FUTURE AUTOMOTIVE FUELS FOR JAPAN AND THE UNITED STATES - SIMILARITIES AND CONTRASTS

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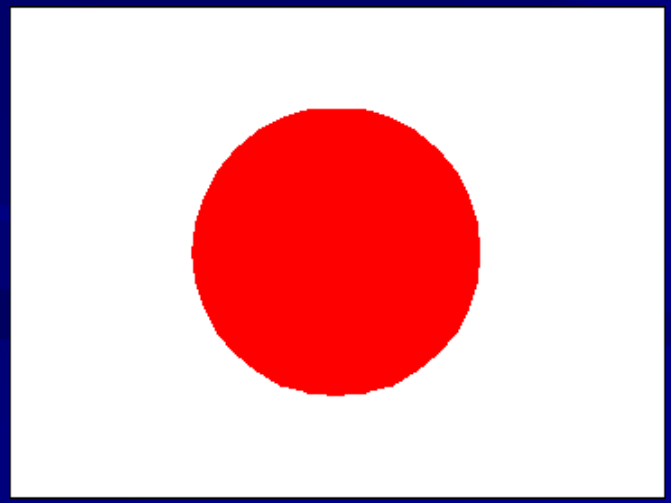


MAJOR FUEL IMPROVEMENTS PAST 40 YEARS

Gasoline

- Lead removed
- Sulfur reduced
- Vapor pressure decreased
- Oxygenates used

Diesel Fuel

- Sulfur greatly reduced

WORLDWIDE BENEFITS OF FUEL CHANGES

- Better vehicle operation
- Reduced vehicle emissions
- Improved air quality
- Improved public health

FUTURE FOCUS OF AUTO, OIL, AND ENERGY INDUSTRIES

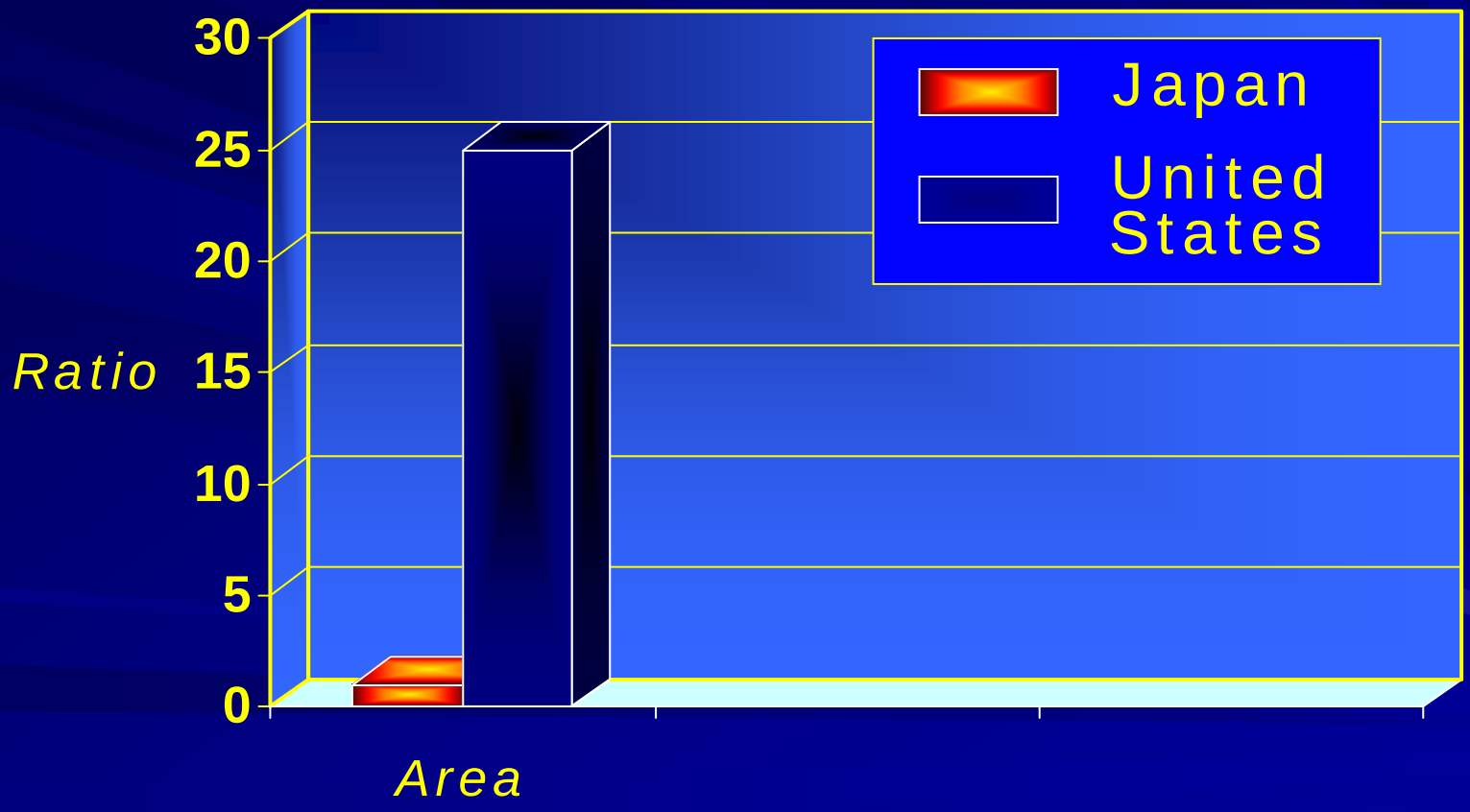
- Reduced fuel consumption
- Reduced greenhouse gas emissions
- Diversified fuel resources

