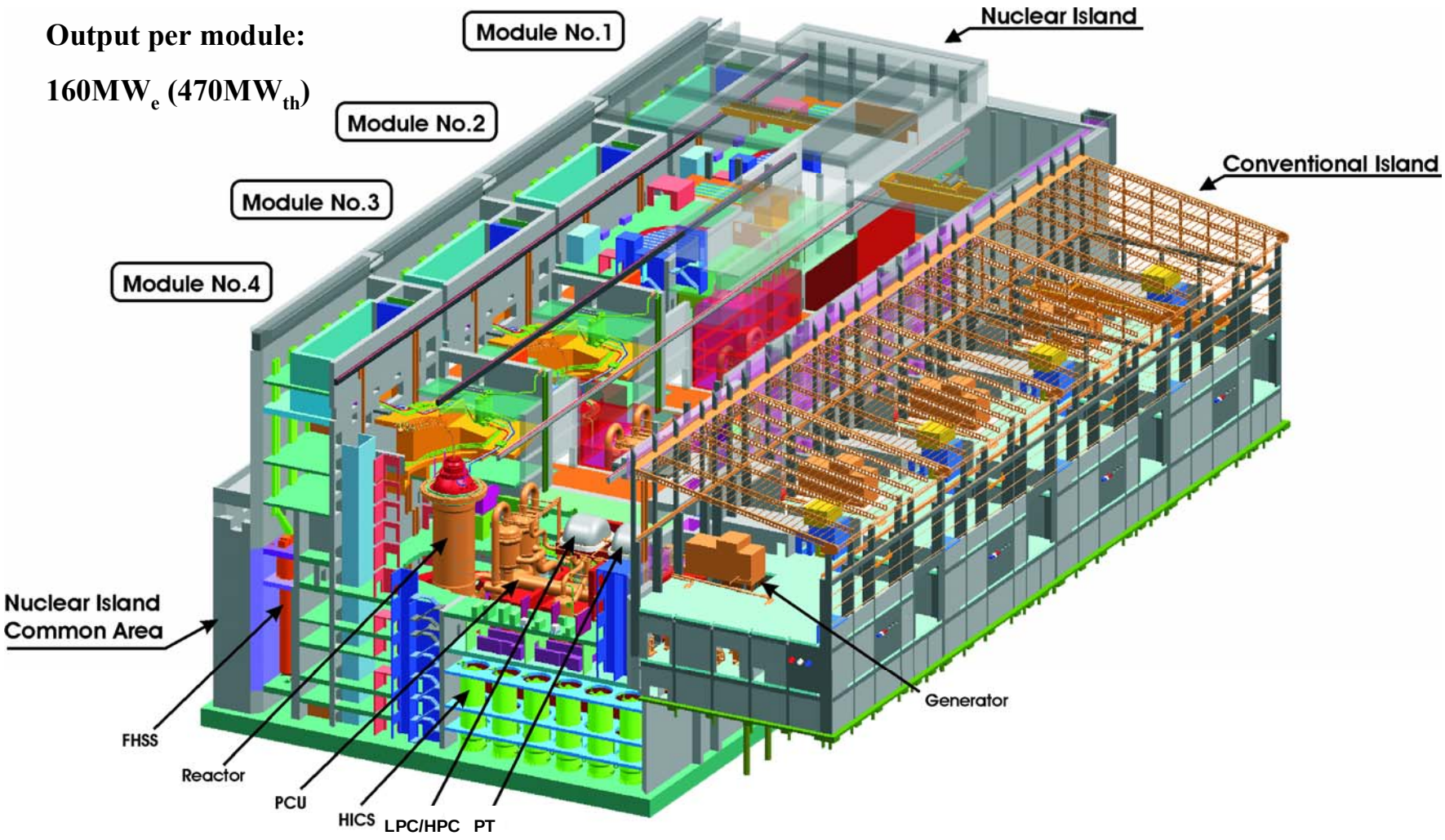


Liquid
Coal

PBMR Multi-Module Electric Plant Configuration

Output per module:

160MW$_e$ (470MW$_{th}$)



Liquid
Coal

Effect of 200 CTL Nuclear Refineries on imported oil

- Output per 320 MW_e CTL Nuclear Refinery: 50,000 barrels/day
- Output of 200 CTL Nuclear Refineries: 10,000,000 barrels/day

- Total amount of imported oil today: 12,000,000 barrels/day

- **RESULT: 83% Reduction in imported oil**

Liquid
Coal

Nuclear Safety

- France, which obtains 80% of its electricity from nuclear energy has reported ZERO deaths due to radiation-related accidents at power plants over a 40 year period.

- Three Mile Island Grand Disaster: (27 March, 1979)
  0 Deaths, 0 Injuries

- Chernobyl Melt-down (26 April, 1986)
  49 confirmed deaths after 20 years (source: 600 page report by the International Atomic Energy Agency)

- The USA Nuclear Power generating industry
  with 104 operating nuclear reactors, has had ZERO radiation-related deaths during almost 50 years of operation.

Liquid
Coal

Nuclear Safety

Chernobyl Deaths compared to other Disasters

Chernobyl (April 1986)	49
Banqiao Dam Collapse (Henan, China 1975)	26,000
Bhopal Disaster (India 1984)	18,000
London Great Smog SO_2 from burning coal (1952)	12,000
Johnstown Flood (PA, USA 1889)	2,209

Liquid
♦ Coal

Barriers to achieving Energy Independence

Obstacles to nuclear power plant construction :

The nation is fortunate that under the leadership of Chairman Dale Klein, morale at the NRC (Nuclear Regulatory Commission) is excellent – the NRC has recently won an award for being the best federal agency to work for.

The NRC is currently adding 200 officials to help speed up the processing of new applications.

Nonetheless, serious problems remain:

- Only 3 reactor designs have been approved during the past 10 years
- There is a minimum 42 month delay in the NRC approval process for new reactors
- In spite of being self-funded, recent $ 100M advance funding delays may hinder the NRC's hiring efforts to improve approval processing time.

