Coal to Liquid Fuels

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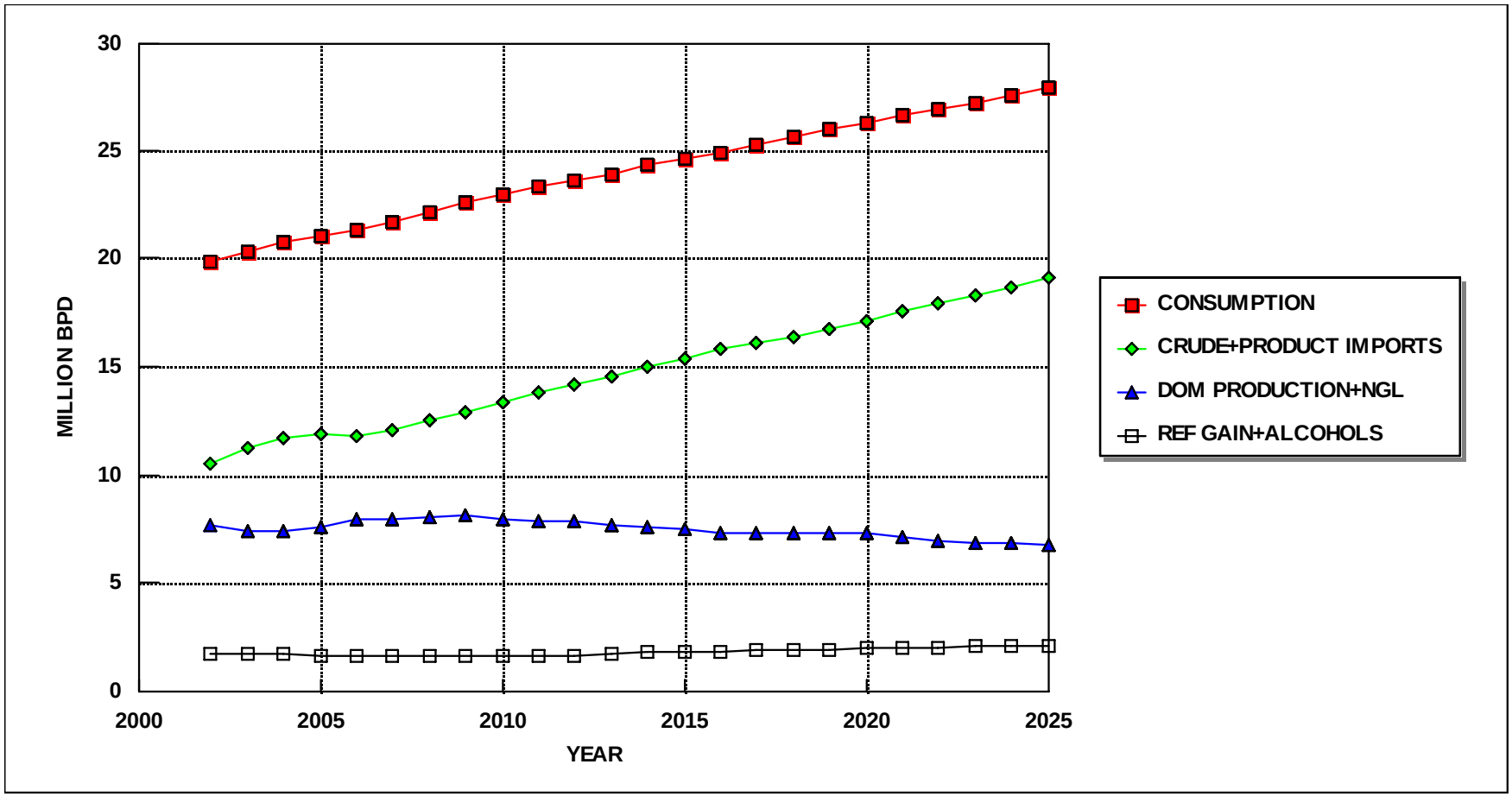
Excerpts from a recent Presidential speech April 05

- **"We now import more than half our oil from abroad…in order to maintain our lifestyles, and our dependence is growing. I believe that creates a national security issue and an economic security issue for the United States. And that is why it is important for us to utilize the resources we have here at home in environmentally friendly ways."**

