Alternative Fuels: Carbon-to-Liquids

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The Fuel Supply System:
Scale, Time, and Capital

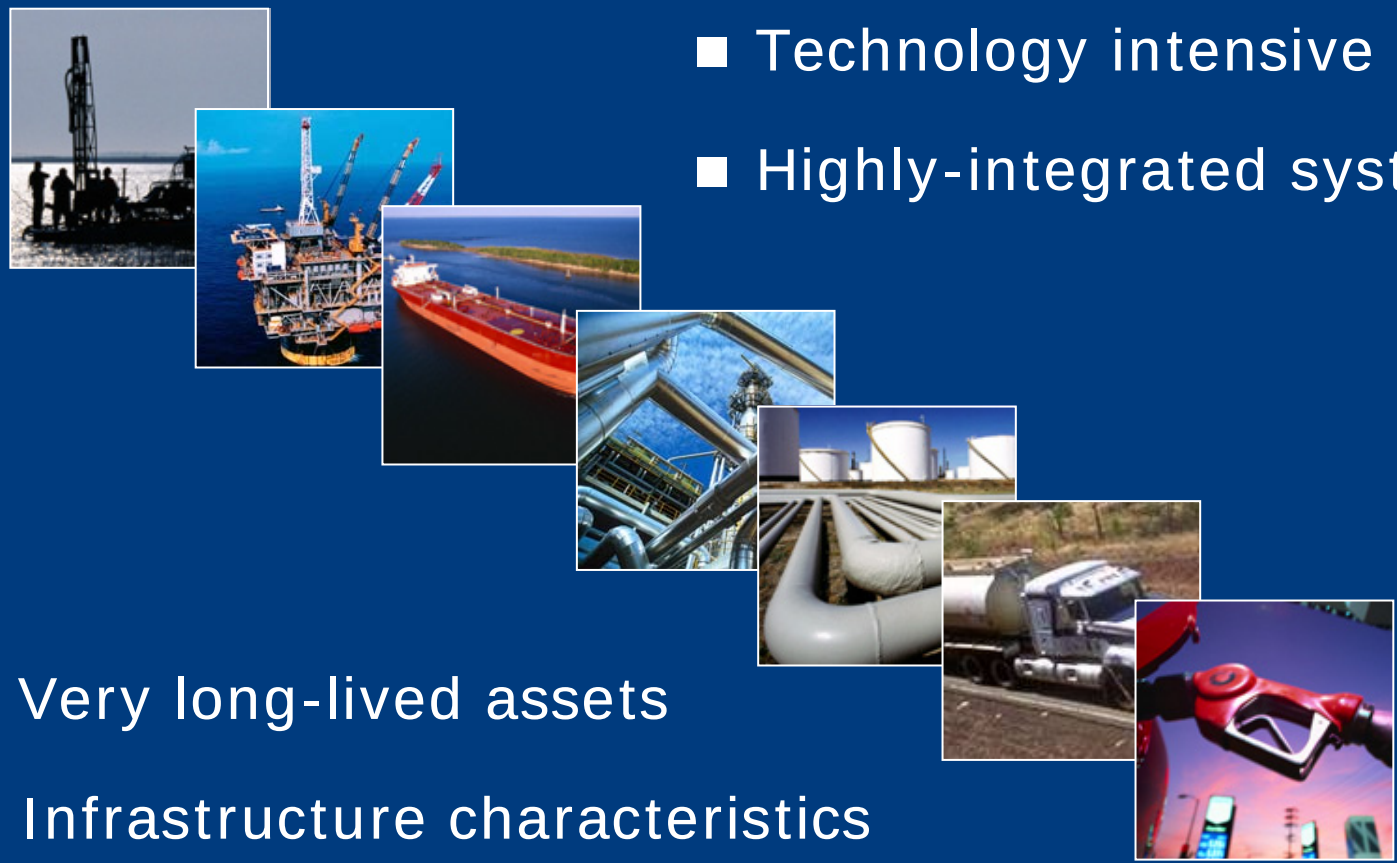
Carbon-to-Liquids: Synthetic Fuels

Molecular Transformation