Liquid
Coal

Barriers to achieving Energy Independence

Obstacles to nuclear power plant construction :

- The present rigid NRC fee structure makes the permitting procedure for small process heat reactors prohibitively expense :
  - $ 125,000 construction permit
  - $ 217/hour NRC staff fees during a long approval process
  - These result in total costs of $ 60M to $ 100M for ***each*** reactor approval application
  - Once in operation, there is a $ 4M/year fee for each power reactor, ***regardless of size***
- NRC's forthcoming standard review policies still in draft stage causing uncertainty in reactor design planning.
- Numerous time delays imposed by law to allow public comment periods add to approval time delays
- Restrictive state laws effectively prevent nuclear reactor construction in certain states. For example Kentucky KRS 278.605
- Some politicians and the media continue to exaggerate nuclear energy dangers.

Liquid
Coal

Barriers to achieving Energy Independence

The present energy sourcing dilemma is purely a political problem.

Our country has huge, untapped resources of oil, coal and natural gas that cannot be accessed because of obstructive legislation.

The nuclear industry has been hobbled by senseless restrictions that have made nuclear power generation far more expensive than it ought to be and that have prevented the construction of any new power plants since 1976.

The barriers to oil and gas exploration such as the ill-considered ban on drilling for oil on Federal Lands and in the Alaska ANWAR basin are well known and will not be repeated here.

Liquid
♦ Coal

Liquid
♦ Coal

Let's look at "Clean Coal" Technology

(1) Convert coal to "SynGas" (H_2 and CO), generating the process heat by Burning Coal (1300ºC)

(2) Capture CO_2 emissions, compress or liquefy this gas, store and transport to suitable site where this CO_2 is injected underground

(3) Both steps waste an enormous amount of precious coal.

Liquid
♦ Coal

Carbon Sequestration and the Danger of CO_2 Suffocation

- CO_2 gas is 50% heavier than air and if suddenly released will drift to low-lying areas, suffocating all Oxygen-breathing creatures
- 21 August 1986 (4 months after the Chernobyl disaster) Lake Nyos in Cameroon emitted a cloud of CO_2 suffocating 1,800 people and 3,500 livestock
- During 1984, 37 people were suffocated at Lake Monoun due to a similar release of CO2

Liquid
Coal

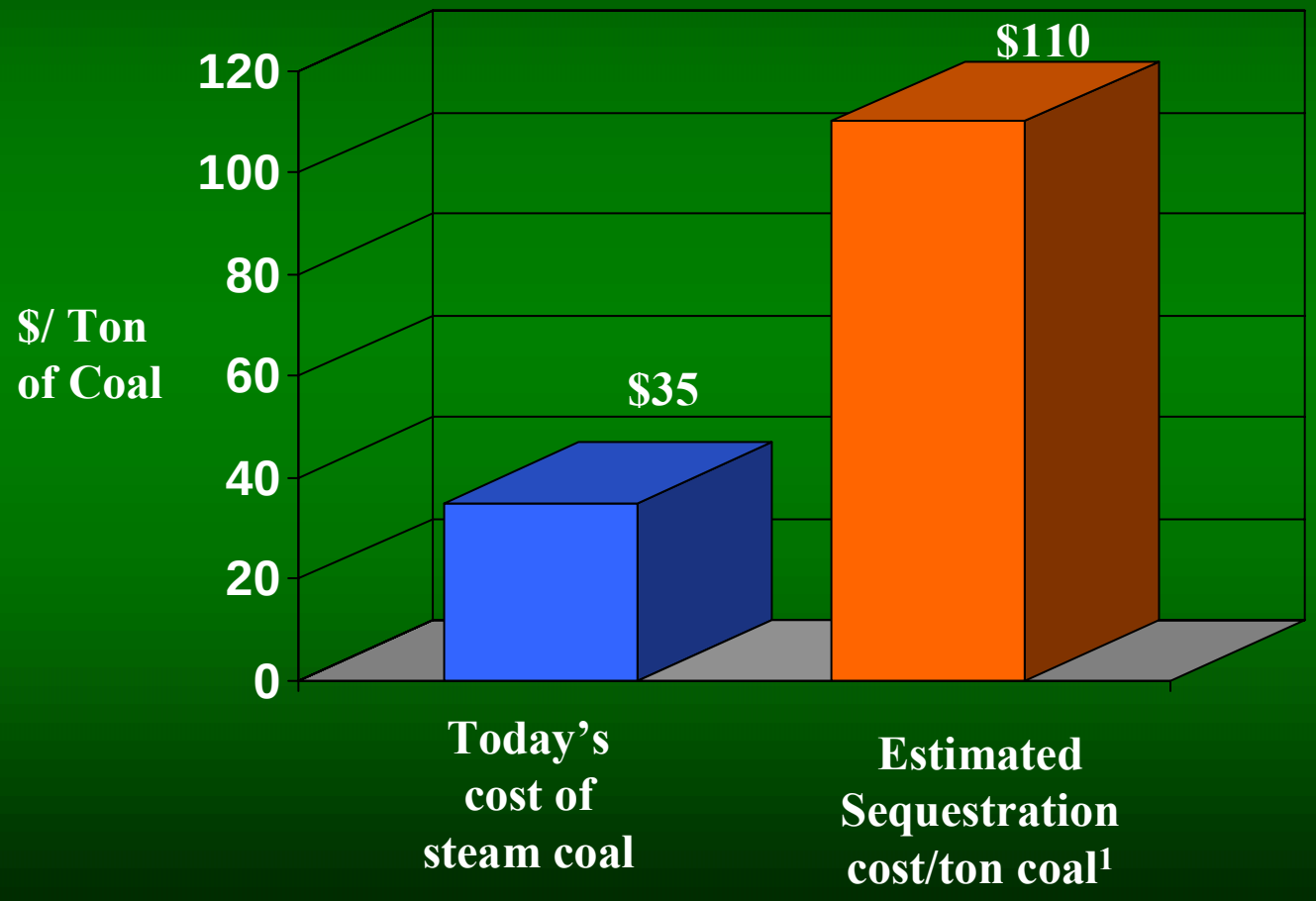
Carbon Sequestration and the Danger of CO_2 Suffocation

A clouded Lake Nyos, silty after a limnic eruption.