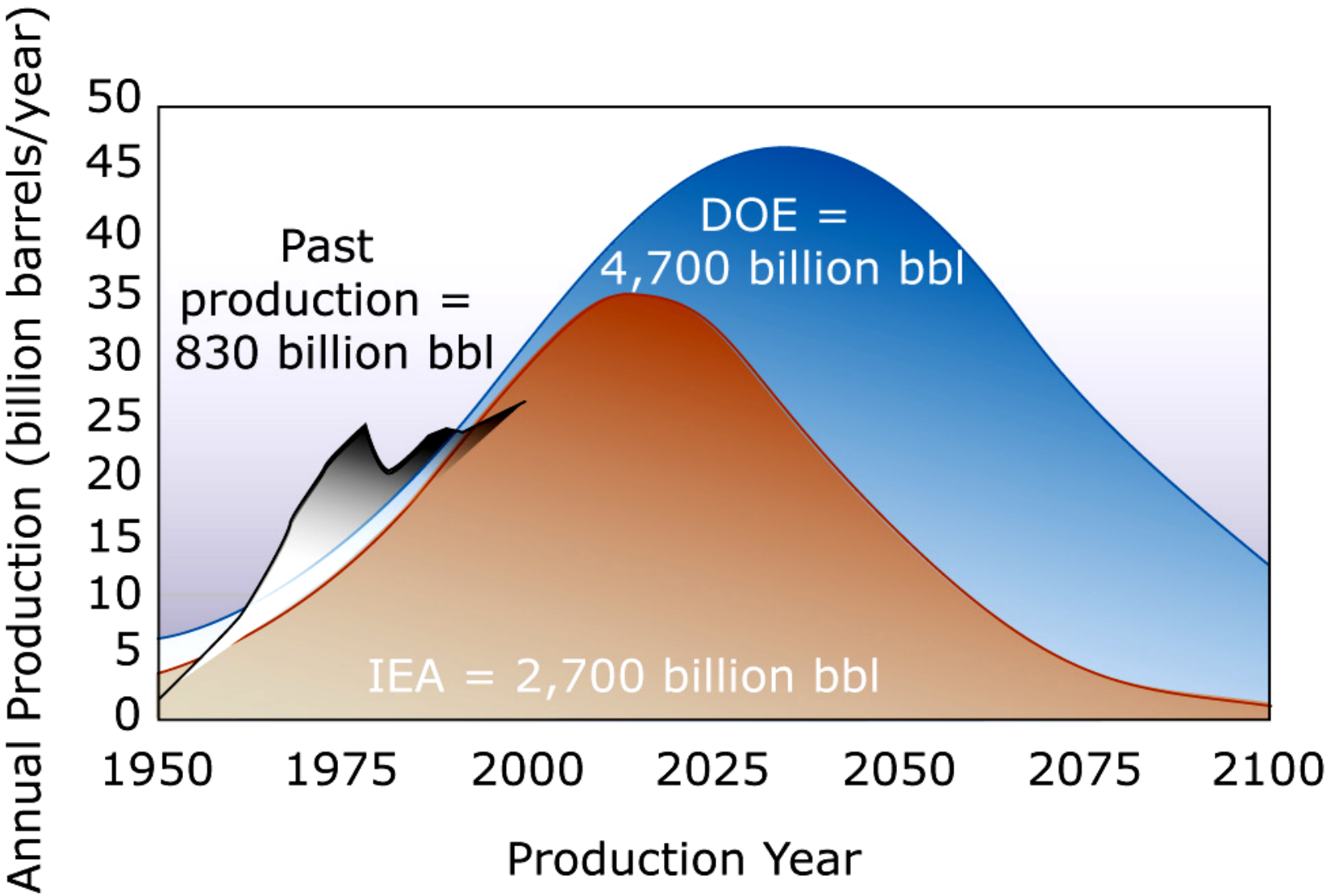
- **"Increasing our energy security begins with a firm commitment to America's most abundant energy source – and that is COAL….it should be at the heart of America's energy strategy"**
- **52% electric power from coal currently**
- **Long term hydrogen from coal with CCS**

- **Mid term CTL?**

U.S. Petroleum Situation till 2025
Source: EIA AEO 2005



World Petroleum Situation?



Diverse Resources and Fuel Options Will be Needed to Meet Future Transportation Needs

- Resources
  - **Conventional petroleum crude**
  - **Heavy oils**
  - **Coal/natural gas/petroleum coke**
  - **Tar sands**
  - **Shale oil**
  - **Biomass**

- Fuels/Blendstocks
  - **Petroleum-derived fuels**
  - **Fischer-Tropsch-derived fuels**
  - **CNG, LPG**
  - **Oxygenates, e.g. dimethyl ether (DME), methanol, ethanol**
  - **Hydrogen**
  - **Additives, e.g., octane and cetane improvers**
  - **Electricity**

Why CTL?

- **Energy Security:**
  - **Large domestic coal resource (250 years supply) could increase domestic transportation fuel production and reduce oil imports**
- **Advances have been made in Gasification through IGCC deployment**
- **Advances made in FT Synthesis step through GTL deployment**
- **Fuels produced are like GTL liquids and are compatible with existing liquid fuels infrastructure**
- **Fuels are essentially refined products and no additional refining capacity is necessary**