OBJECTIVE OF PRESENTATION

Review future automotive fuels for Japan and USA

- Short term - 10 to 15 years
- Long-term - > 25 years

Japan – United States Comparisons



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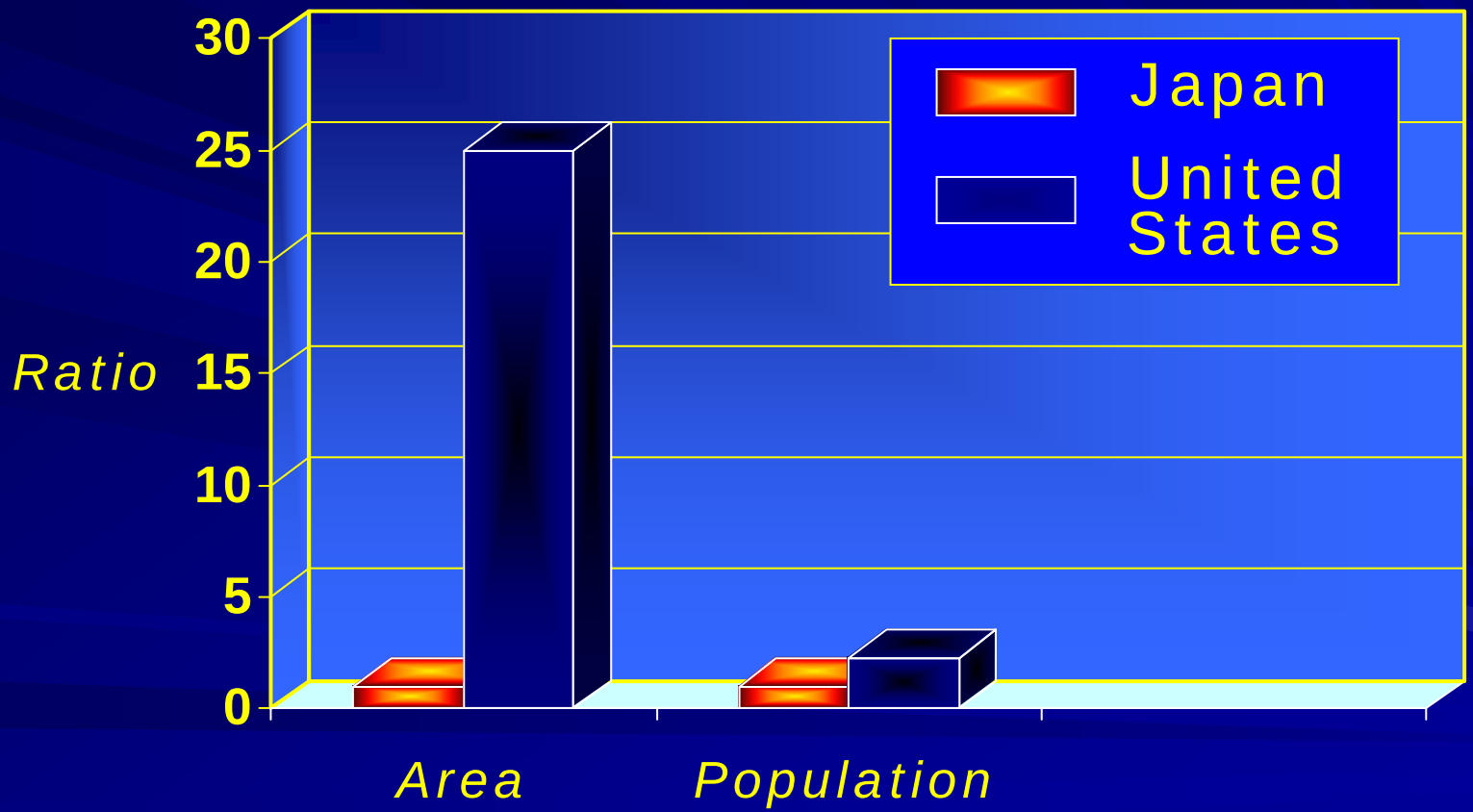