Summary Thoughts

The Fuel Supply System

- Capital intensive
- Technology intensive
- Highly-integrated systems

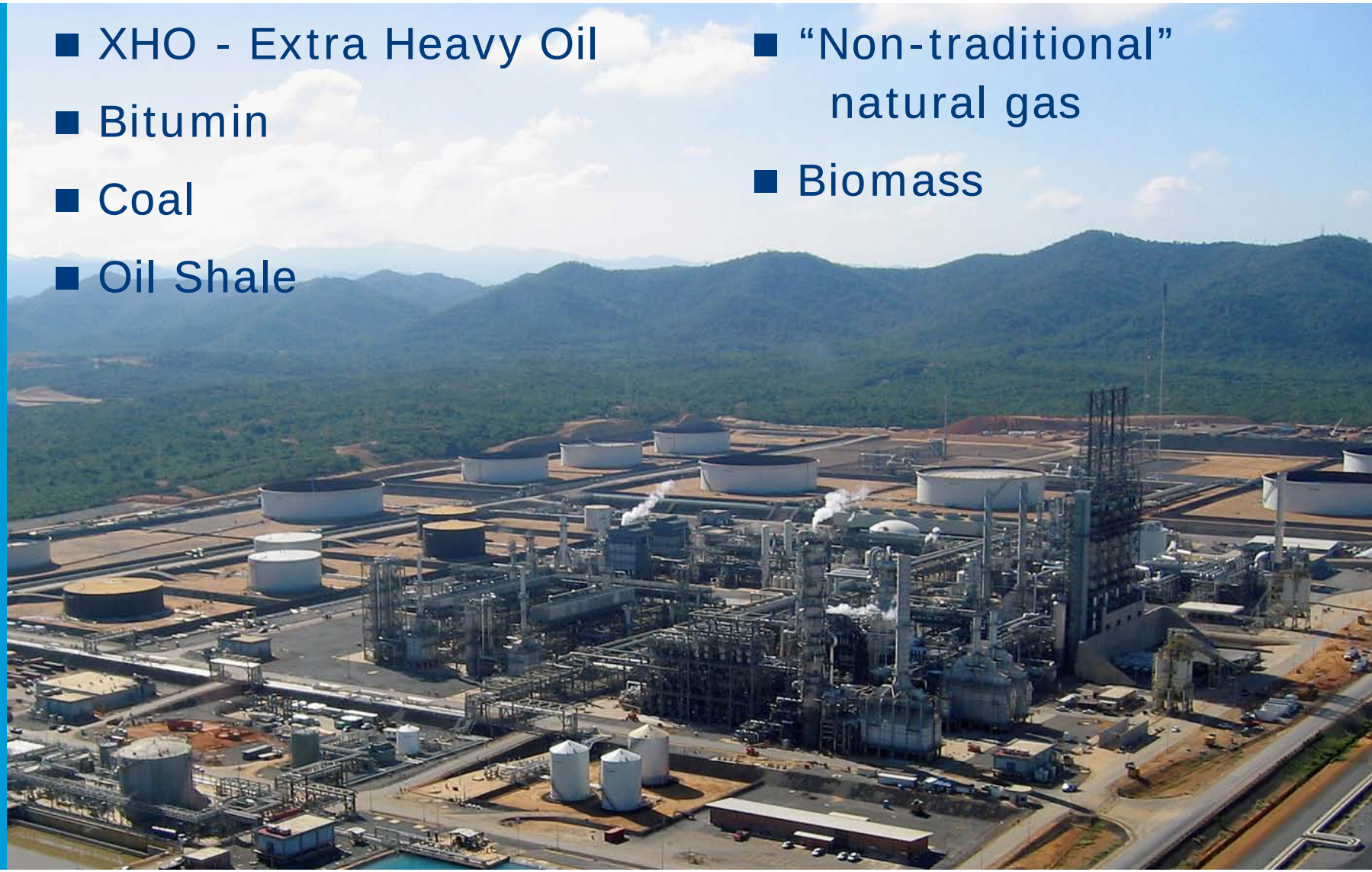


- Very long-lived assets
- Infrastructure characteristics
- Intersects global economics and politics