Cow killed by Lake Nyos CO_2 emissions.
Photo by Jack Lockwood of the US Geological Survey

Liquid
Coal

Cost of CO2 Capture and Sequestration (CCS)



(1) "MIT Executive study on the future role of coal as an energy source" © 2007 MIT

Liquid
Coal

Cost of CO2 Capture and Sequestration (CCS)

The same MIT report states:

"The scale of CCS required to make a major difference in global greenhouse gas concentrations is massive."

For example, sequestering one gigatonne of carbon per year (nearly 4 gigatonnes of carbon dioxide) requires injection of about 50 million barrels per day of supercritical CO_2 from about 600 1000MW_e of coal plants.

Liquid
Coal

Converting Coal to Liquid Fuel

(1) **Fischer-Tropsch (FT) Process (indirect coal liquefaction)**

Developed in Germany in 1923

by Franz Fischer and Hans Tropsch

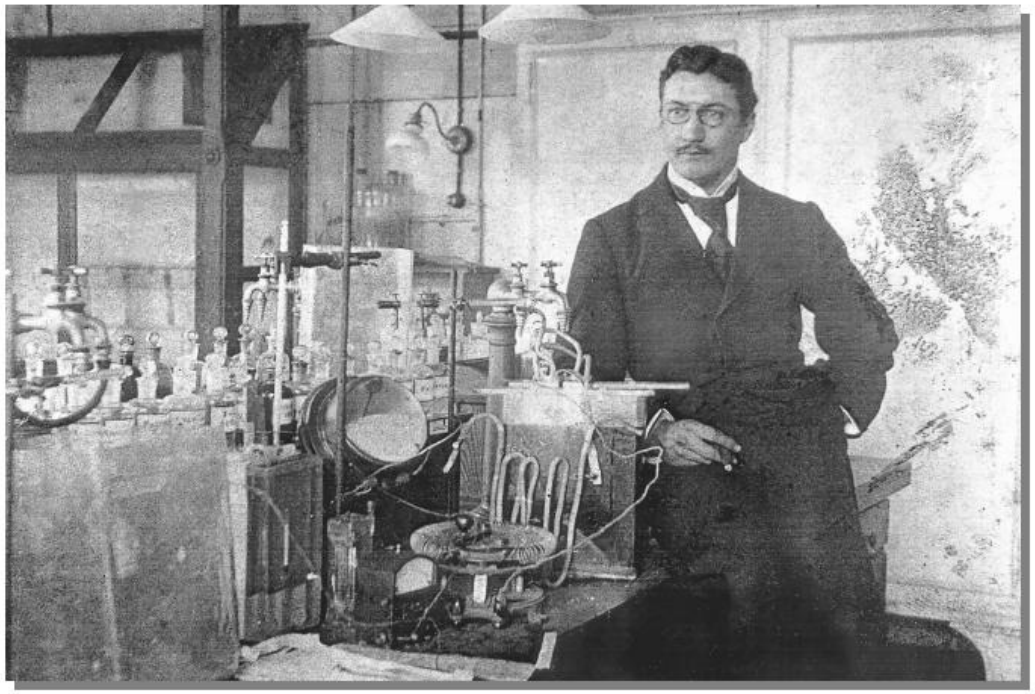
(2) **Bergius Process (direct coal liquefaction)**

Hydrogenation of Coal (combining Hydrogen with the Carbon in coal) developed in 1921 by Nobel Prize winner Friederich Bergius

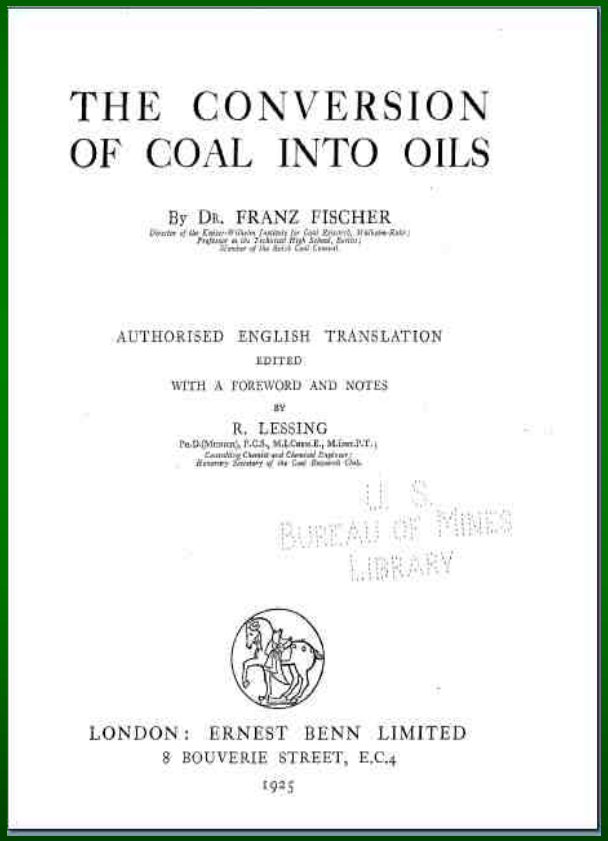
FT Process for Converting Coal to Liquid Fuel

Liquid
Coal

Franz Fischer at Work in 1918



Financial Mail 2000



THE CONVERSION OF COAL INTO OILS

By Dr. FRANZ FISCHER

AUTHORISED ENGLISH TRANSLATION
EDITED
WITH A FOREWORD AND NOTES
BY
R. LESSING

U. S. BUREAU OF MINES LIBRARY

LONDON: ERNEST BENN LIMITED
8 BOUVERIE STREET, E.C.4
1925

Liquid
♦ Coal

(1) FT Process (three stages)

- (1) $C + H_2O \rightarrow H_2 + CO$ (at about 1300°C)
- (2) $H_2O + CO \rightarrow CO_2 + H_2$ (gives off heat)
- (3) $(2n + 1)\ H_2 + nCO \rightarrow C_n\ H_{2n+2} + nH_2O$ (at about 300°C yields oil and water)