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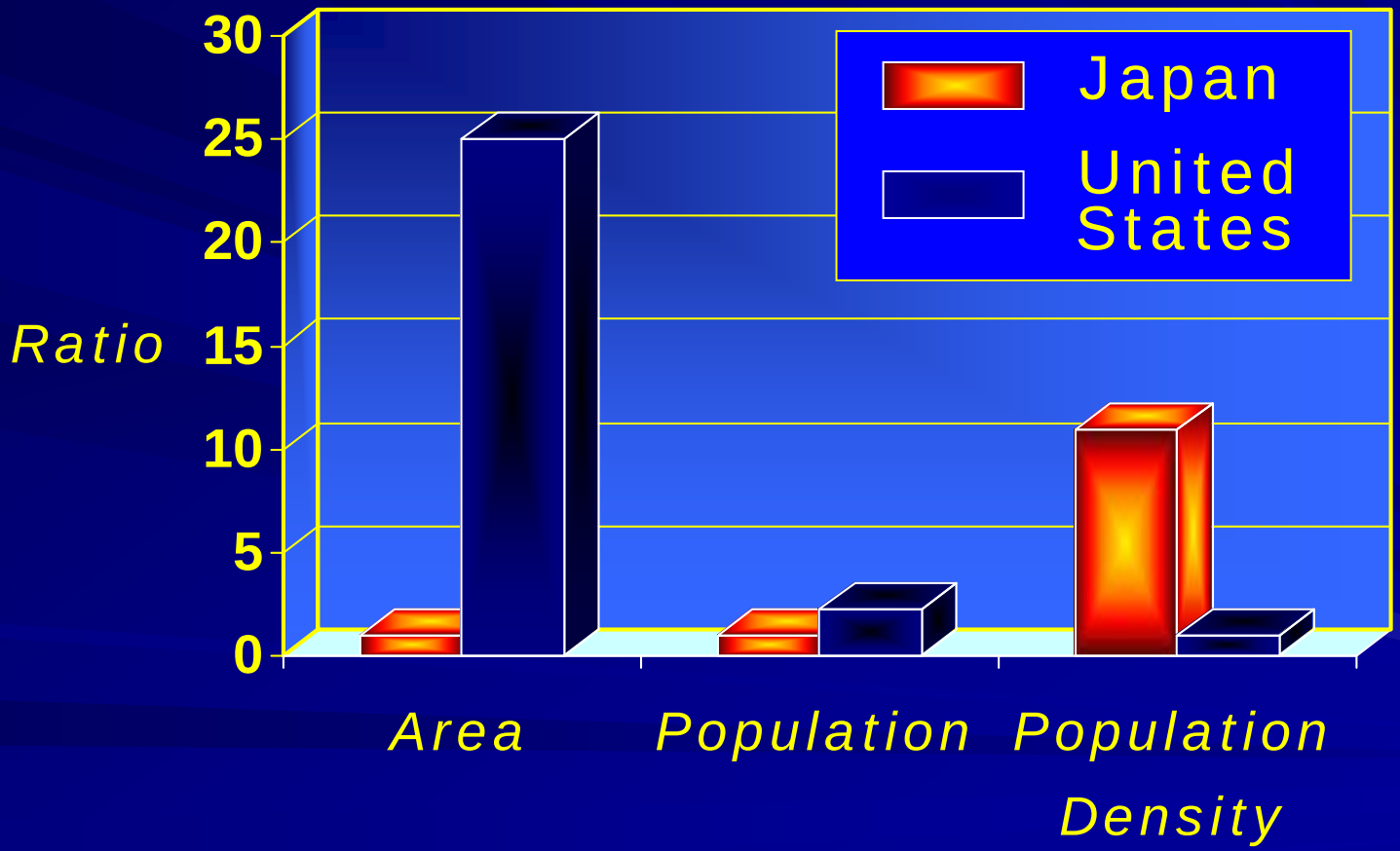
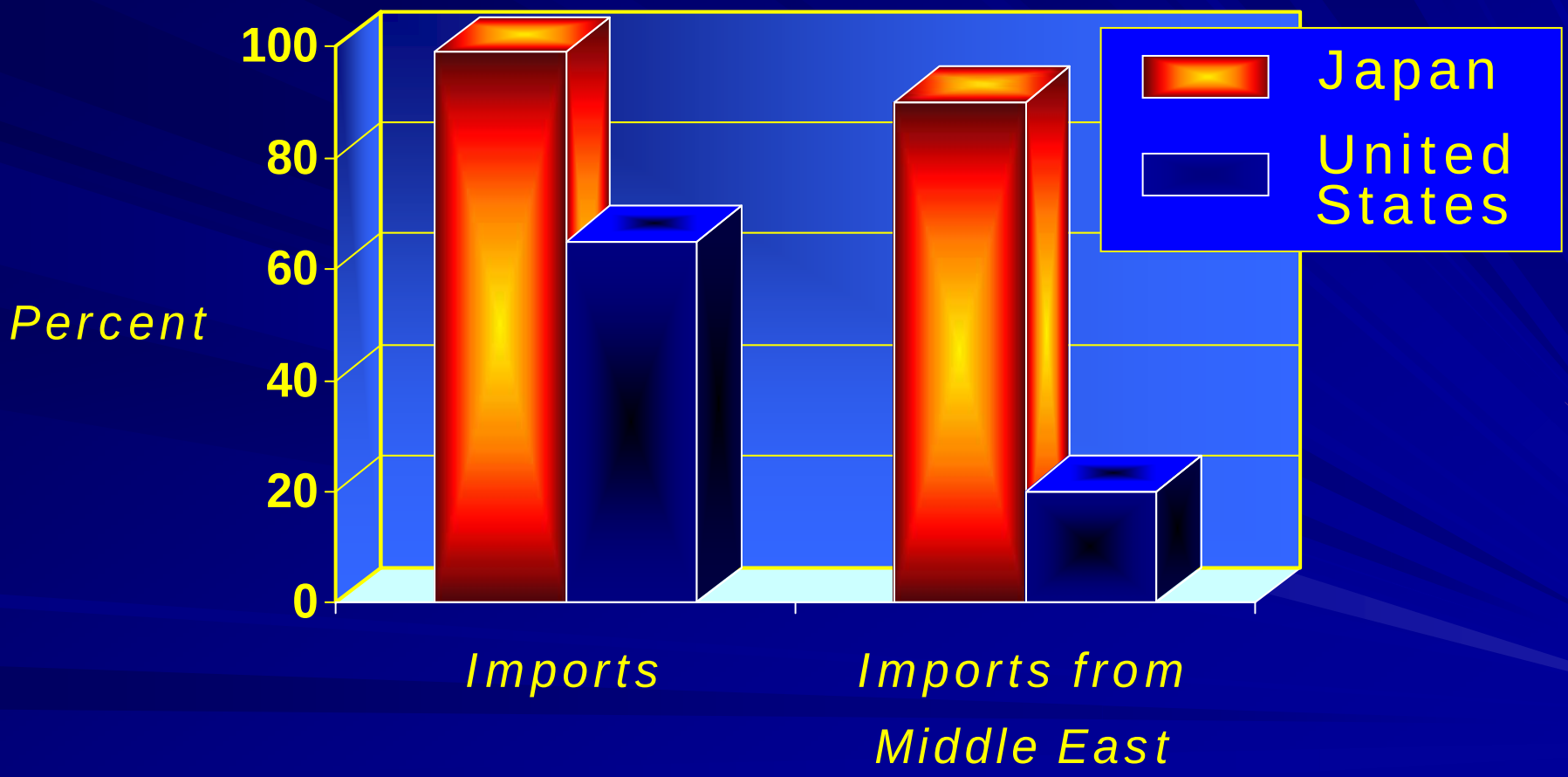


