Environmental, Energy and Mobility Challenges during the 21st Century

Dr. Dennis Schuetzle, Director
International Research and Technology
Asia Pacific, South America and South Africa
Ford Research Laboratory

GLOBAL CHALLENGES FOR THE TRANSPORTATION INDUSTRY

PROTECT THE GLOBAL ENVIRONMENT

CONSERVE ENERGY AND RESOURCES

PROVIDE EFFICIENT AND SAFE MOBILITY

ENHANCE COMMUNICATION

AND EDUCATION

SOLVING FUTURE CHALLENGES - APROACHES

- Develop an Understanding of Personal Transportation – Past and Present
- Establish Cooperative Partnerships between Industry, Government and Academia
- Support Workshops to help develop Key Recommendations
- Consider the Future Needs and Requirements of Customers – Obtain Input from Diverse Groups
- Establish Programs to develop New and Improved Technologies and Approaches

SOLVING FUTURE CHALLENGES - APROACHES

- Utilize Energy, Environmental and Economic (EEE) Life Cycle Models as a Major Systems Approach Tool
- Implement the Most Viable Approaches
- Educate the Public and Policy Makers

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Automotive Technology
Yesterday, Today and Tomorrow

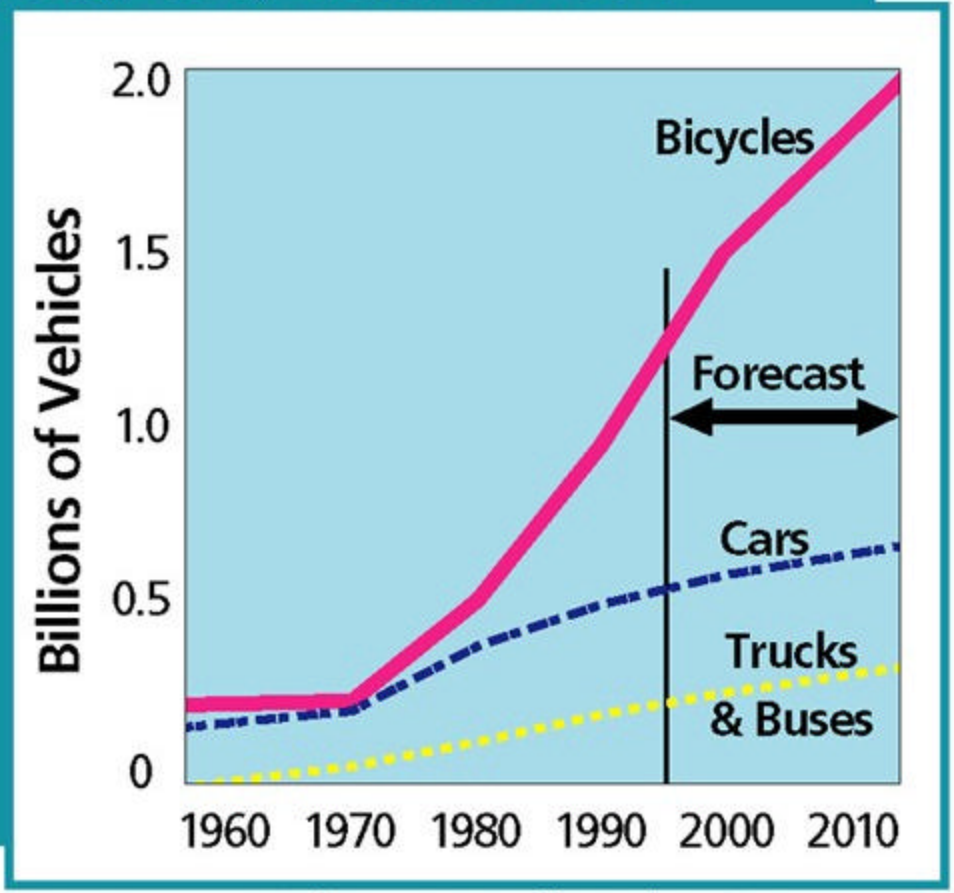
Public Transportation

Personal Use Vehicles

Recreational Vehicles

Aerospace

World Vehicle Fleets:
Bicycles, Cars, Buses & Trucks



Data Source: "Vital Signs", World Watch Institute
Earthscan London, 1996 ©Alan A Park

