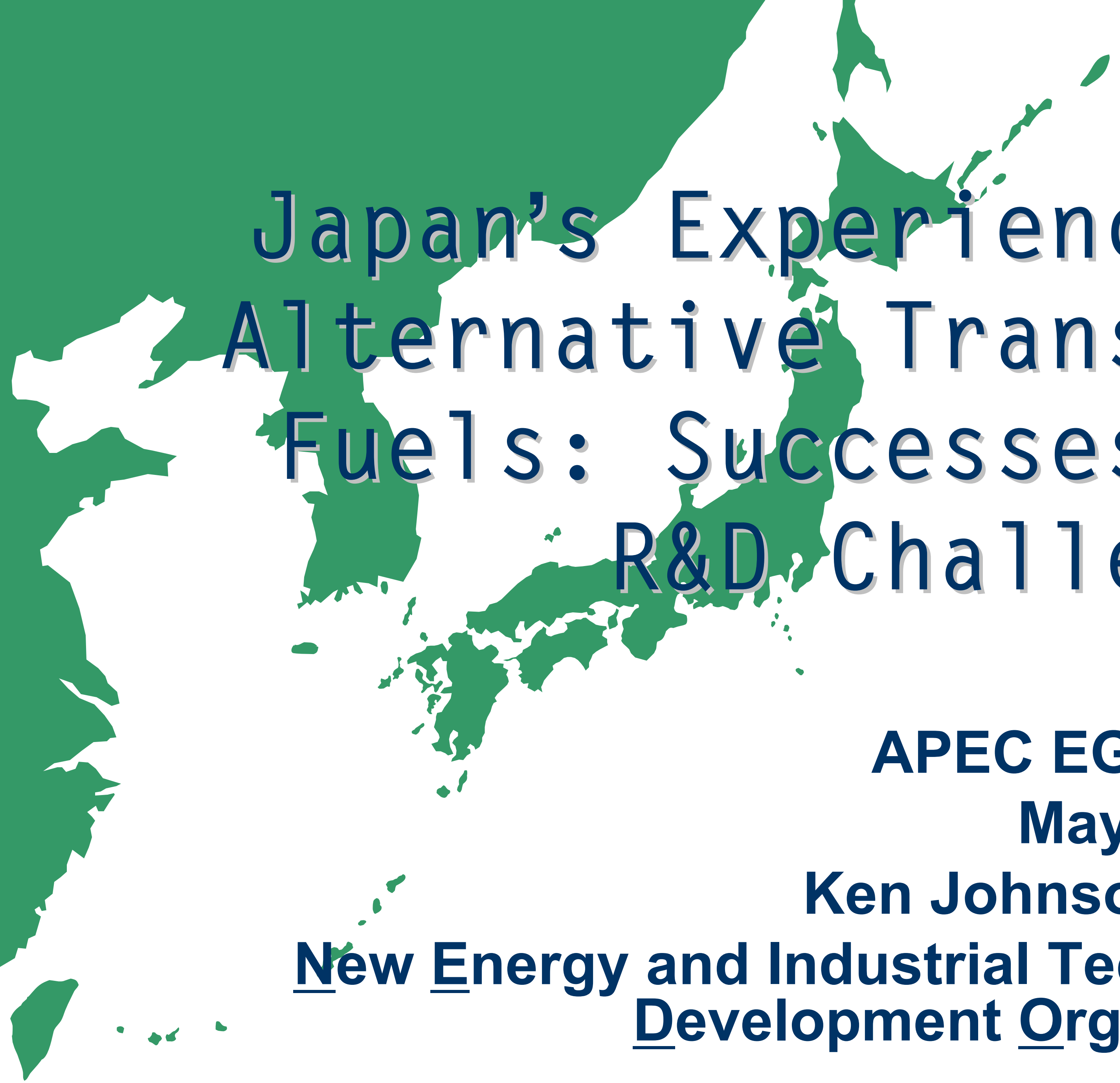


Japan's Experience in Alternative Transport Fuels: Successes and R&D Challenges

APEC EGNRET 24

May 18, 2005

Ken Johnson, NEDO

New Energy and Industrial Technology Development Organization

NEDO Background

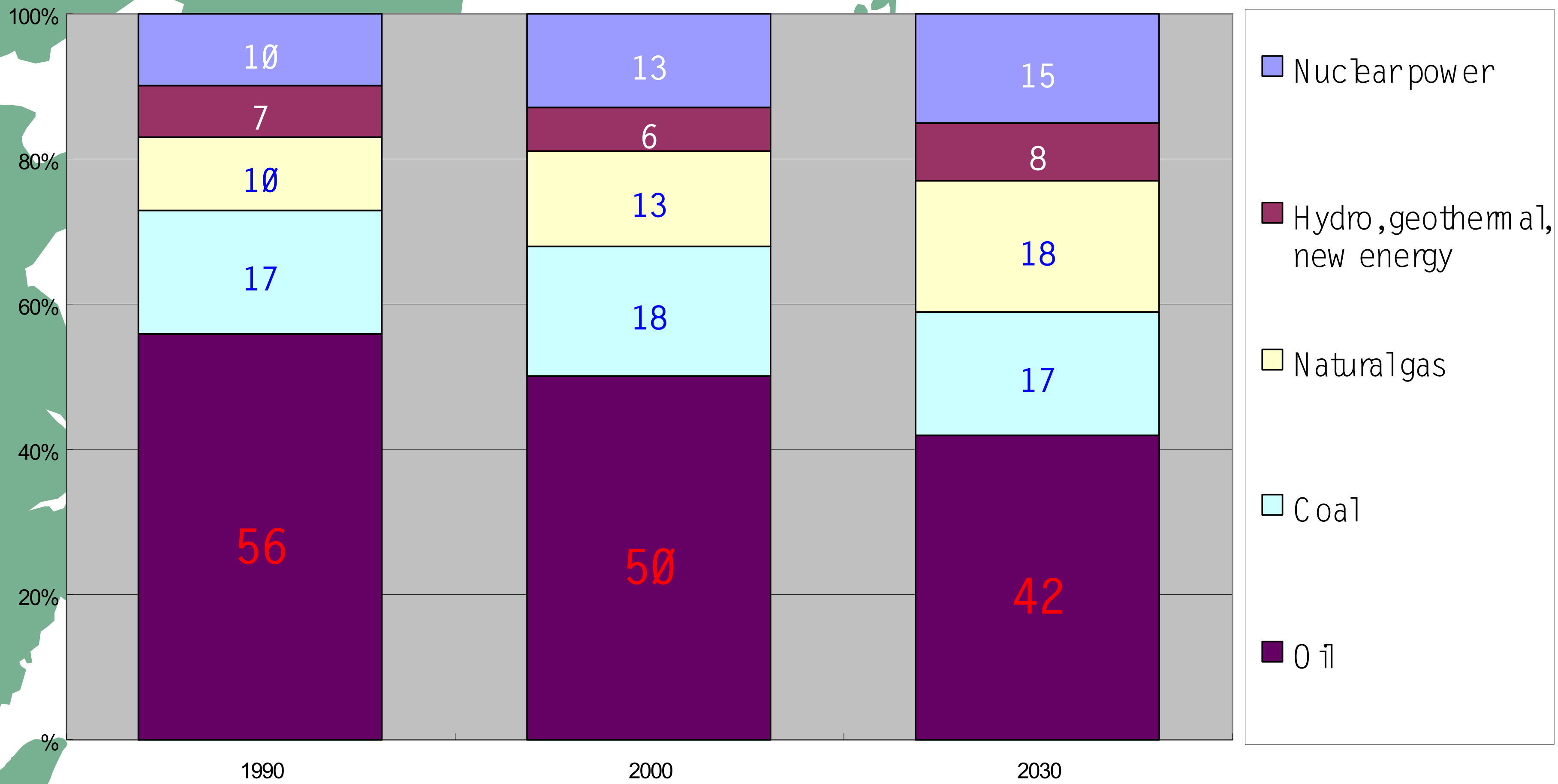
- Incorporated Administrative Agency under Japan’s Ministry of Economy, Trade and Industry (METI)
- Established: 1980, following the second oil crisis
- Number of personnel: 1000 (as of Apr. 2004)
- Capital: ~150 billion JPY ($1.43B) as of Apr. 2004
- Budget: ~250 billion JPY ($2.38B) Apr. 2004 □ Mar. 2005