Liquid
♦ Coal

(2) Bergius Process

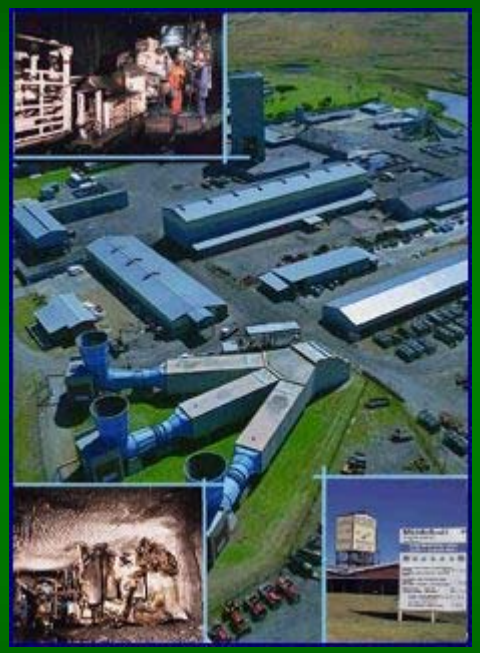
♦ $(n + 1)H_2 + nC \rightarrow C_nH_{2n+2}$ (at about 400°C and 2,500 psi))

Friedrich Bergius

Shared 1931 Nobel Prize in Chemistry with Carl Bosch

Liquid
Coal

FT Plants in South Africa



SASOL 150,000 barrels a day (6.3 million gallons) coal conversion plant - Secunda, SA

Liquid
Coal

Liquid Fuels

Liquid Fuels have an approximate ratio of 2 hydrogen atoms for every carbon atom. The table below shows the number of carbon atoms per molecule for different fuels. Coal typically has 0.8 hydrogen atoms for each carbon atom and to convert it to liquid (2:1 ratio hydrogen to carbon) hydrogen must be added.

Gasoline:	C_5 to C_{12}
Diesel:	C_{13} to C_{22}
Heavy Fuel Oil:	C_{23} to C_{70}

Liquid Coal's goal is to optimize a process producing $C_{16}H_{34}$ (cetane) which is diesel fuel.

Liquid
Coal

Coal Gasification

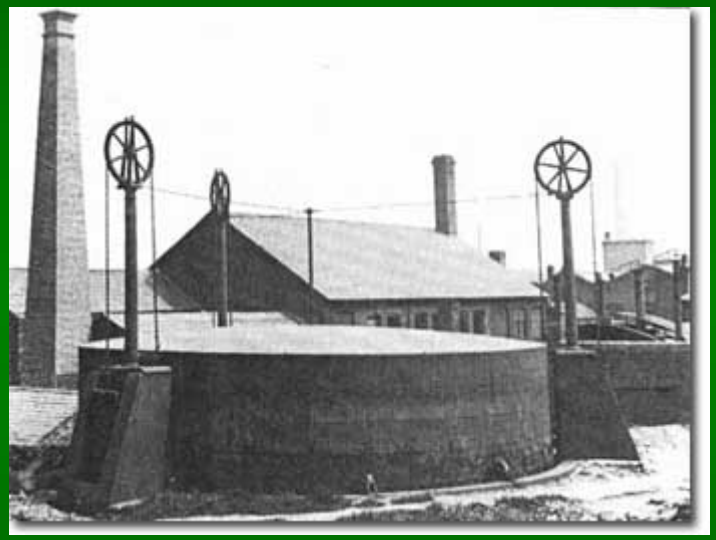
(first step in FT process – can also be used to produce Hydrogen for the Bergius Process)

- **Convert Coal to "SYN Gas"**

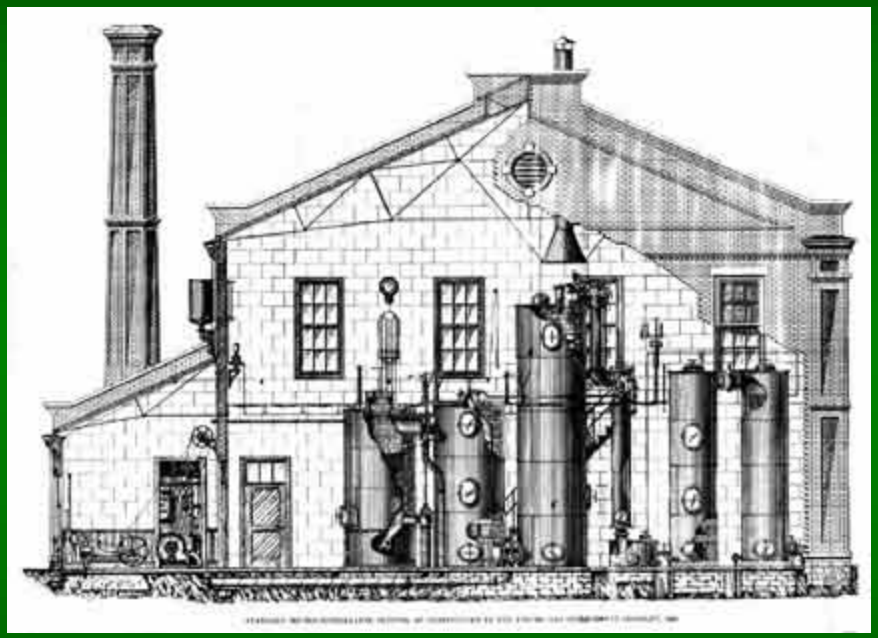
- **The precursors to "SYN Gas" were "Town Gas" and "Water Gas" invented simultaneously in the USA, Great Britain and Germany in 1805**

Liquid
Coal

Coal Gasification



William Murdock's Independent
Gas Supplier
(Birmingham, England, 1805)