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CHINA AUTOMOTIVE TECHNOLOGY WORKSHOP ORGANIZATION MEETING
中国汽车技术研讨会筹备会
KONGHUI GUO
NI WEI-DOU
DENNIS SCHUETZLE
WENG SHUE
DON RAO

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China Automotive Technology Workshop Recommendations

Sponsored by

Ford Motor Company

Chrysler Corporation
North American Automotive Suppliers

In Cooperation with

State Science and Technology Commission, China
Ministry of Machinery Industry, China
National Environmental Protection Agency, China
Chinese Academy of Science
China National Natural Science Foundation
China Automotive Technology and Research Center
China Academy of Engineering
Tsinghua University
SAE China
U.S. Department of Commerce
U.S. Department of Energy
U.S. Environmental Protection Agency
National Science Foundation - U.S.
SAE International

26-28 OCTOBER 1995 • BEIJING, CHINA

95-1662

Philippine Automotive Technology Conference/ Workshop

The Commercial Service
United States of America
Department of Commerce

10-14 April 2000, Dusit Hotel Nikko, Manila, Philippines

Honorary Co-Chairs

Vaughn A. Koshkarian
President, Asia Pacific Operations
Ford Motor Company

Rudy Schlais, Jr.
Group Vice President,
General Motors Corporation

Dakila B. Fonacier
Undersecretary, Board of Investments
Department of Trade and Industry
Philippines

Willie Evangelista
Undersecretary, Department of Transportation and Communication