CTL: Current Status

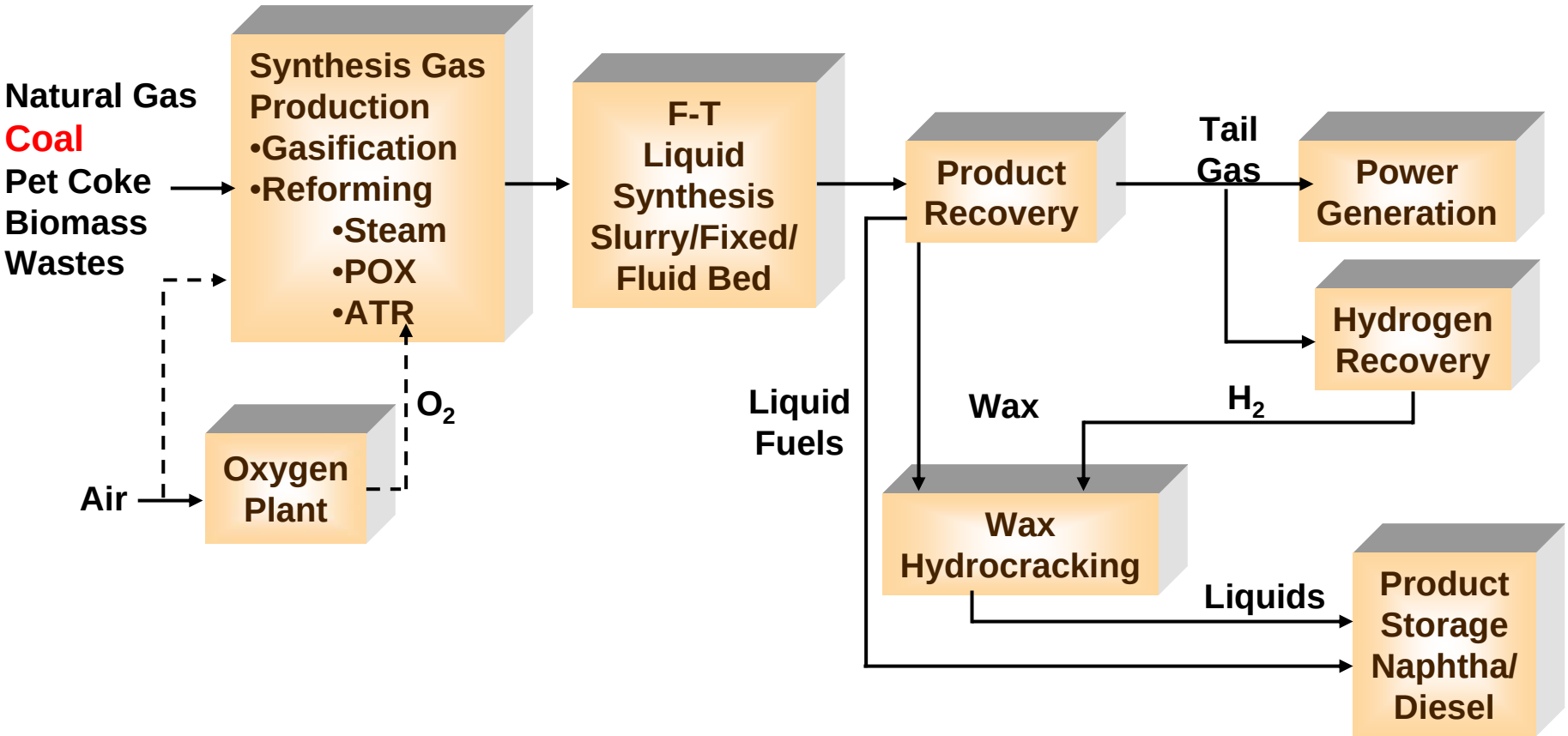
- **Gas to Liquids (GTL) is commercial**
  - **Approximately $25,000/bbl construction cost**
  - **Natural gas at $0.50-$1.0/ MM Btus**
    -RSP ~ $20-25/BBL
  - **Exxon-Mobil, Shell and Sasol plants planned in Qatar and Nigeria**

- **Coal to Liquids technology**
  - **Sasol 150,000 BPD FT plants in South Africa**
  - **China Shenhua direct liquefaction plant**
  - **China Shenhua Sasol feasibility studies for 2 large FT plants**
  - **No large scale integrated plants built with advanced technology**
  - **FE RD&D program developed direct and indirect CTL technologies**
  - **improved processes, catalysts and slurry reactors, LPMeOH**