Transport overview in Japan

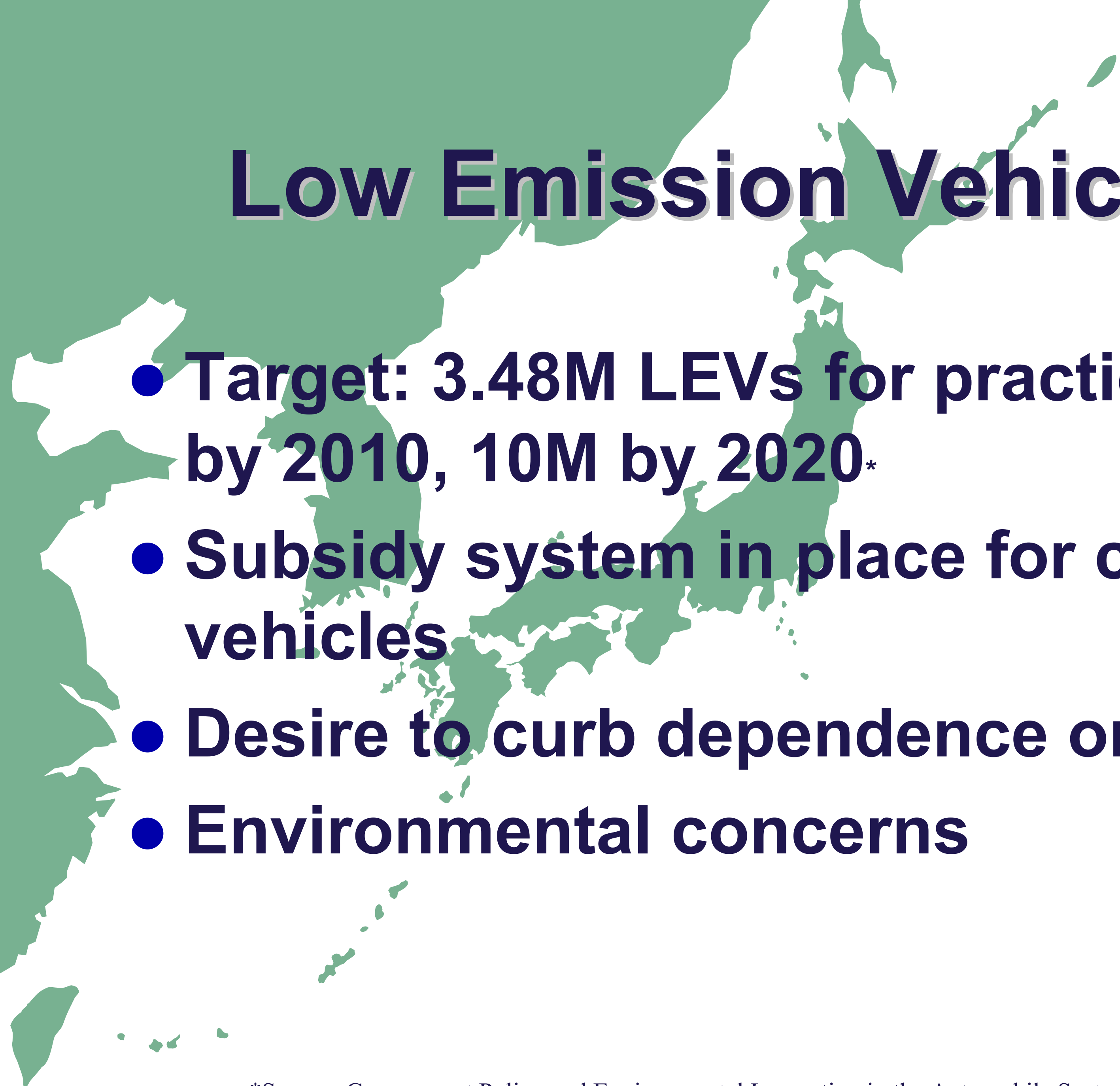
- Energy consumption in transport sector in 2002 2.1 times 1973 level*
- Automobiles are responsible for 40% of Japan's crude oil consumption**
- 20% of CO_2 emissions from transport sector**
- 70M registered vehicles in Japan***
- 4.2M new passenger vehicles registered annually***
- Need for 1) energy conservation, 2) alternative fuels

*Energy in Japan 2005; **Nikkei Net; ***Jama 2001

Japan's Primary Energy Supply



Source: Energy Outlook for 2030, Agency for Natural Resources



Low Emission Vehicles

- Target: 3.48M LEVs for practical use by 2010, 10M by 2020*
- Subsidy system in place for certain vehicles
- Desire to curb dependence on oil
- Environmental concerns