United Gas Improvement Company,
of Philadelphia, in 1884

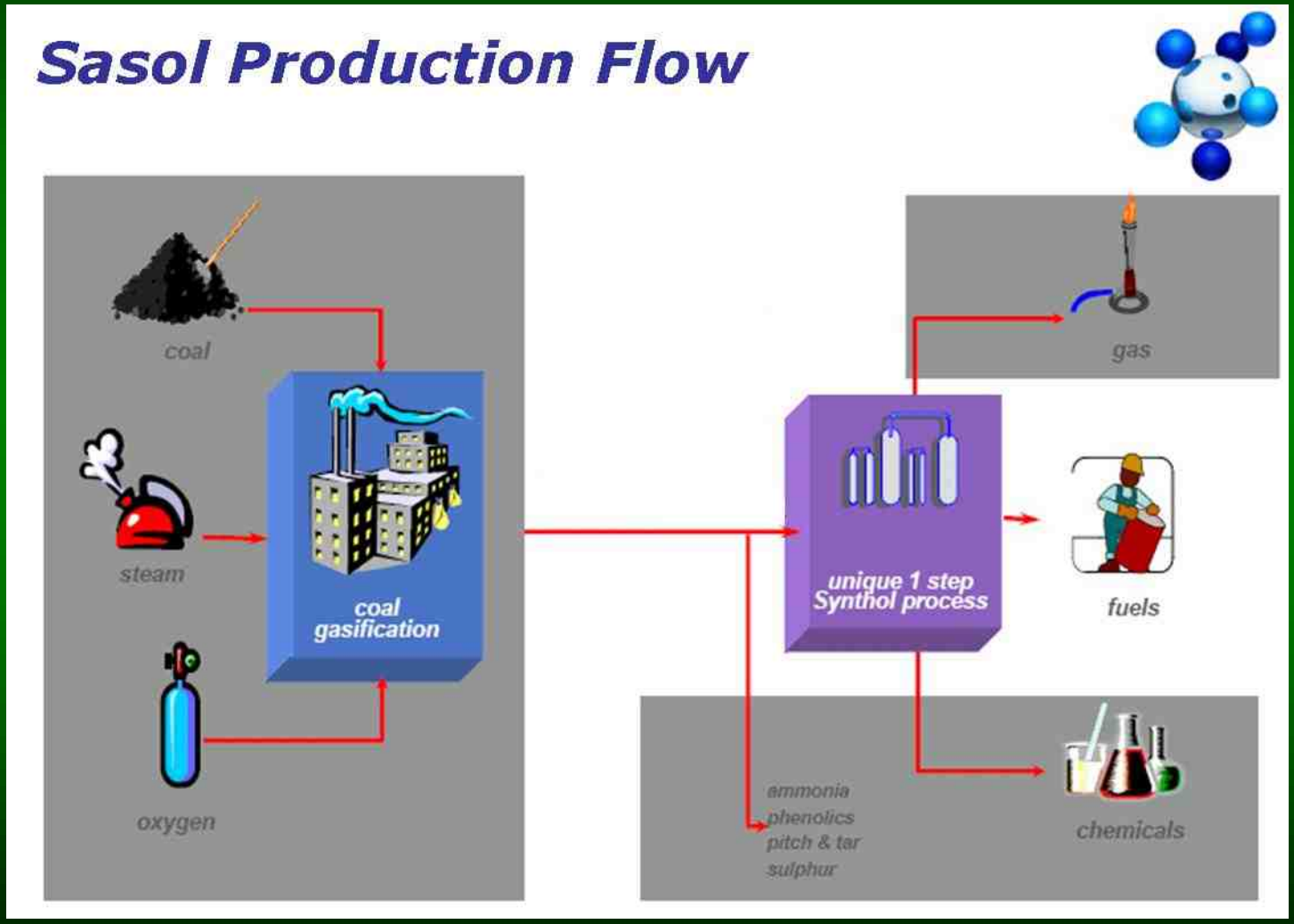
Liquid
Coal

Coal Gasification

- During the 1940's there were more than 20,000 Gasification plants in the USA.
- The increase in production of Natural Gas in the 40's and 50's, as well as the construction of a pipeline network for distribution, put Gasification plants out of business.
- Town Gas is toxic because of CO content, Natural Gas is not (mainly methane CH_4).

Liquid
Coal

Sasol Production Flow



Liquid Coal

F-T Liquefaction Process

Liquid Coal

- Generally Known as Indirect CTL Processing
- Used in South Africa and China

Disadvantages:

- As implemented today, it is dirty, wastes energy, complicated (but could be improved using new Clean Coal Technology)
- Burns almost one ton of coal for every ton converted to liquid fuel (Secunda burns 125,000 tons/day)

A Better Way:

- Direct Liquefaction (modified Bergius Process)

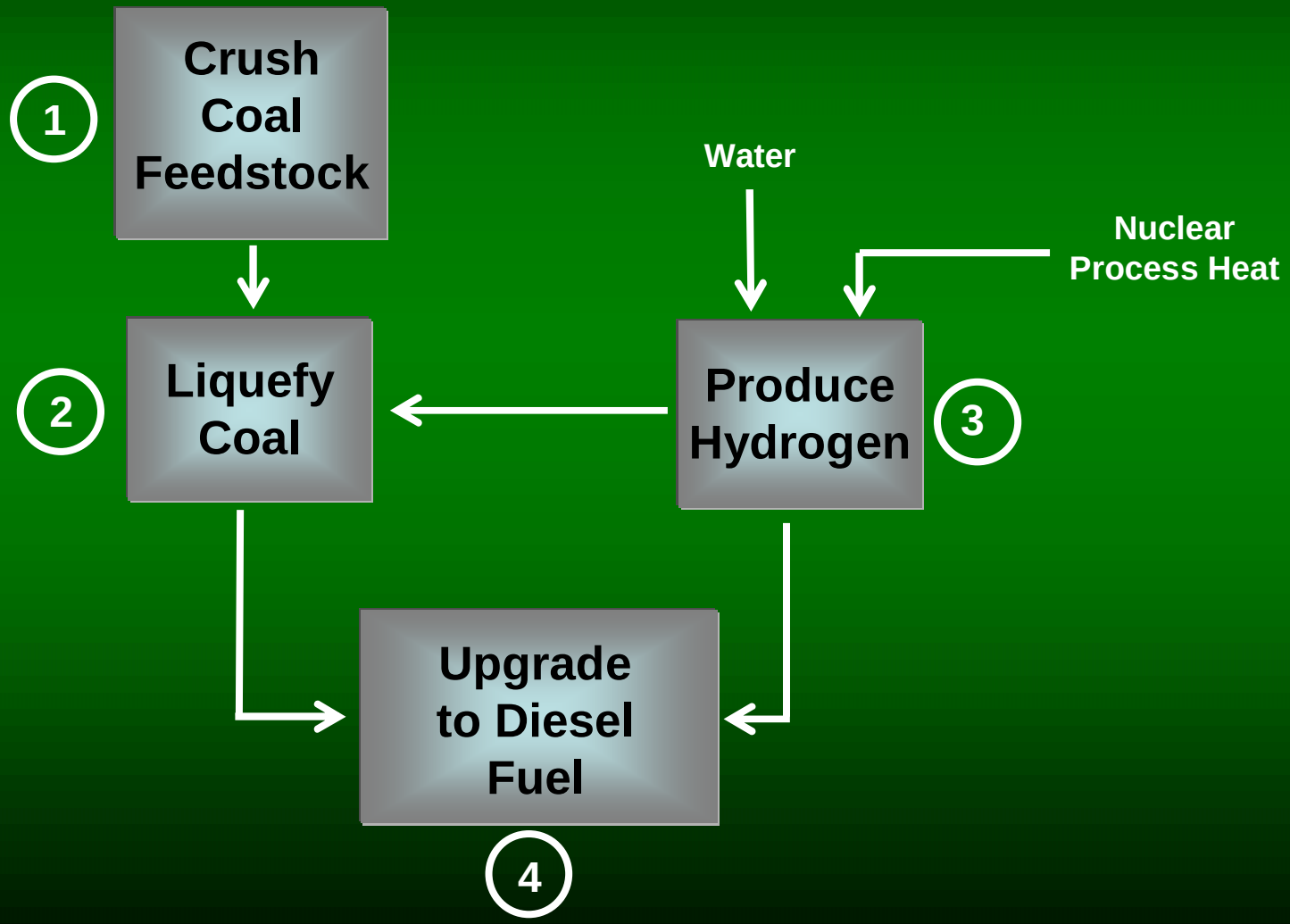
"Nowadays, several factors have emerged that may, individually or collectively, signal that the time for commercialization of direct liquefaction has come at last" H.H. Schobert [1]