Barriers to CTL

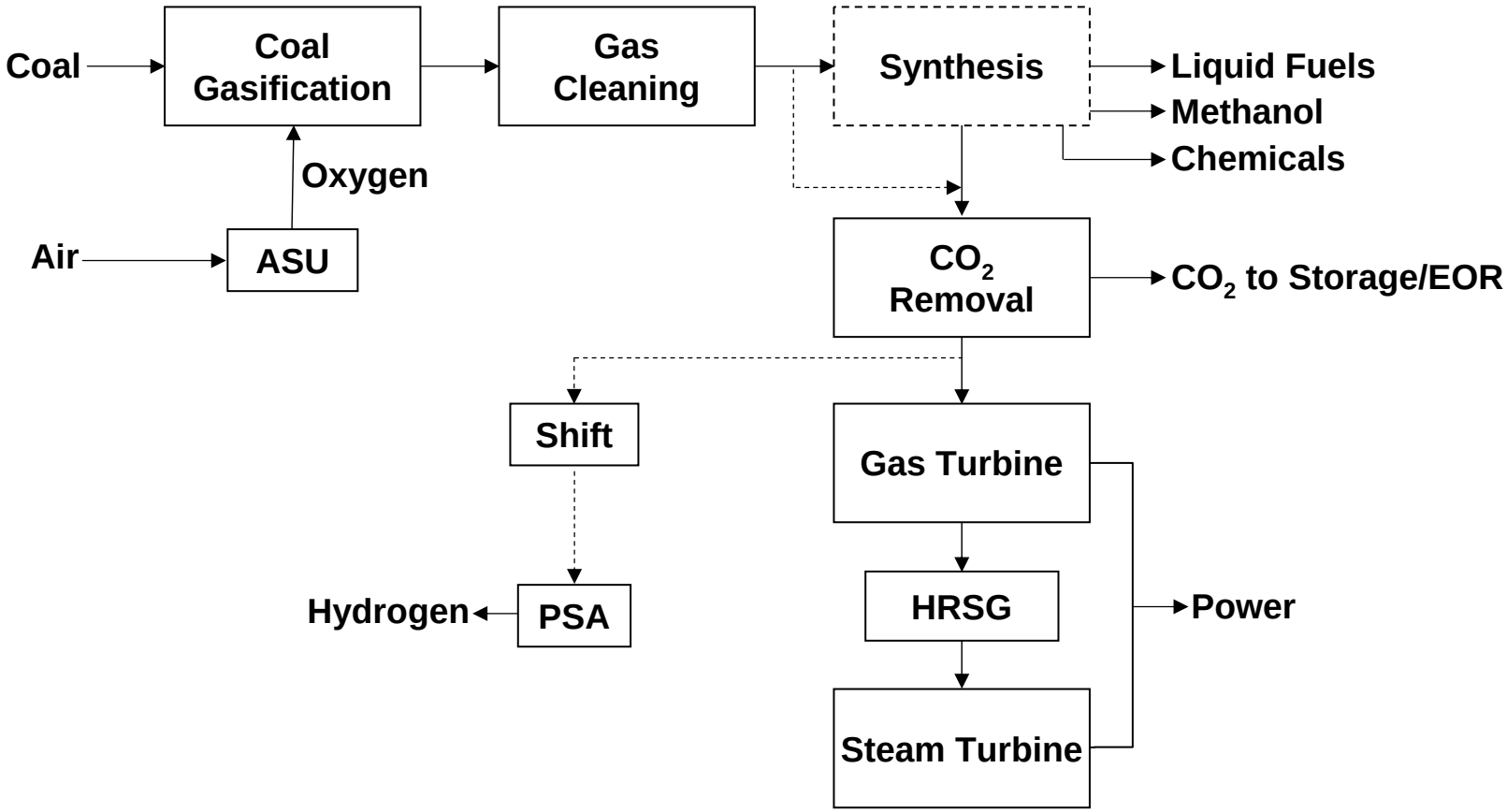
- **Technical:**
  - **Integrated operations of advanced CTL technologies have never been demonstrated**
- **Economic:**
  - **Uncertainties about future WOP**
  - **High capital and operations costs**
  - **Investment risks**
- **Environmental:**
  - **CO_2 and criteria pollutants emissions**
  - **Expansion of coal production**
- **Commercial Deployment:**
  - **Competition for critical process equipment and engineering skills**
    -Who would take the lead in commercial deployment? Part power part liquid fuels
- **Social:**
  - **NIMBY & Public resistance to coal use**