General Motors Corporation

SAE INTERNATIONAL

Ford Motor Company

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ICE MOUNTAIN

Ford Motor Company
ENTRANCE
Ford

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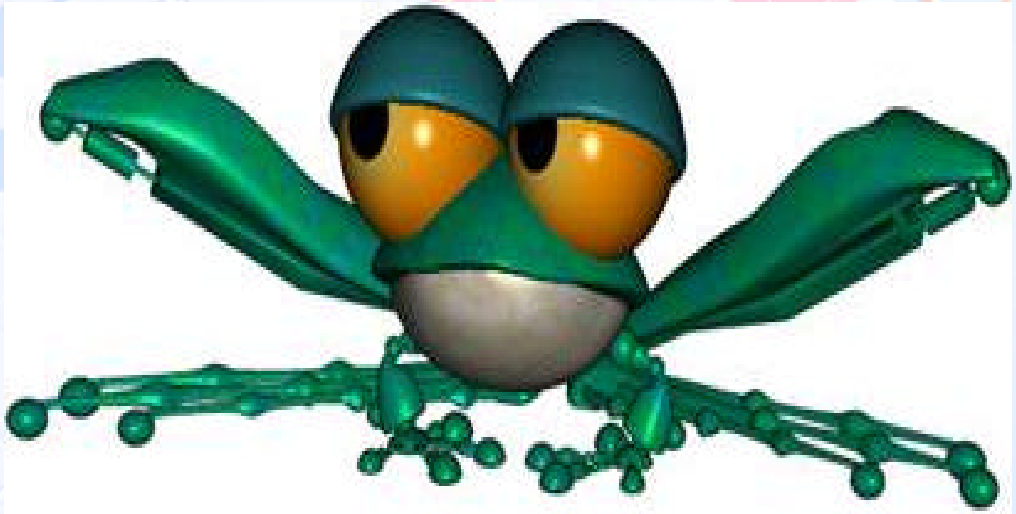
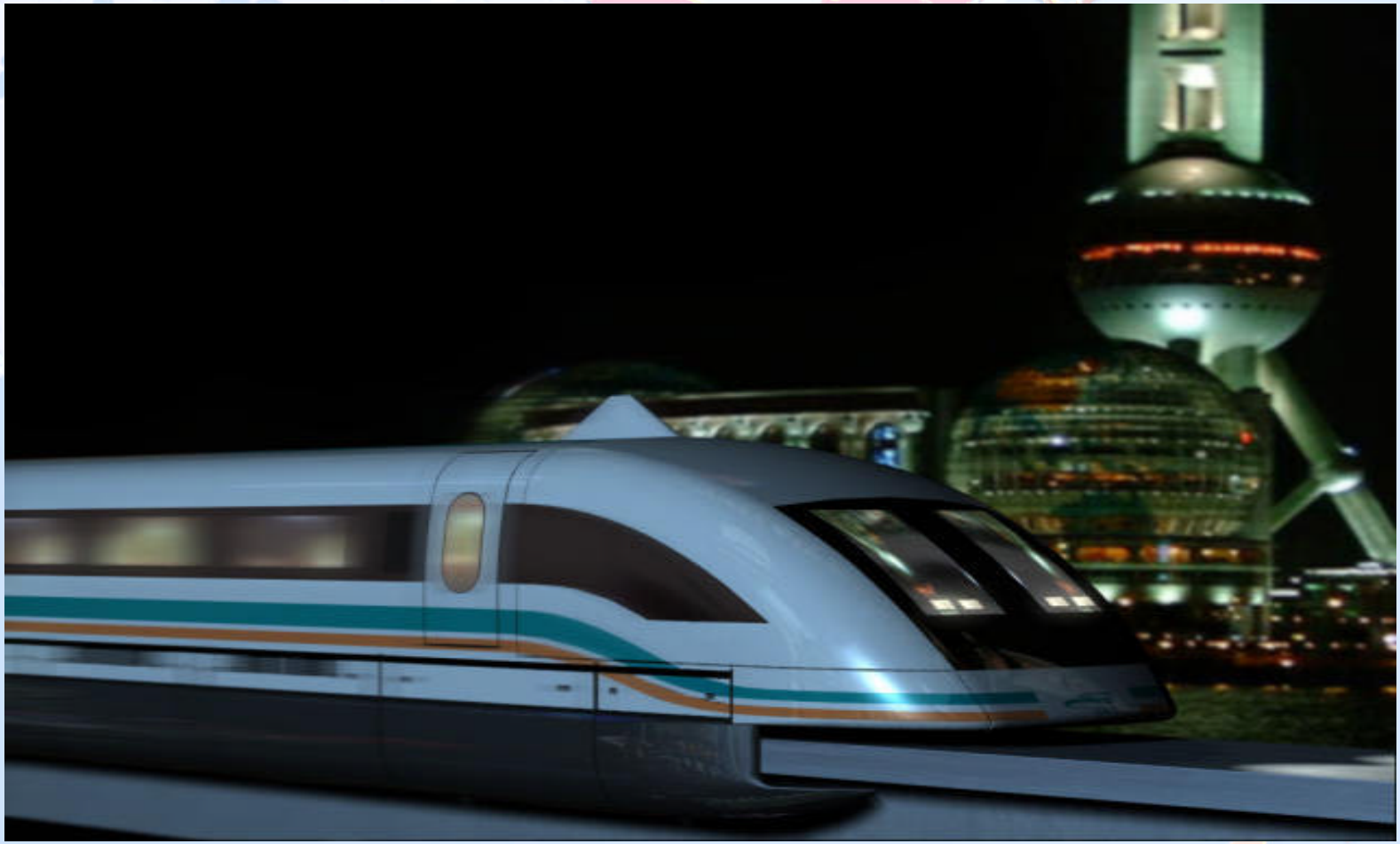
LEAPFROG TECHNOLOGIES