(1) Schobert, H.H., Production of Diesel Fuel from Appalachian Coal and Hydrogen – a literature review – Dec 2006

(comprehensive CTL study financed by Liquid Coal Inc)

Liquid Coal

Preliminary Candidate Liquid Coal CTL Technology



Why Diesel Fuel?

Liquid
♦ Coal

- Diesel cars get 30% better mileage than gasoline cars
- Diesel Fuel has the HIGHEST specific energy of any liquid fuel
- In the past, Diesel Fuel contained 500ppm Sulfur, causing diesel emissions to exceed tail pipe emission limits. However, as of July 2006, ultra-low sulfur diesel fuel (less than 15ppm) has been phased in allowing new diesel cars to meet the most stringent emission regulations
- In South Africa, 100% of all diesel fuel is derived from coal (F-T process) and contains less than 5ppm sulfur
- In Europe, 60% of all autos are diesel powered, and in India it is 85%.
- Detroit is gearing up for the up-coming boom in diesel-powered cars with Daimler-Chrysler taking the lead by providing diesel engines in their 2008 Jeep Cherokees and other popular models
- Diesel Fuel is safe and has lower volatility than Gasoline. Coal derived diesel fuel is almost odorless
- An infrastructure to transport and dispense diesel fuel already exists

Liquid
Coal

The VW Jetta

- The VW Jetta*, pictured below can be provided with either a diesel or gasoline engine.

Diesel Mileage:
35 City 42 Highway

Gasoline Mileage:
22 City 30 Highway

Fuel Tank: 14.5 gallons

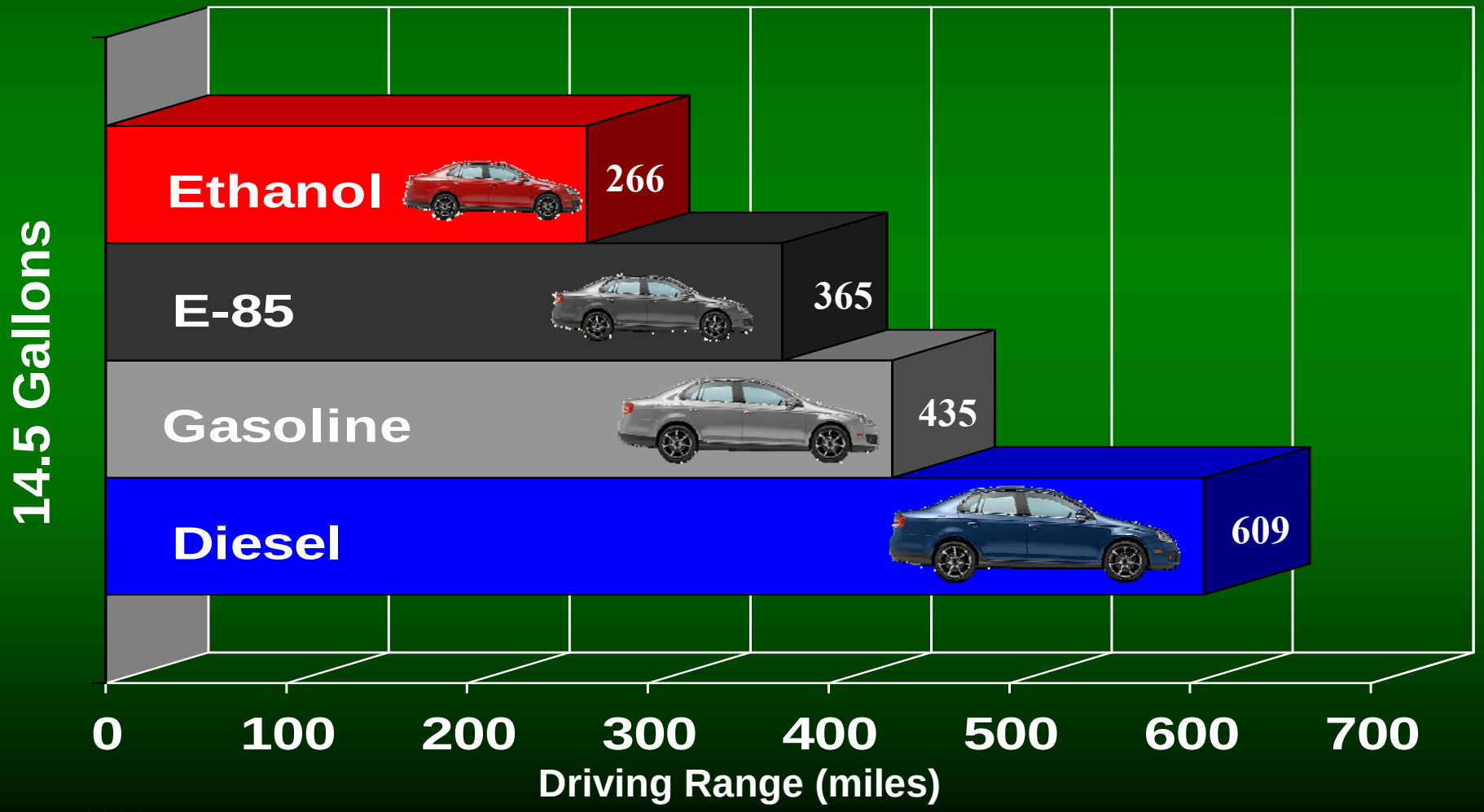
* This car will not be available from 2007 on because it was designed for operation with the older 500ppm Sulfur Diesel Fuel. In 2008, it will be replaced with a different VW model featuring a cleaner engine.