Fischer-Tropsch Technology: Overview



Polygeneration Concept

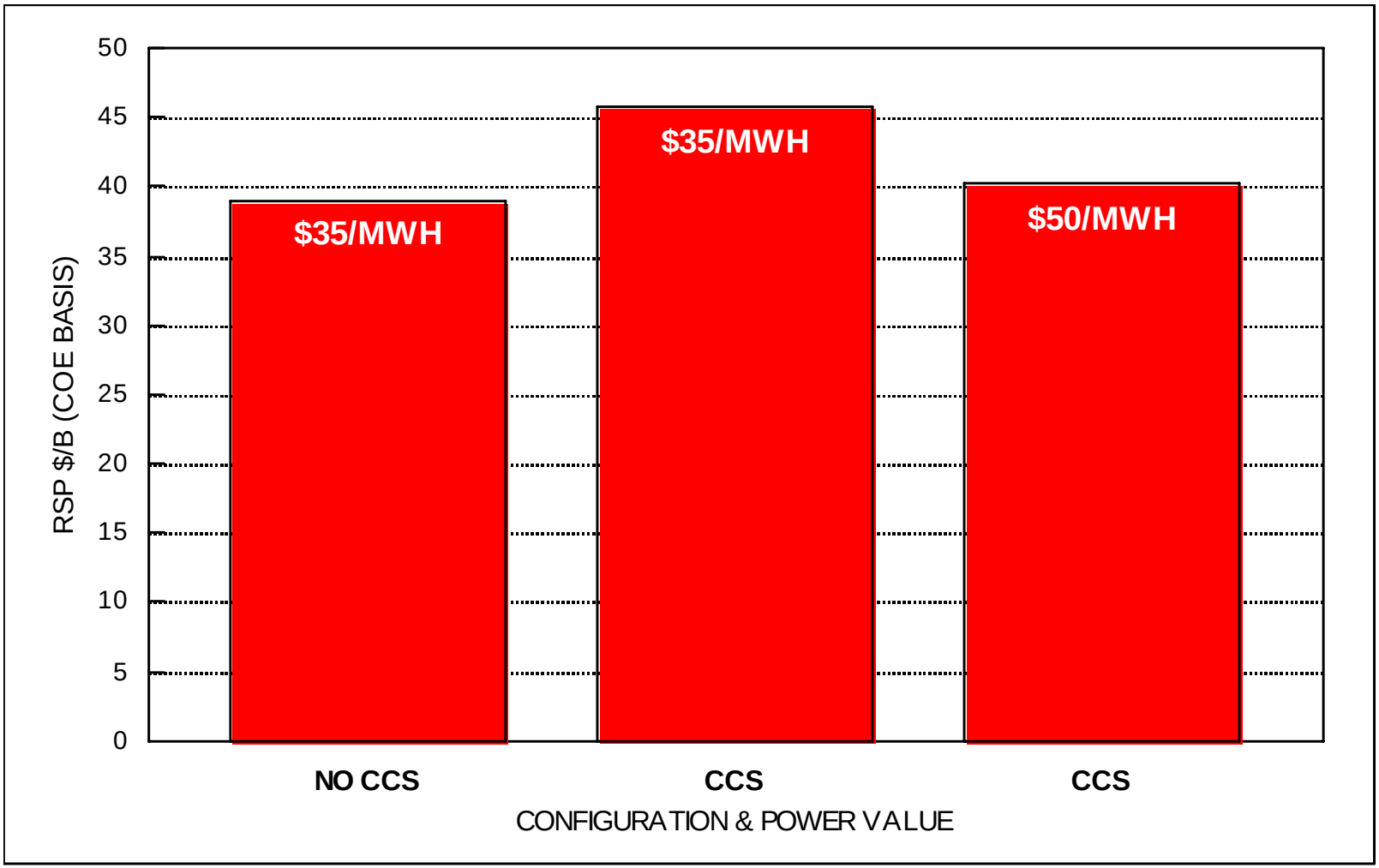
CTL plant configured to produce electric power and liquid fuels can readily be modified to a FutureGen-type plant producing hydrogen.