*Source: Government Policy and Environmental Innovation in the Automobile Sector in Japan, January 2004, Max Ahman

Alternative Transport Fuels in Japan

- Electricity
- Hydrogen
- CNG
- LPG

- Ethanol
- Biodiesel (BDF)
- Methanol
- DME (Di-Methyl Ether)

Electric

- **Electric Vehicles (EV) target 110,000 by 2010***
- **Challenges:**
  - **Acceleration power, limited range, electricity generation=CO2 emissions**
  - **Cost**
  - **Battery volume, weight**

*Source: Government Policy and Environmental Innovation in the Automobile Sector in Japan, January 2004, Max Ahman

Hybrid Electric Vehicles

Source: toyota.com

- Hybrid Electric Vehicles (HEV) target 2.06M by 2010*
- Most HEV R&D is being carried out by private sector
- No need to plug-in for re-charge
- Challenges:
  - Low-cost batteries, cost

*Source: Government Policy and Environmental Innovation in the Automobile Sector in Japan, January 2004, Max Ahman

Hydrogen-Fuel Cell

- World leader in hydrogen technology
- Successful public-private-academic R&D partnership
- Aiming for full commercialization by 2020
- Fuel Cell Vehicle 2010 target: 50,000*
  2020 targets: Vehicles: 5M*
- Largest alternative fuel R&D budget in Japan

*METI

Hydrogen Accomplishments

- Safety advance: Development of hydrogen-absorbing alloys for hydrogen storage, 2.5% mass ratio, inflammable while absorbing and discharging. Next target 5.5%
- Ten+ hydrogen fuel stations have been built in Japan and are operable

Photo http://web-japan.org/nipponia/nipponia28/en/feature/feature03.html

Hydrogen Challenges

- Cost
  - Vehicles, infrastructure, etc.
- Safety
- Weight, size of storage tanks
- Driving distance
- Best way to produce hydrogen?
- Enhancing public awareness
- Starting engine under cold weather conditions

Hydrogen-Internal Combustion

- Mazda Hydrogen Rotary RX-8
- Dual fuel system (hydrogen/gasoline)
- Currently in test phase
- May be sold commercially in 2 years
- Hydrogen tank in trunk
- Challenges: storage, safety

Photo:http://media.ford.com/mazda/article_display.cfm?article_id=17134&CFID=4320745&CFTOKEN=47855328af9ba7c9-D4E98F50-F209-6BC8-2B04B1C51FF6AE97&jsessionid=b430208131d7$F4$EF$C

Shonandai CNG Station

CNG

- March 2004: 20,000 vehicles on the road
- 300+ fueling stations
- Natural Gas Vehicle 2010 target: 1M*
- Success as route buses and delivery vehicles in urban areas
- Challenges:
  - Limited fuel storage=limited driving distance

*The State of NGVs in Japan, Kenichi Hayata, Japan Gas Association.

Photo: http://www.isuzu.co.jp/world/press/news_event/n_030425.html

LPG

- LPG Trucks 2010 target 260,000*
- 94%, (260,000) taxis run on LPG**
- Second largest user (behind South Korea) of LPG as an auto fuel
- Very safe
- Adequate refueling stations
- Rising fuel costs