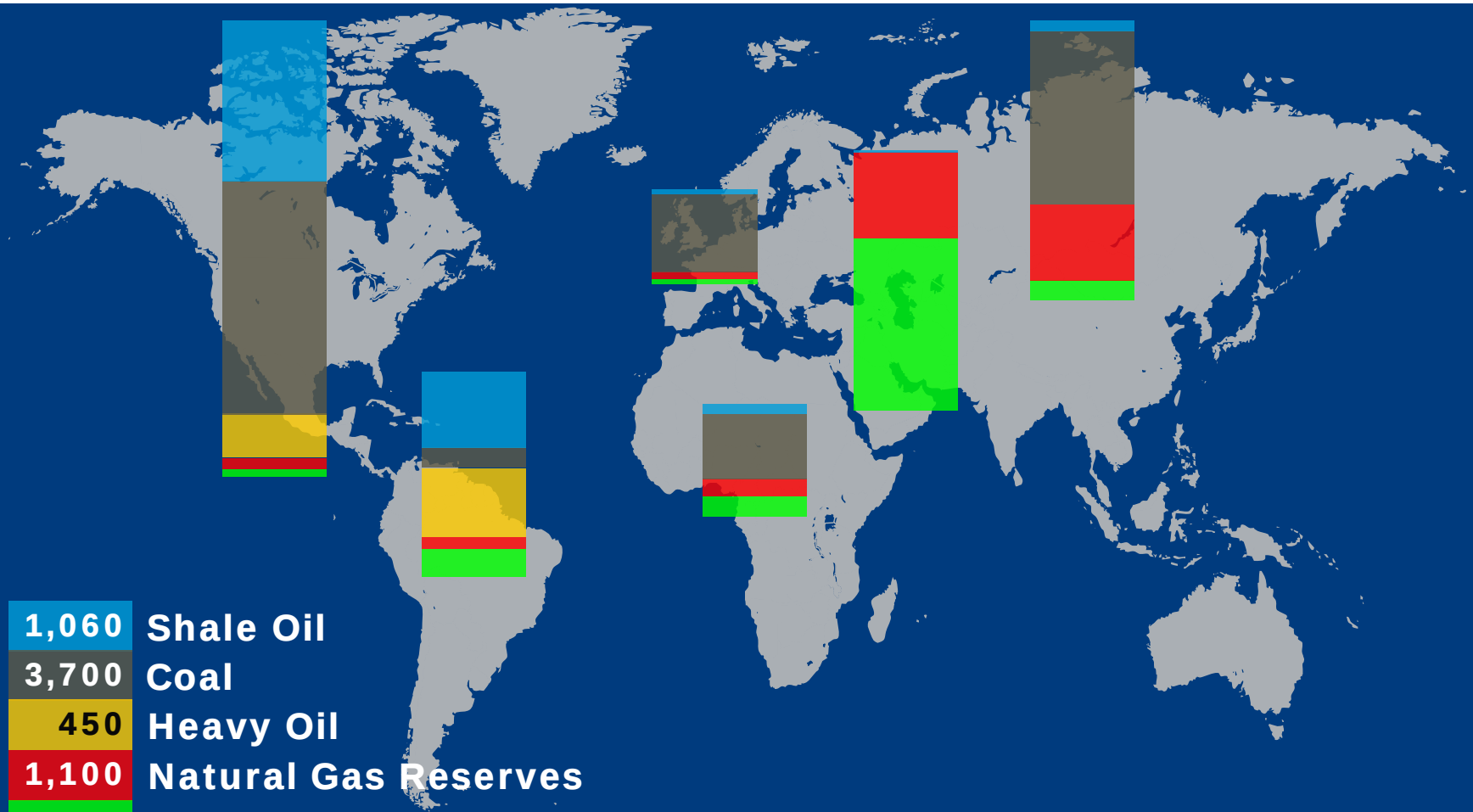
Scale	Time	Capital
Global oil volume: • World's largest supply chain • 40,000 gal/sec • 0.5 gal for every human, every day • 250 Billion gals of fuel in transit in the U.S. alone	Infrastructure: • Takes decades to develop at scale • Lasts generations to centuries Giant oil fields: • Typically 20 years from discovery to full production	All upfront: • ~ $10+/BBL reserves • $20,000+/daily BBL for fuel manufacturing *$ Trillions of investment* needed over next 30 years