Economic Assumptions

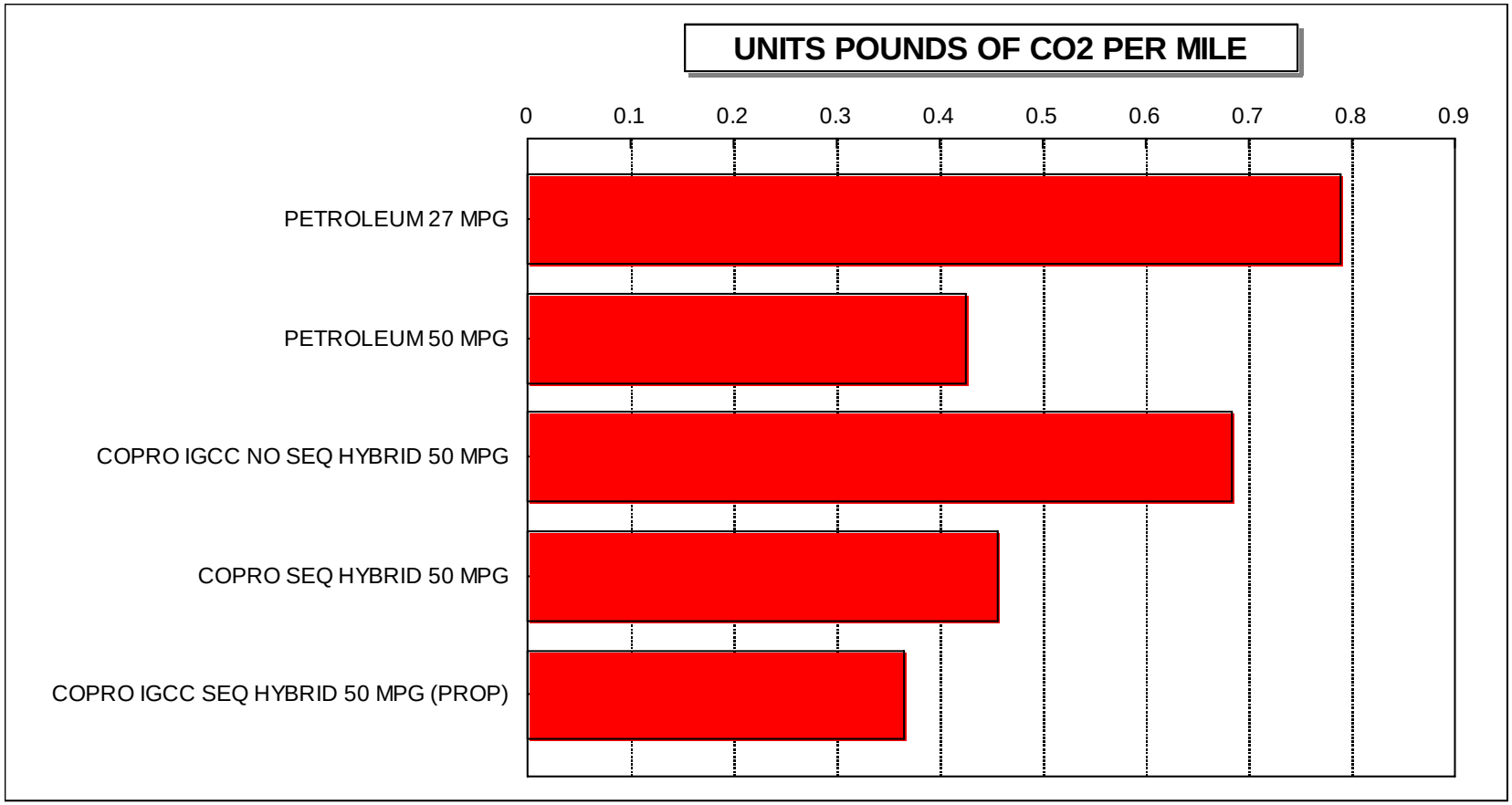
Initial Plant Output 50% (Year 1) 90% (Year 2)
Debt: Equity = 67:33
Require Selling Price (RSP) in constant dollars necessary for 15% ROE (current $1)
Debt: 16 years @ 8% interest
General inflation 3%
Escalation in accordance with EIA projects
Depreciation 16 years with double declining balance
Federal and state income tax (Fed 34%) (State 6%)
Local tax and insurance 2% of depreciable capital

Polygeneration Economics Summary (2005$)



Source: Gray et al, Mitretek Systems, 2005

Summary of CO2 Emissions



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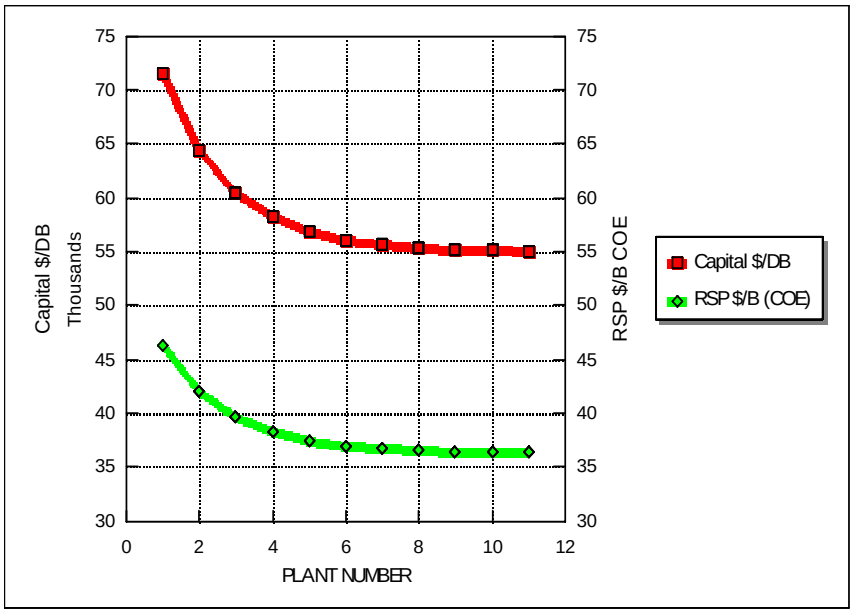
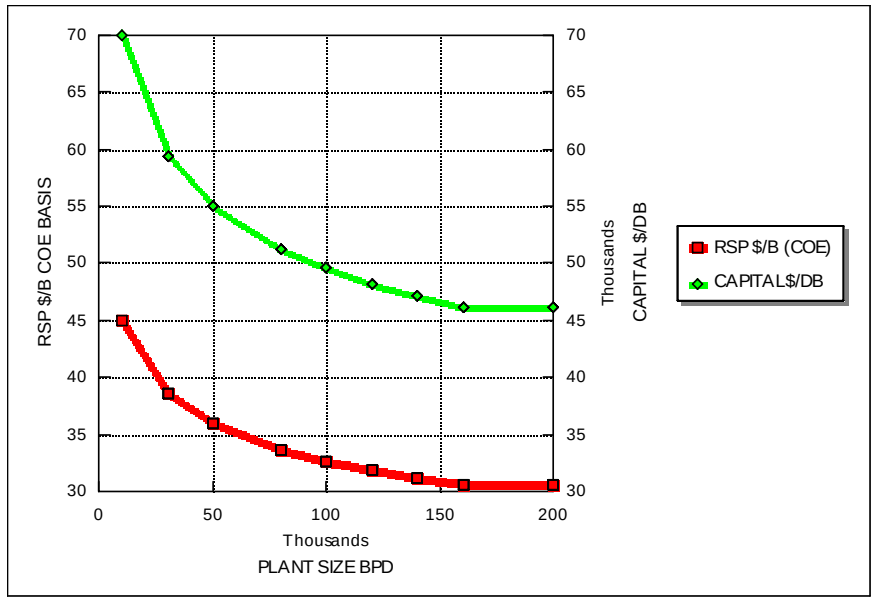
Cost versus number of plants and plant size