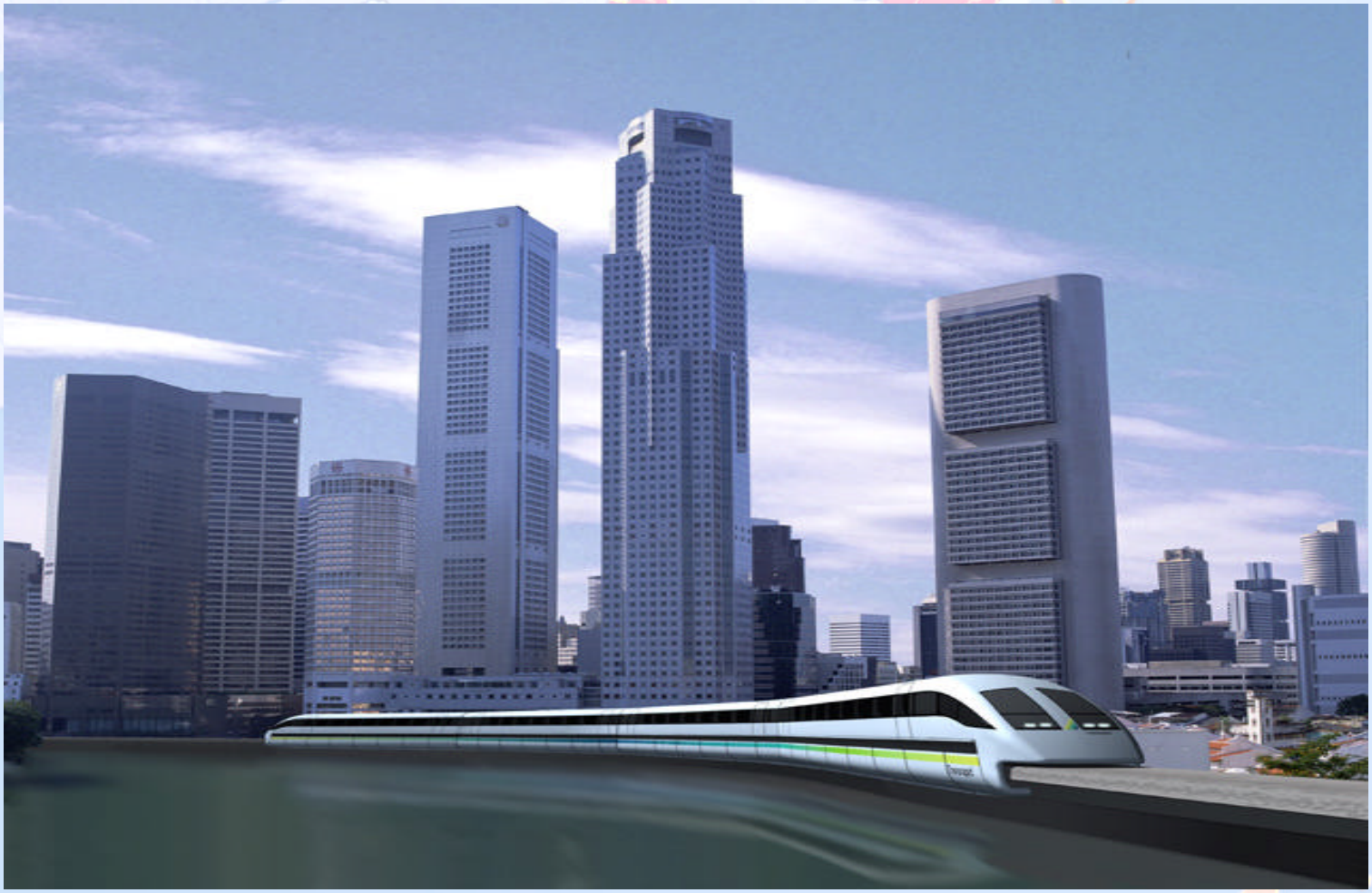


The Deployment of Cutting-Edge Technologies In Emerging Market Countries in Advance of their Deployment in Mature Market Countries