PETROLEUM

Key resource for auto fuels for

- Japan
- United States

Petroleum Source

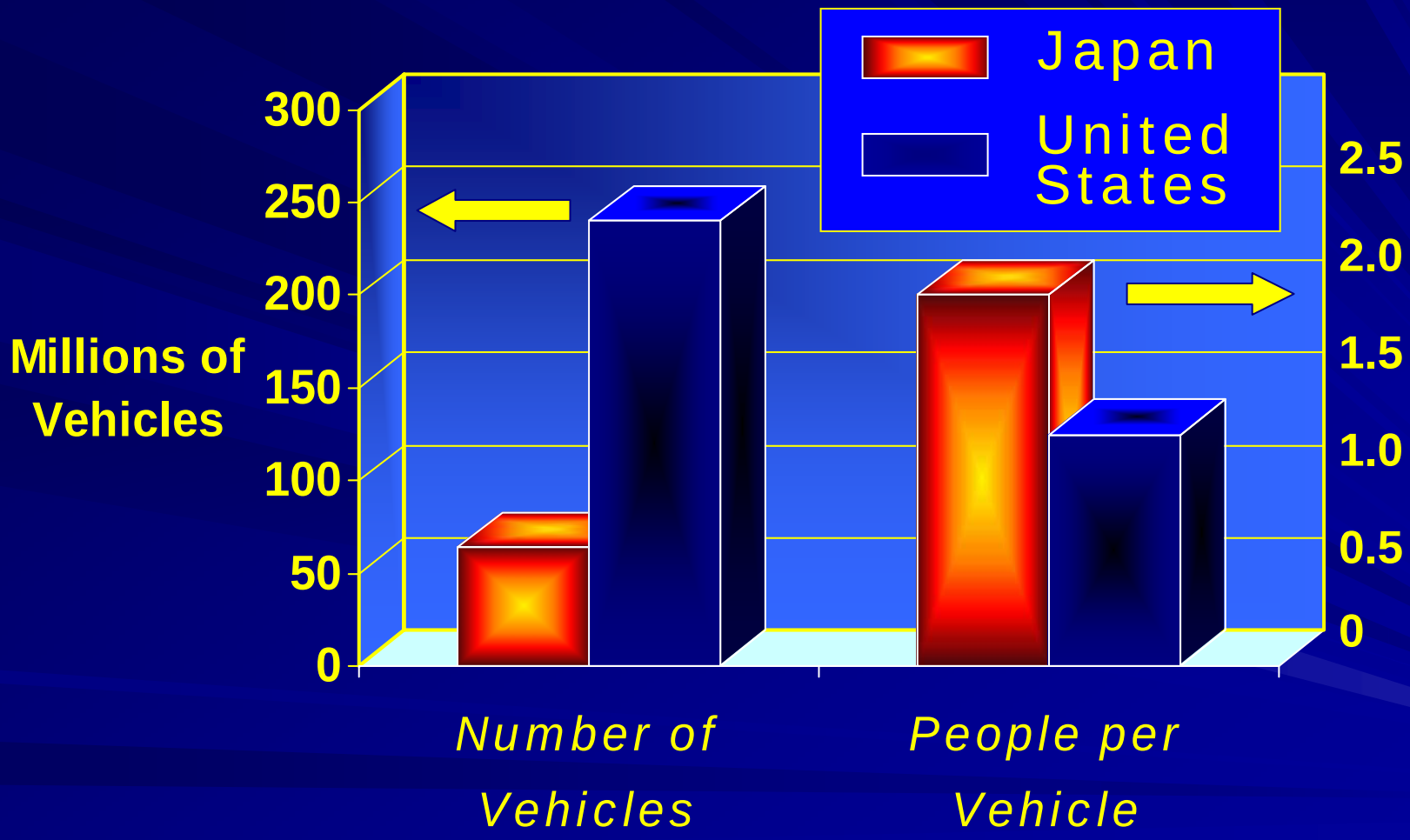


NATURAL GAS

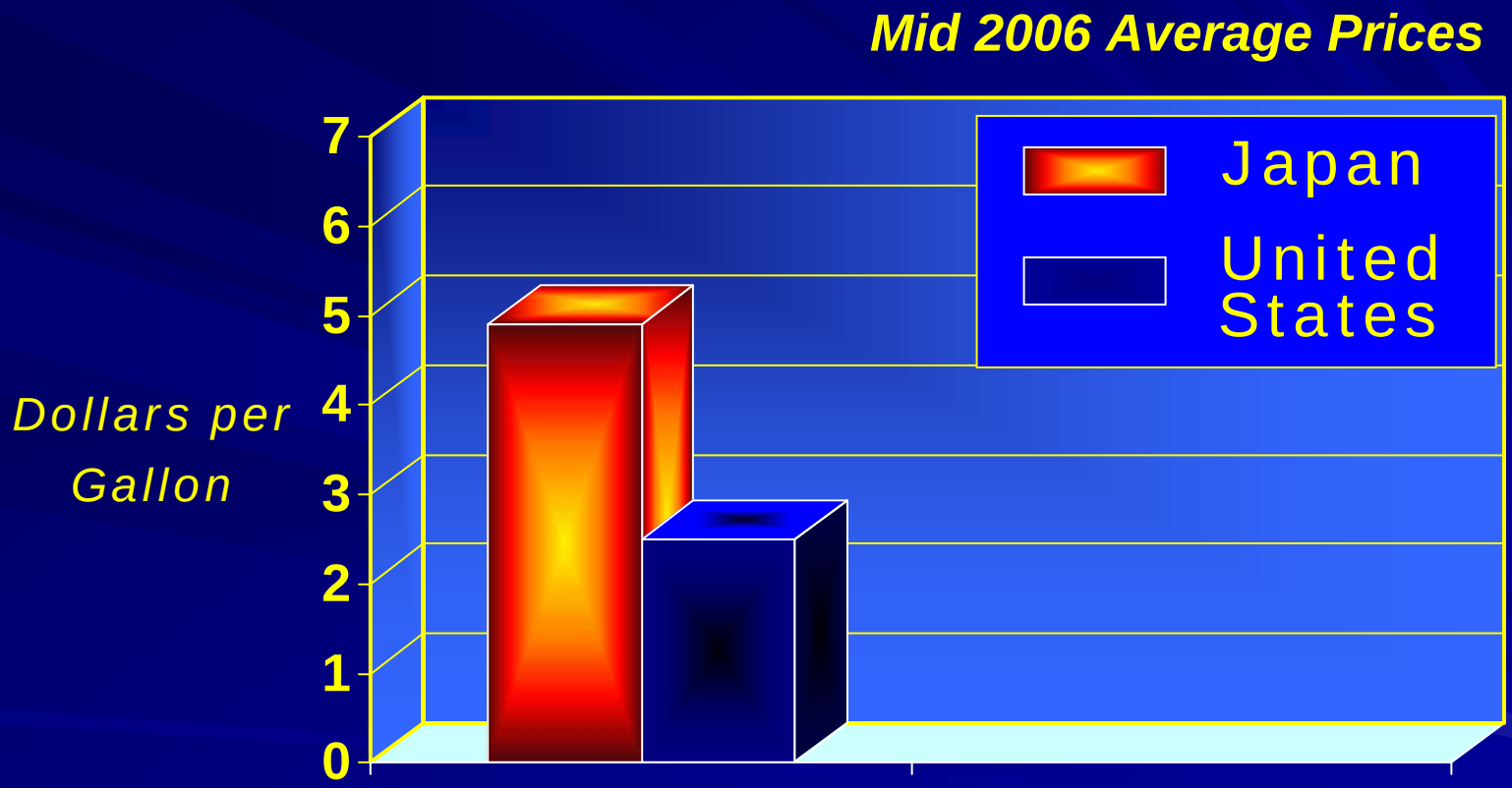
Resource base

- United States
  - 5 ½ trillion cubic meters
- Japan
  - 40 billion cubic meters