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Benefits

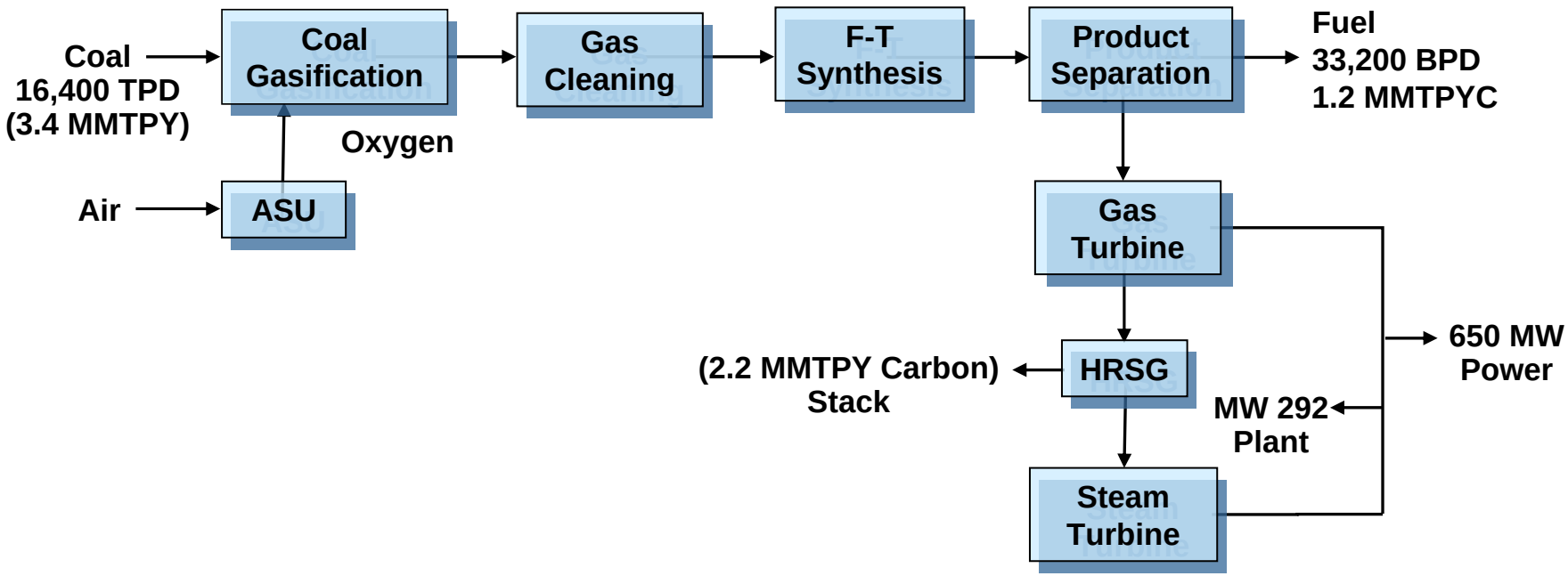
- Establish domestic industry (jobs)
- Enhanced energy security
- Clean domestic liquid fuel production
- Demonstrate CO2 recovery
- Electric power by product