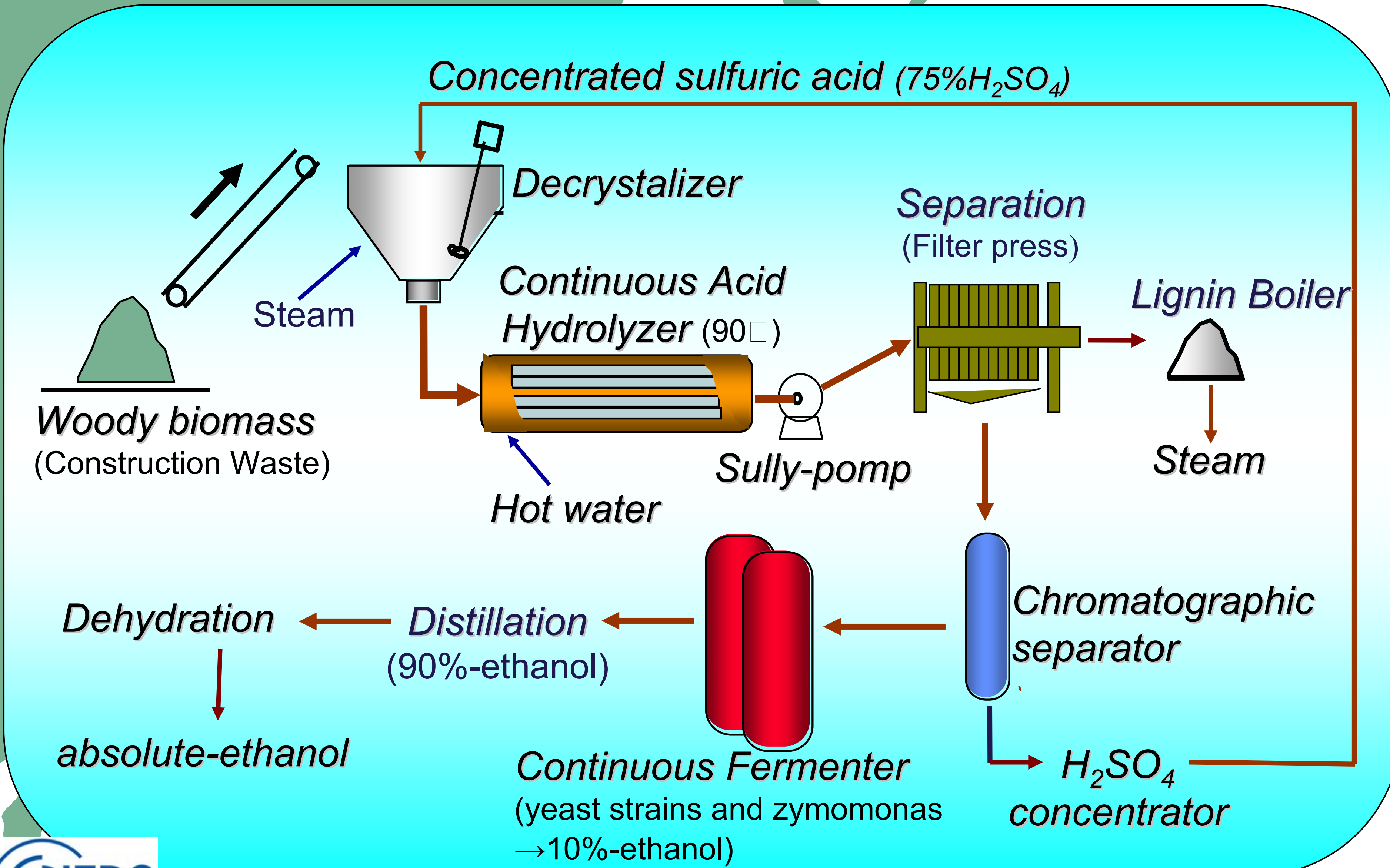
*Agency of Natural Resources and Energy, Japan, 2001

**Clean Air Initiative for Asian Cities

Ethanol

- Recently passed a measure that allows an ethanol blend up to 3% (E3)
- Currently studying conversion of wood waste to ethanol
- Project budget: 3.1B Yen (US$ 30M)
- Challenges:
  - Woody biomass sugar yield is low
  - Improving energy recovery rate (>35%)
  - Lack of suitable agricultural materials
  - Cost of producing ethanol domestically

Development of fuel ethanol production from cellulosic biomass based on highly efficient ethanol fermentation