Vehicle Population and Use



Gasoline Price



THE SHORT TERM

10 to 15 Years

REASONS FOR CHANGING AUTOMOTIVE FUELS

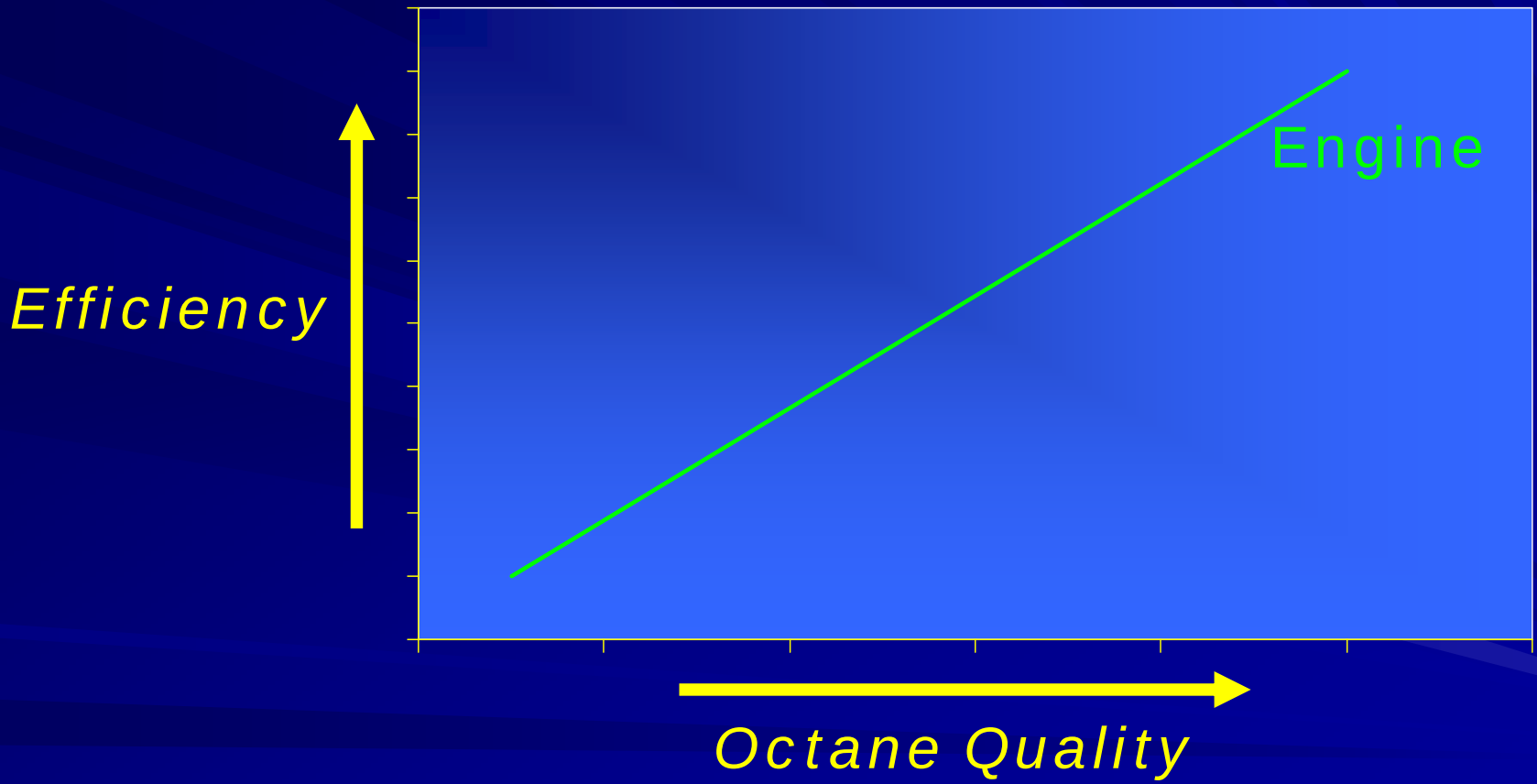
- **Conserve energy**
- **Reduce Imports**
- **Diversify resources**
- **Reduce greenhouse gas emissions**

“STRETCHING THE BARREL”

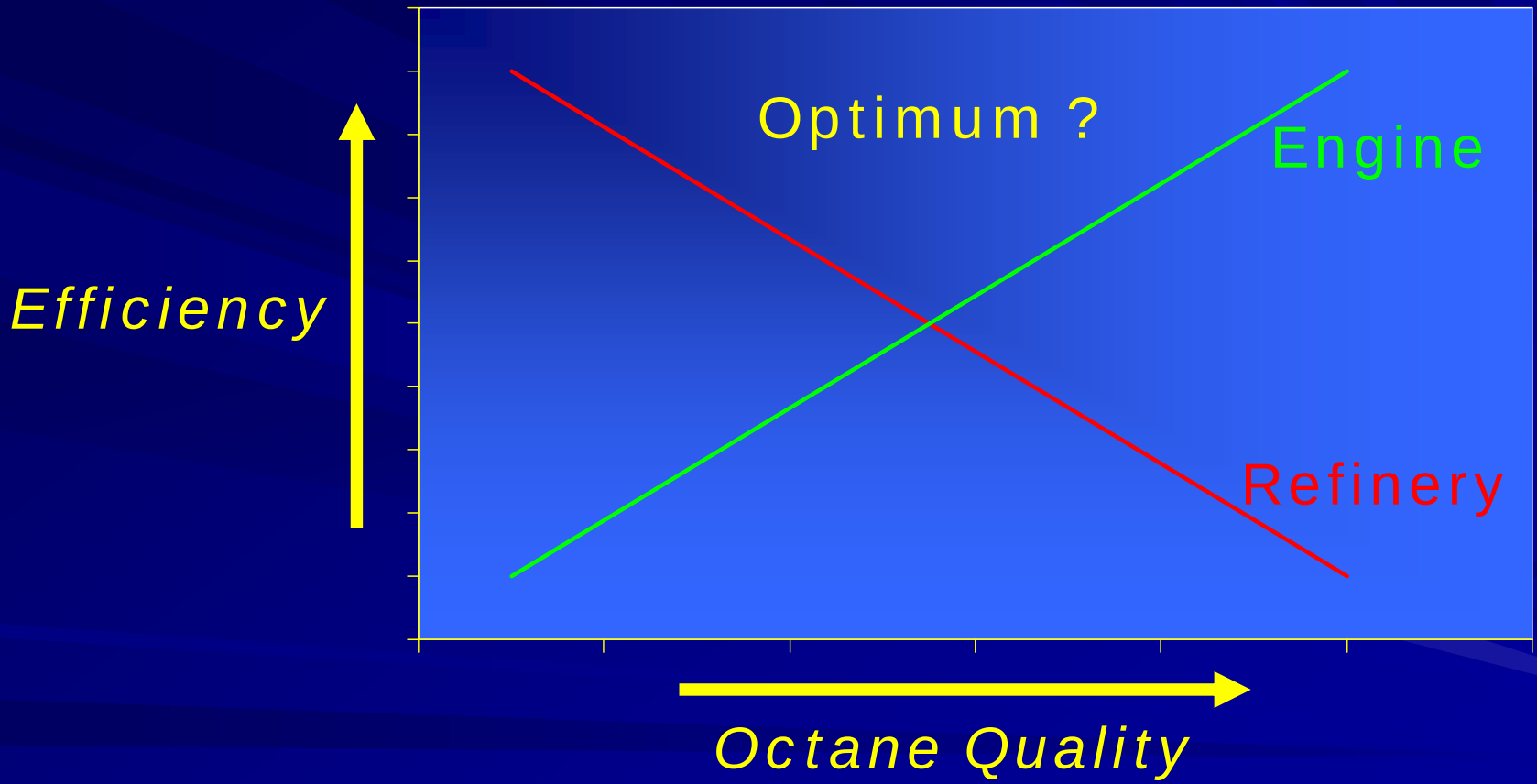
PROPOSED STUDIES

- **Optimum gasoline octane quality**

Optimizing Gasoline ?