Conclusions

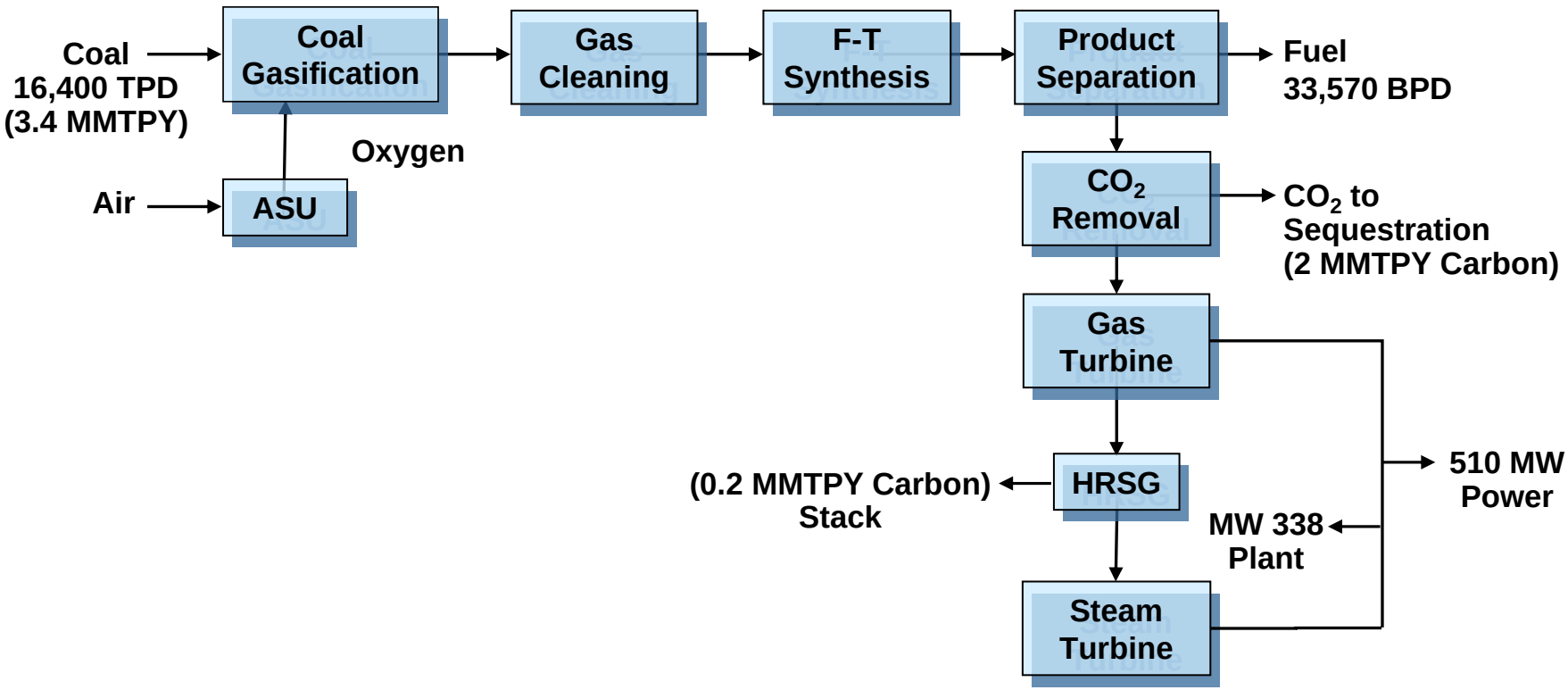
- **It will be necessary in the future to develop alternatives to conventional petroleum when world demand outstrips supply and GTL and CTL could be used as petroleum alternatives**
- **GTL and CTL produce ultra clean liquid fuels and would use existing transportation infrastructure.**
- **Cost of production of clean liquid fuels from coal in non-sequestration polygeneration plants is estimated to be about $39/BBL COE . From sequestered plants, CTL cost is estimated to range between $40 and $45/BBL COE depending on power value.**
- **Continued high world oil prices above $50/BBL would make CTL an economically viable option in the U.S.**
- **Countries with large coal reserves and little domestic petroleum are candidates for using CTL to provide fuels to supplement conventional petroleum (China, US, Australia, India)**
- **Continued R&D and GTL & CTL deployment will improve the economics nevertheless government incentives will probably be necessary for FOAK CTL plants to reduce risks for investors and thus accelerate commercial deployment.**

Back up slides

CTL Technology Overview Without Carbon Capture



CTL Technology Overview With Carbon Capture



Economics of CTL: Base Case

Advanced Coproduction plant without Carbon Sequestration

- Capital $2,670 MM (2005$)
- O&M
- Coal Cost
- CRF 15%
- Power value assumed
- RSP of liquid fuels
- Premium over crude
- RSP
  Overall Plant Efficiency (HHV%)

Coal cost $29/ton ($1.25/MMBtu)

$147 MM/year (excluding coal)

$157 MM/year

Capacity 90%

$35/MWH (650 MW)

$48/barrel

$9/BBL

$39/barrel crude oil equivalent

~59

Economics of CTL: Base Case

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- O&M
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- Power value assumed
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- RSP
- Power value assumed
- RSP of liquid fuels
- RSP
- Overall Plant Efficiency (HHV%)

Coal cost $29/ton

$172 MM/year (excluding coal; includes $10/ton carbon for sequestration)

Capacity 90%

$35/MWH (510 MW)

$54.80/barrel

$45.80/barrel (crude oil equivalent)

$50/MWH (510 MW)

$49.35/barrel

$40.35/barrel (crude oil equivalent)

~56

Incentives

- Government incentives may be required for the first commercial coproduction plant because of high risk and capital. These could include:

  -excise tax exemption
  -investment tax credit
  -accelerated depreciation
  -section 29 credit
  -cost share
  -price guarantee
  -purchase guarantee (floor price)
  -loan guarantee
  -ethanol model