“Unconventional” Resources

- XHO - Extra Heavy Oil
- Bitumin
- Coal
- Oil Shale
- “Non-traditional” natural gas
- Biomass



Fossil Reserves and Resources



7,360 Billion Barrels of Oil Equivalent Reserves & Resource

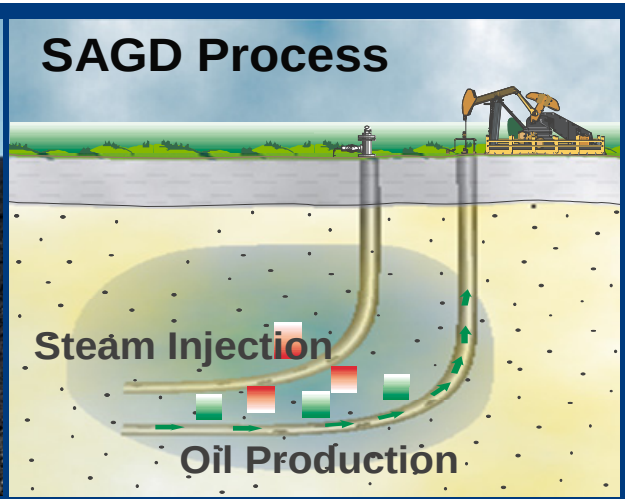
Source: EIA and IEA as at 1/1/2006

Synthetic Fuels from Natural Gas

- Fuels entering premium markets
- Commercial plants under construction
- Active R&D to reduce capital costs

- Connected to world-scale gas resources
- Distributed manufacturing
- Molecular transformation

Synthetic Oil and Fuel from XHO, Bitumin, Coal, and Shale Oil



- Large-scale bitumin development in Alberta
- Shale oil RD&D leases in Colorado

- Distributed manufacturing
- Hydrogen production at scale
- Molecular transformation
- Energy and carbon management

Biofuel Growth Drivers

Industrial-scale Infrastructure

2nd Generation Technology

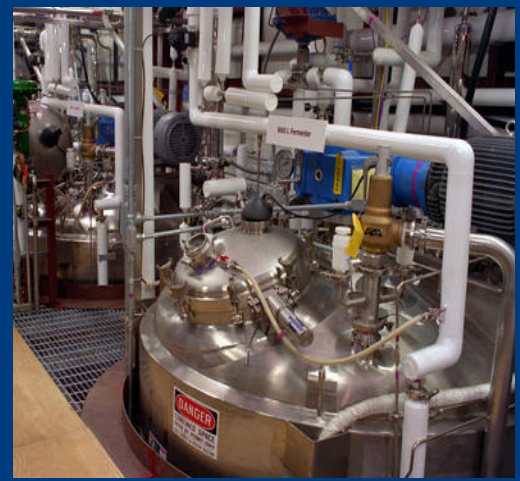
Large, concentrated supplies of feedstock

Biomass-to-Fuel

Bio-fuels

Bio-products

Bio-processing



- Feedstock supply development
- Molecular transformation
- Scalable, distributed manufacturing
- Fuel market and infrastructure evolution

Molecular Transformation

- Unconventional resources require significant molecular “readjustment”
- New engine technologies will likely require fuel evolution
- Fuel synthesis provides the opportunity to create superior products
- Significant and growing molecular science base

Deployment of New Fuel Technology at Scale

~ 10 years

Bench Top	Pilot Plant	Experimental Plant	World-scale Commercial Plant
$ Millions	$ 10's Millions	$ 100's Millions	$ Billions
			
<.01 B/D	~ 1 B/D	~1000 B/D	~100,000 B/D

Illustrative example

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- Molecular transformation
- Infrastructure development
- Carbon management
- Sustainable business models

Questions ?