Optimizing Gasoline ?



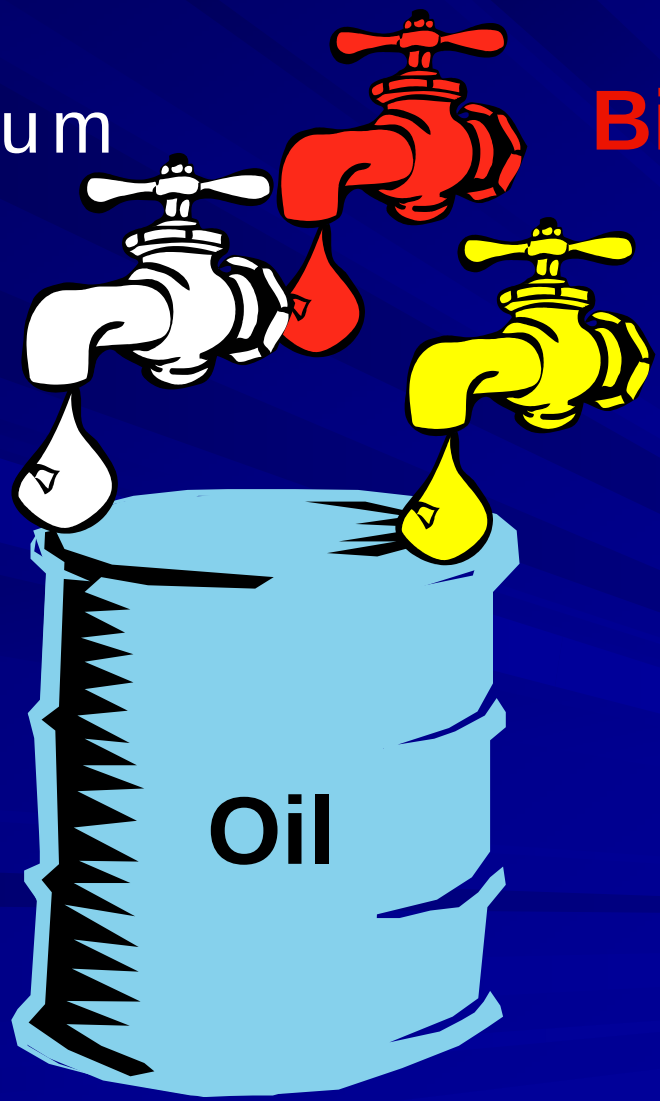
PROPOSED STUDIES

- **Optimum gasoline octane quality**
  (maximize miles per gallon)

- **Optimum mix of gasoline and diesel fuel**
  (maximize miles per barrel)

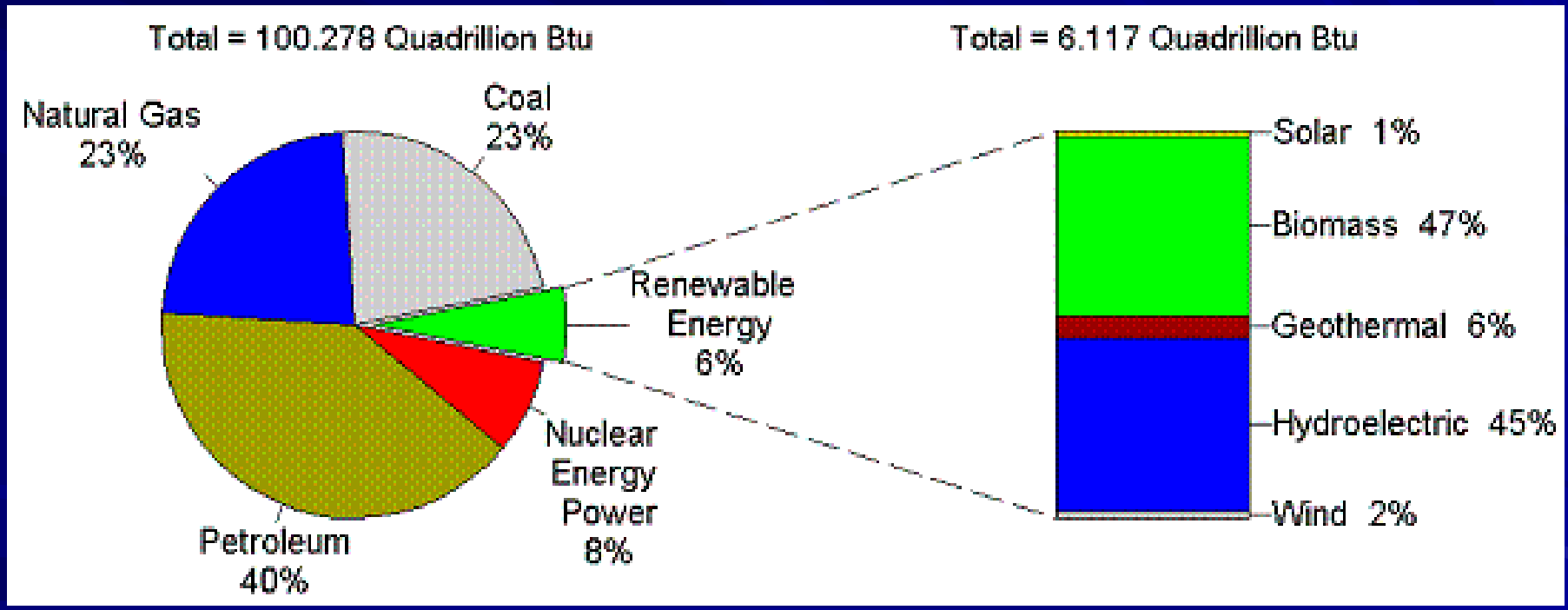
"SUPPLEMENTING THE BARREL"