Liquid
Coal

Liquid
Coal

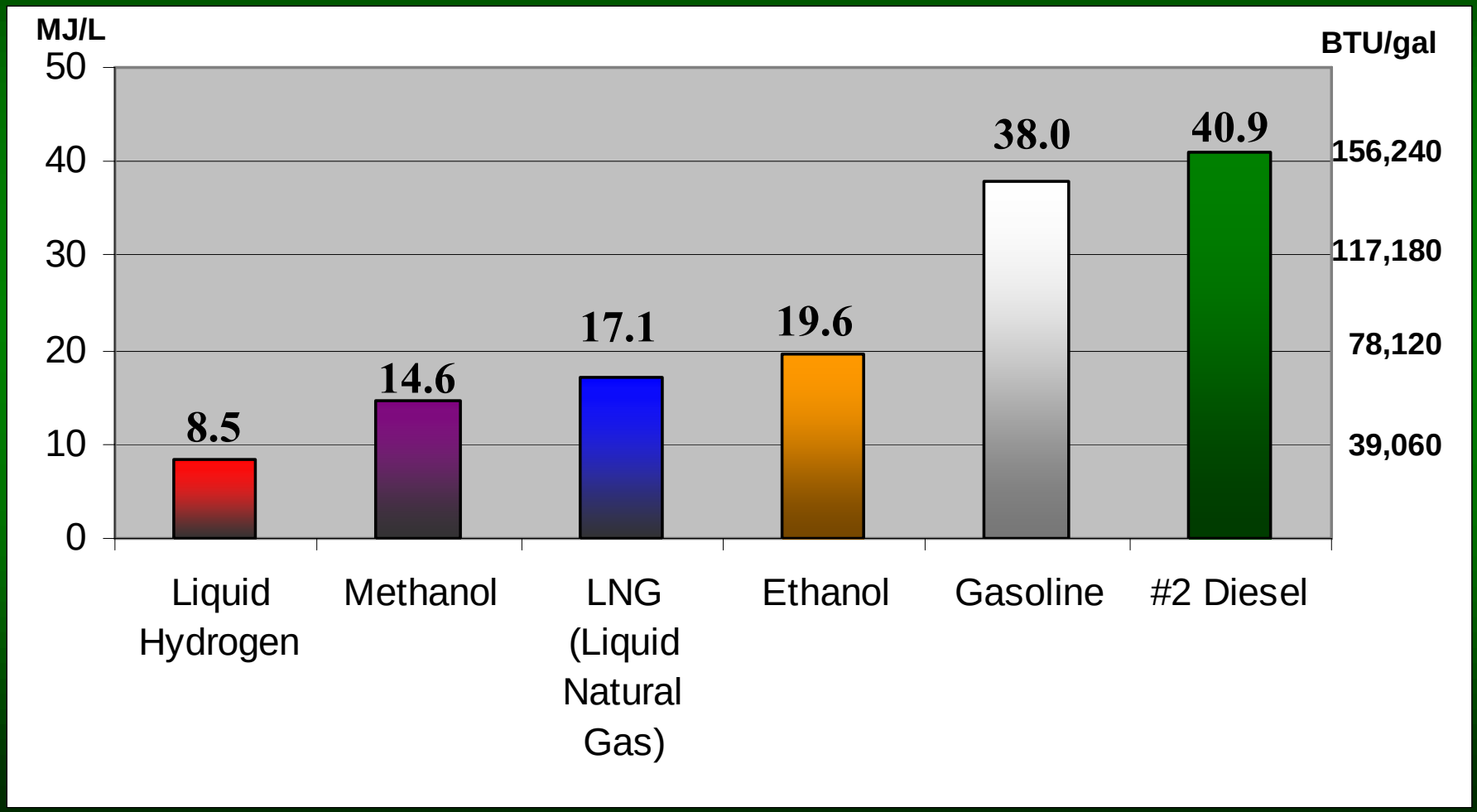
Highway Driving Refueling Range for VW Jetta

One tank of Diesel takes the Jetta 40%, 50% and 120% further than one tank of Gasoline, E-85, and Ethanol, respectively



Liquid
Coal

Energy Content of Liquid Fuels (Lower Heating Value)



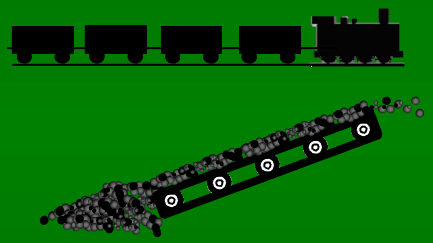
Liquid Coal

Liquid Coal

Liquid Coal Nuclear Refinery

(50,000 barrels/Day diesel fuel)

15,000 Tons/Day Raw Coal via 150 Rail-Cars/Day or Conveyer Belt for Mine-Mouth Refinery