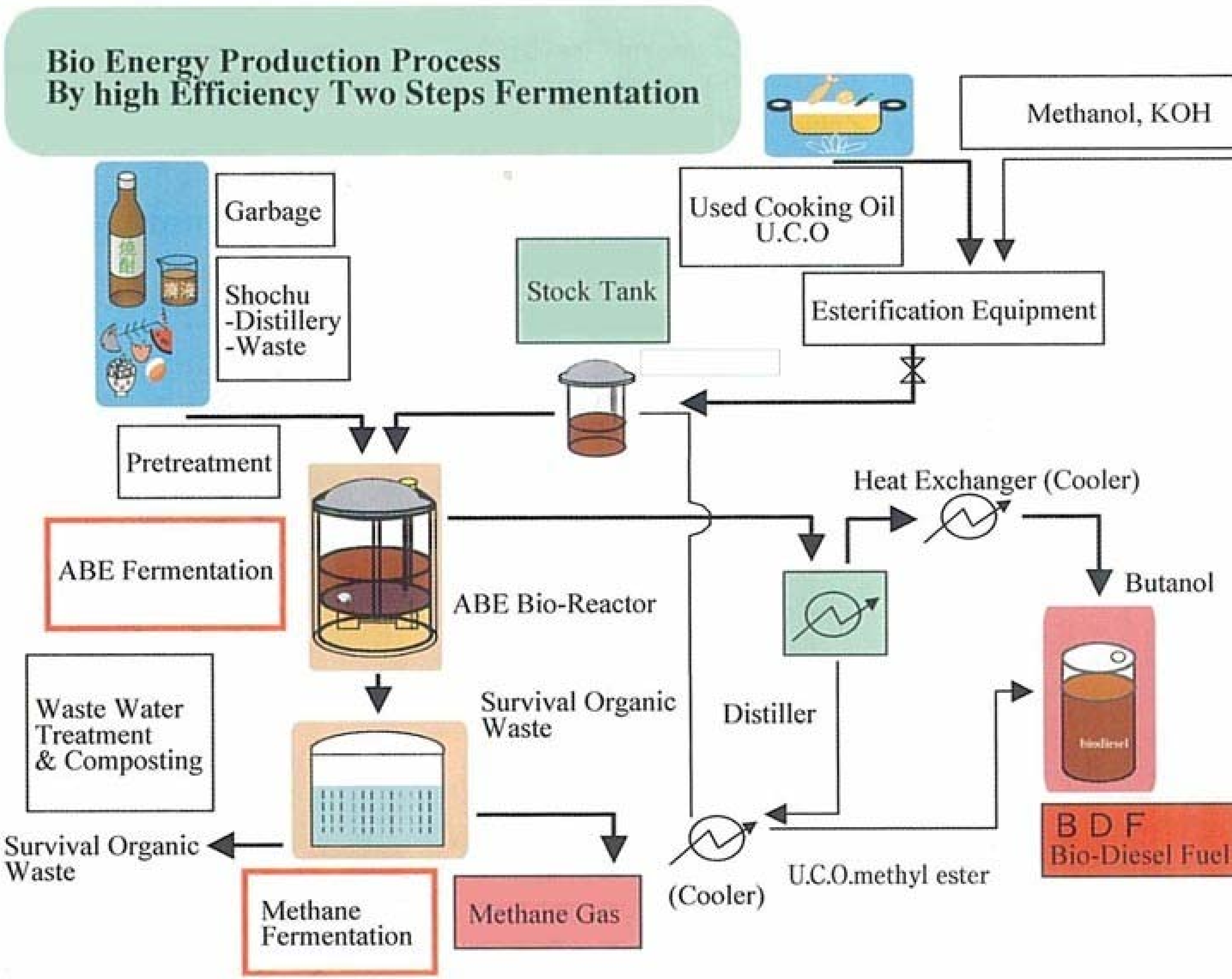


Biodiesel

- NEDO funding "R&D for BDF by 2-Step Supercritical Methanol Method" FY2003-2006
- Project budget: 840M Yen (US$ 8M)
  - Objective: to develop non-catalytic biodiesel production by supercritical methanol treatment
    - Super reaction time, purification
    - Higher yield
    - High processing cost

Research & Development for Biodiesel Fuel (BDF) Production by Two-Step Supercritical Methanol Process

System Configuration



Methanol

- Development of Highly Efficient Energy Conversion to Liquid & Gas Fuel by Biomass Gasification Technology
- Project budget: 1.34B Yen (US$ 12.8M)
- Future plans to blend biomass derived methanol with BDF (impurities are too high to be used with fuel cells)

DME (Di-Methyl Ether)

- Well known since 19th century
  - Low toxicity, highly soluble, similar physical properties to LPG, sulfur free
  - Synthesized from Methanol, can be mfg from many resources
  - Applications: diesel, FCV, hydrogen source
  - Can be reformed as H2 at much lower temp’s.
  - Commercialization underway in China, S. Korea

Source: Prof. Fujimoto, Japan DME Forum

DME Highlights

Liquefies at -25°C →	Can be stored and transported like LPG
Higher cetane value than diesel →	Can be used in diesel engines
Safe, no adverse health impact →	No problems expanding use
Decomposes in the atmosphere in several tens of hours →	No concern over ozone layer depletion (alternative to CFCs)
No sulfur content →	No SOx emission from combustion
No direct carbon bonds (CH_3-O-CH_3) →	No particulate matter (PM) or soot emission from combustion
Lower-temperature catalytic reforming than gasoline →	Better fuel for fuel cells

Source: JFE Holdings