Non-petroleum resources



THE ROLE OF RENEWABLE ENERGY IN THE 2004 UNITED STATES ENERGY SUPPLY

(from US EIA)



OPTIMUM USE OF ETHANOL

In gasoline at:

- 3 percent
- 10 percent
- as ETBE

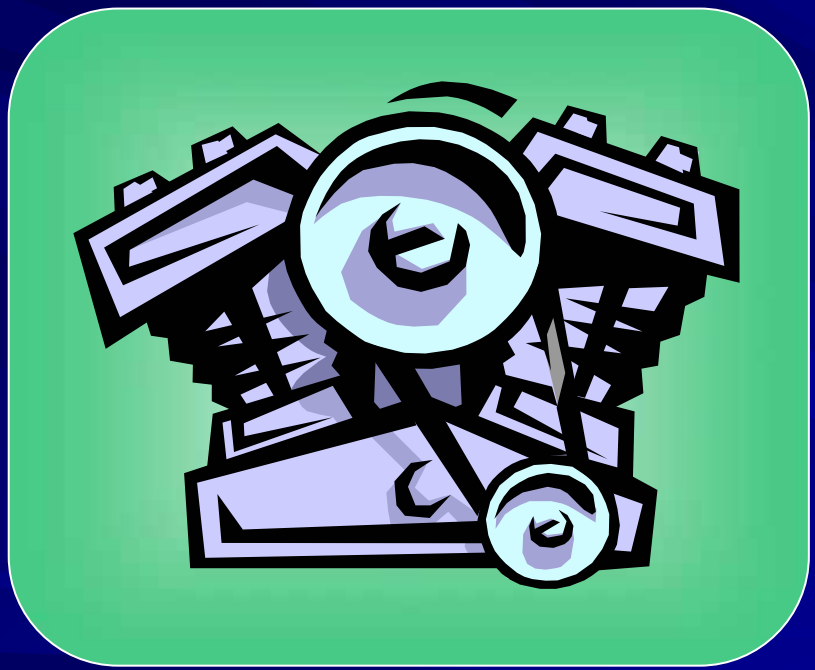
In specially designed vehicles:

- E85 (United States FFV's)
- Hydrated ethanol (Brazil)
- E100 (Sweden)

SAAB BIOPOWER CONCEPT CAR

High Efficiency Engine

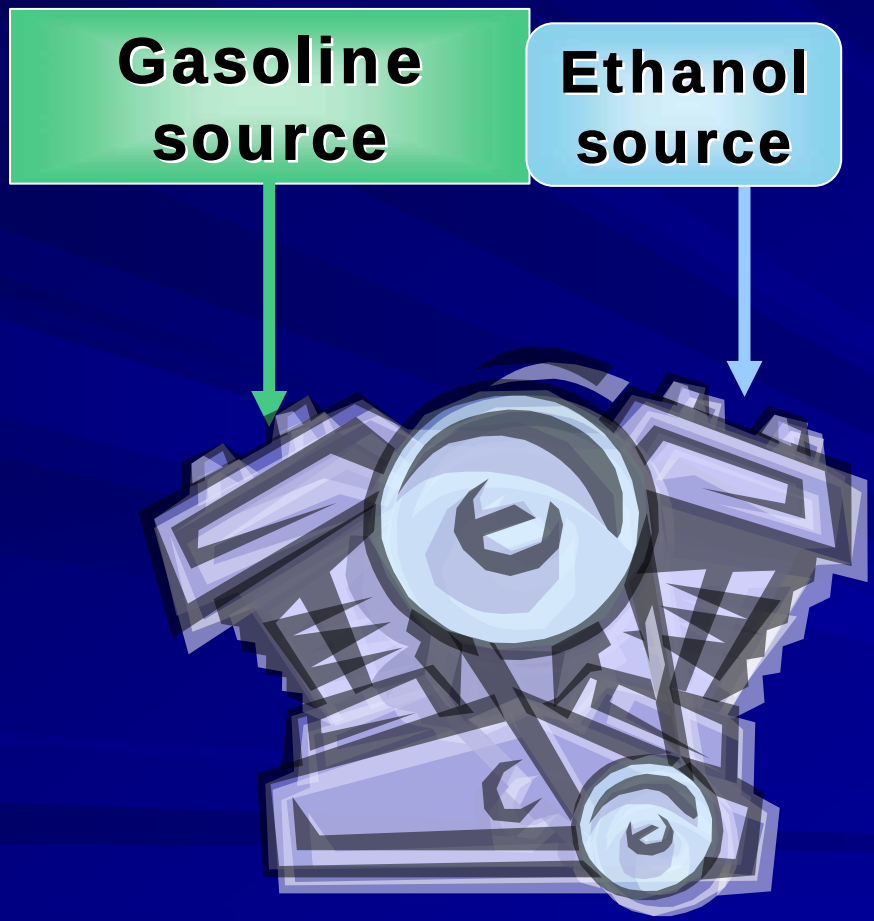
Replacement of a standard gasoline engine…



… with a much smaller, turbocharged engine with same power

Cohn, Bromberg and Heywood

Removing Knock Limit On Engine Power



Direct Injection suppresses knock at high torque

Highly turbocharged engine

BIODIESEL SOURCES

- Soy
- Rapeseed
- Coconut
- Palm
- Used cooking oil
- Algae
- Pulp/paper mill “black liquor and woody residue”

KEY ISSUES FOR BIODIESEL INDUSTRY

QUALITY !

QUALITY !

QUALITY !