Liquid Coal CTL Process

800°C Process Heat

PBMR

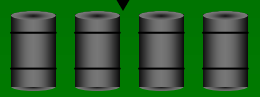
320MW$_e$

940MW$_{th}$

320 lbs/Day HL waste (only 60 tons/year)

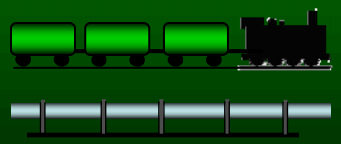
Stored on premises for 10 years

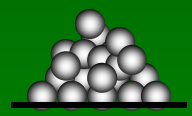
5,000 tons/day other fuels



50,000 barrels/day Ultra-Clean Diesel Fuel (7,000 tons/day)

Shipped via Pipeline or Rail





3,000 Tons/Day easily sequestered solid residue

Re-inserted into mine or hauled by 30 Rail-cars/Day

Liquid
♦ Coal

Features of 50,000 bbl/day Nuclear Refinery

- Zero emissions of SO_2, Mercury, NO_X, Arsenic and Radio Active elements
- Zero emissions of CO_2
- 3,000 tons/day of solid residue could be re-introduced into mine, or hauled away for other uses
- *NO* requirements for:
  - Electrostatic precipitators to capture fly ash
  - SO_2 scrubbers
  - Mercury removal installation
  - CCS processor
- Efficient, clean, safe, environmentally benign

Liquid
Coal

Benefits of Nuclear energy to electric utilities and coal companies

- Coal companies can expect huge increases in revenue, up to $300/ton if they invest in "Mine Mouth Refineries"
- Coal companies can expect long-term, highly profitable income from the transportation sector
- Utilities will avoid prohibitive costs associated with compliance to SO_2, NO_X, Mercury and Fly Ash Capture requirements, and avoid the CCS nightmare

Benefits to the Nation

Liquid
♦ Coal

If Liquid Coal's energy recommendations were in effect today, all of the benefits would be too numerous to list. These would include:

- **Make us totally independent of imported oil**
- **Have assurances of plentiful, cheap, clean energy for the next 2 centuries**
- **create millions of high-paying jobs**
- **Wipe out our balance-of-payment deficits**
- **Re-invigorate our automotive industry by manufacturing ultra-clean, highly efficient diesel cars**

Liquid Coal

CO_2 Emissions Reductions

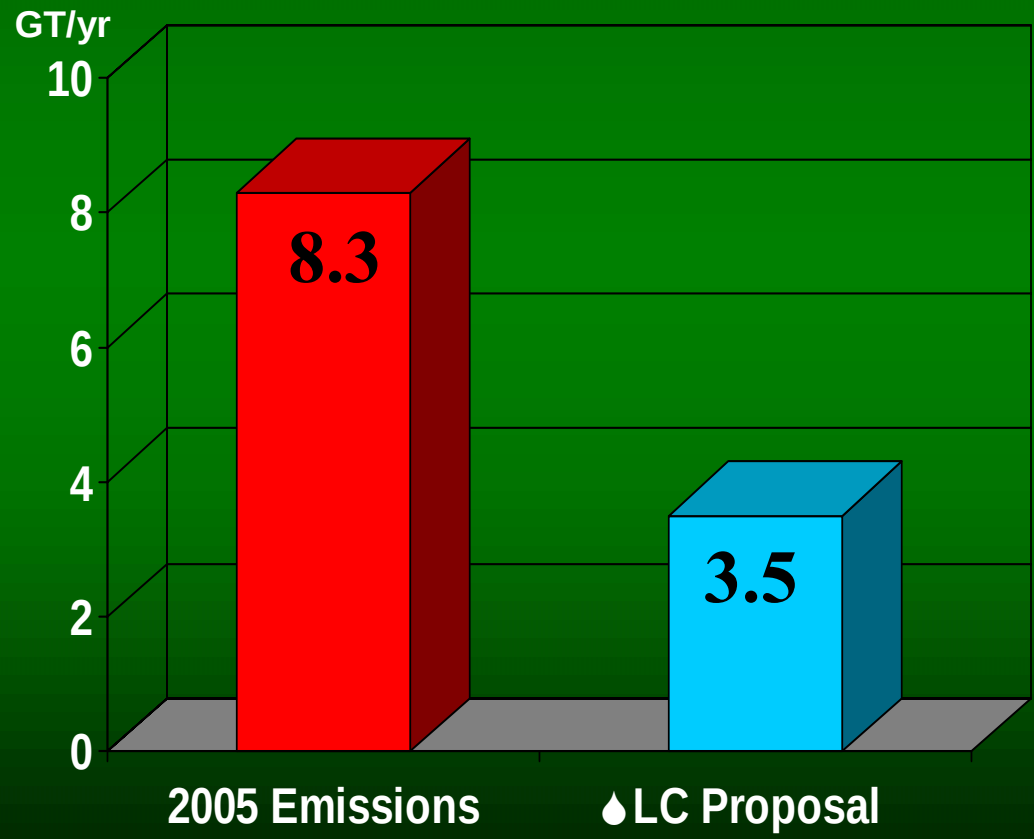
Liquid Coal

- The major disadvantage of substituting nuclear for hydrocarbon-sourced process heat is the ***reduction*** in the rate of increase of the important plant nutrient CO_2 to the earth's atmosphere.

- Present annual USA CO_2 emissions = 8.3 GT/year

(1 GT = 1,000,000,000 Tons)
Source: eia.doe.gov/oiaf/1605/ggrpt/excel/historical.co2.xls

- If Liquid Coal's energy strategy was in effect today, CO_2 emissions would be reduced to about 3.5 GT/year, corresponding to ***1961*** levels



Enabling Free Men…

Liquid
♦ Coal

- Remove all subsidies to "alternative energy" projects
- Restore and increase NRC's resources (NRC is self-funding)
- Implement serious reforms at the NRC to speed-up licensing process, reduce fees, fairly consider new reactor technologies, such as high temperature helium-cooled reactors
- Until our country becomes energy self-sufficient, repeal laws hindering the economical expansion of the fossil fuel industry
- In short, enable free men through the process of

LEGISLATION BY REPEAL

To cure our country's addiction to imported oil