REFINERY-BASED BIODIESEL

- **Neste Oil's Next Generation**

Biomass to Liquids (NExBTL) Technology

PERSPECTIVE ON UNITED STATES BIOFUELS CONTRIBUTION

Assumptions for 10 years from now

- All gasoline contains 10% ethanol
- All diesel fuel contains 20% biodiesel
- 30% of autos use E85

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Outcome

- US petroleum demand reduced 10%

ALTERNATIVE FUELS PERSPECTIVE

- LPG, CNG, LNG, Methanol, Electricity
- Some fleet use of LPG and CNG in Japan and United States
- Overall, a failure
- Less than 2% of US vehicles use alternative fuels

NON-PETROLEUM AUTOMOTIVE FUEL RESOURCES

- **Biomass**
- **Natural Gas**
- **Coal**
- **Tar Sands**
- **Oil Shale**

KEY FOR SUCCESS OF NON-PETROLEUM RESOURCES (EXCEPT FOR BIOMASS)

- Carbon Dioxide (CO_2) capture and sequestration

"WELL-TO-WHEELS" ANALYSES

To date

- Energy use
- Regulated emissions
- Greenhouse gas emissions

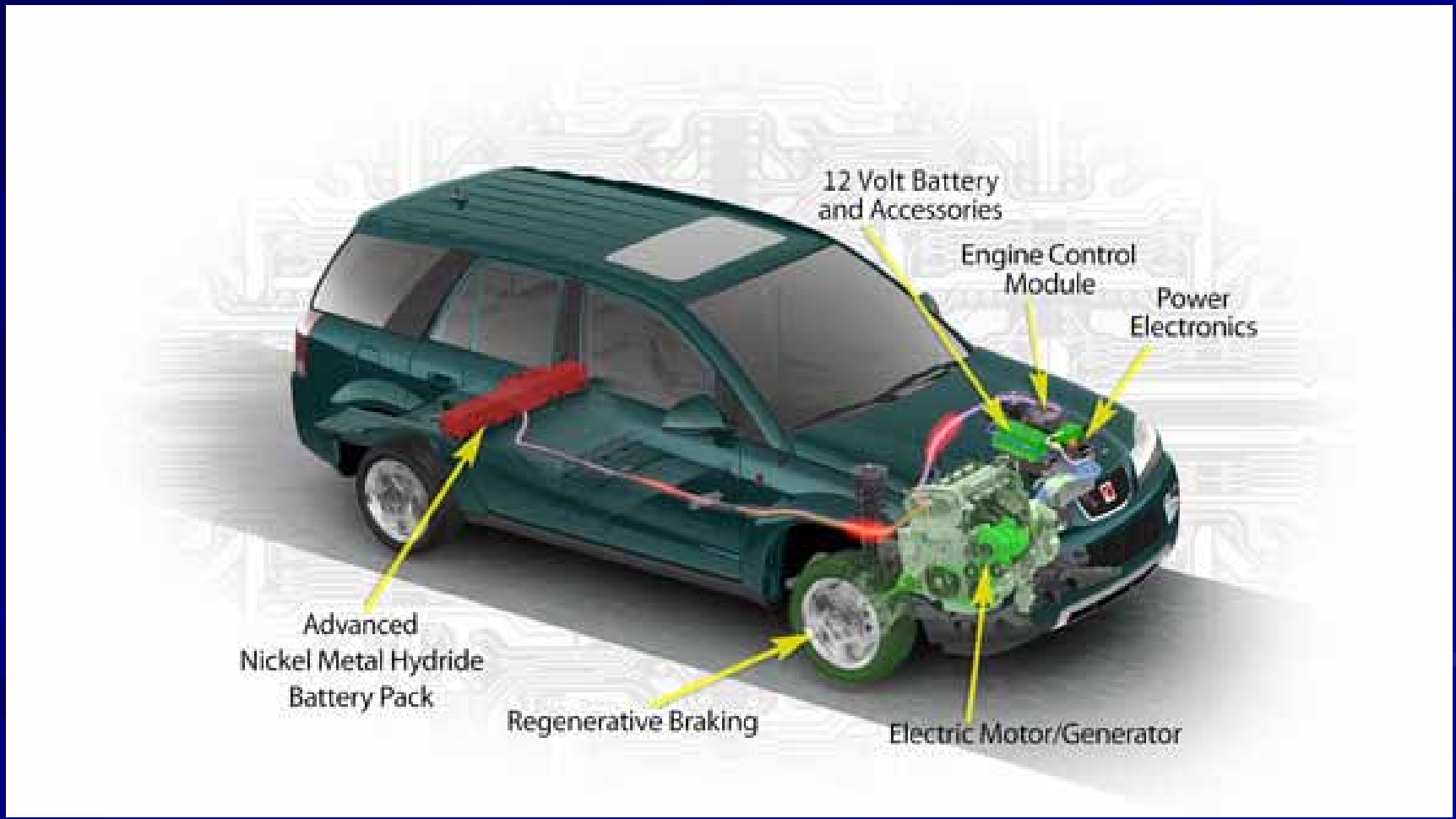
Needed

- "Well-to-wheels" cost

TOYOTA PRIUS HYBRID

GM CHEVROLET HYBRID

GM SATURN VUE GREEN LINE HYBRID SUV



GM HYBRID CITY BUS

The Auto / Oil Program

OUTLOOK FOR THE SHORT TERM; 10 to 15 YEARS

1. **Japanese and US vehicles will become more efficient**
   - Highly dependent on petroleum-derived gasoline and diesel fuel
2. **Both countries will remain heavily dependent on imported petroleum**
   - The situation will be more severe in Japan than in the US

OUTLOOK FOR THE SHORT TERM; 10-15 YEARS

3. **Ethanol and biodiesel will supplement conventional fuels**
4. **Tar sands, coal, natural gas, and oil shale will be increasingly used**
   - CO_2 capture and sequestration needed
5. **"Well-to-wheels" analyses will become more important**

THE LONGER TERM

>25 YEARS

GM'S LATEST HYDROGEN-FUELED FUEL CELL VEHICLE –

CHALLENGES FOR HYDROGEN-FUELED FUEL CELL VEHICLES

- **Fuel cell cost**
- **On-board storage**
- **Hydrogen production**
- **Hydrogen infrastructure**
  - Distribution
  - Storage
  - Refueling
- **“Well-to-wheels” cost analysis needed**

GM's EV-1 ELECTRIC VEHICLE

NUCLEAR POWER PLANT

GM'S PROTOTYPE CHEVROLET VOLT PLUG-IN HYBRID VEHICLE

OUTLOOK FOR LONG TERM; >25 YEARS

1. **Vehicles will continue to get more efficient with better engine and hybrid technologies**
2. **Japan and the United States remain heavily reliant on petroleum**
3. **Gasoline and diesel will be the primary fuels**
4. **Biofuels will be important contributors**

OUTLOOK FOR LONG TERM; >25 YEARS

5. **Other fuel sources will grow, but only if CO_2 capture and sequestration is successful**

6. **In both Japan and the United States, there could be resurgence in electric vehicles using domestic electricity from nuclear power stations**

7. **Hydrogen-fueled, fuel cell vehicles might be introduced in small numbers**

WHAT WILL SUPPLY THE WORLD'S ENERGY

100 YEARS FROM NOW ?

200 YEARS FROM NOW ?

400 YEARS FROM NOW ?