MAGLEV PROPOSED TO MAYOR XU KUANGDI BY SCHUETZLE AND POWERS AT SHANGHAI HIGH-TECH CONFERENCE (10/2000)



MAGLEV TRAIN TO BECOME OPERATIONAL IN SHANGHAI DURING 2003



GLOBAL CHALLENGES FOR THE TRANSPORTATION INDUSTRY

PROTECT THE GLOBAL ENVIRONMENT

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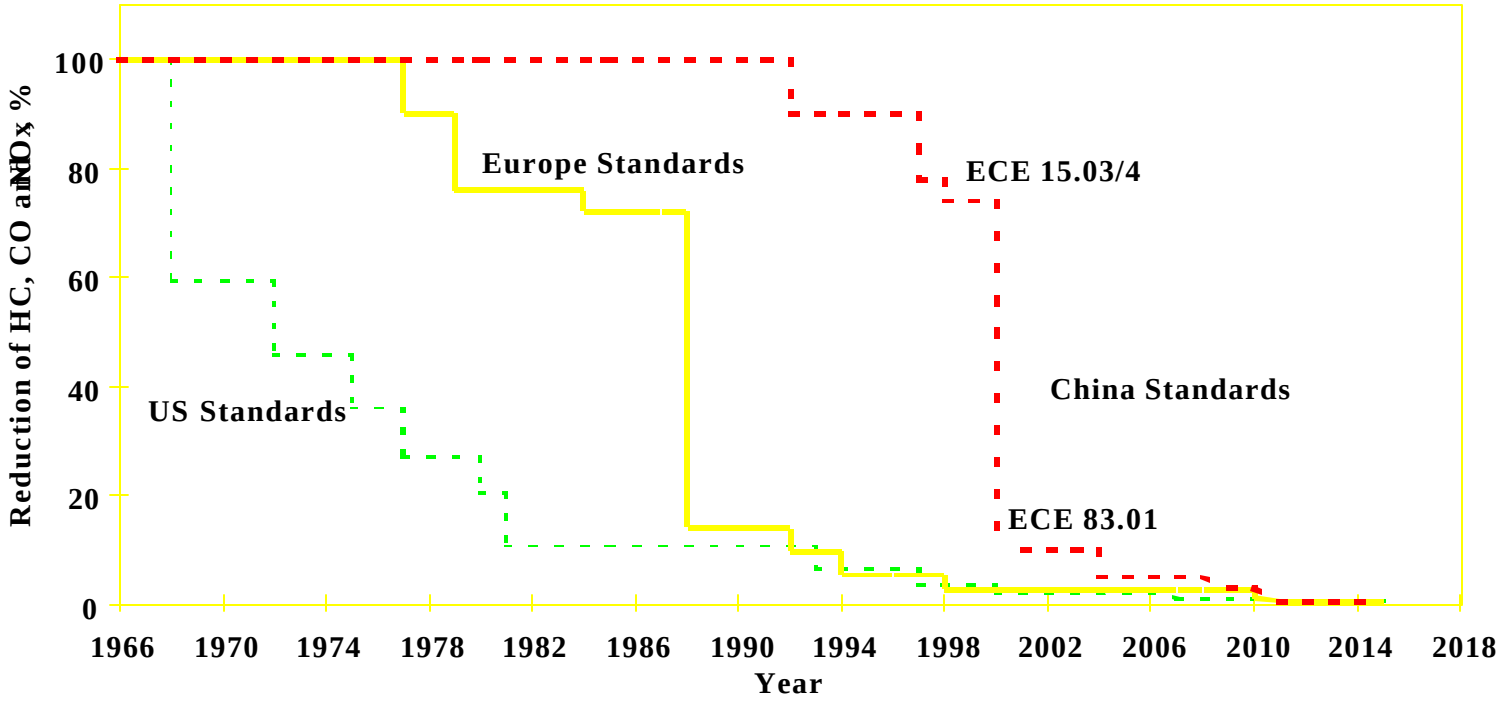
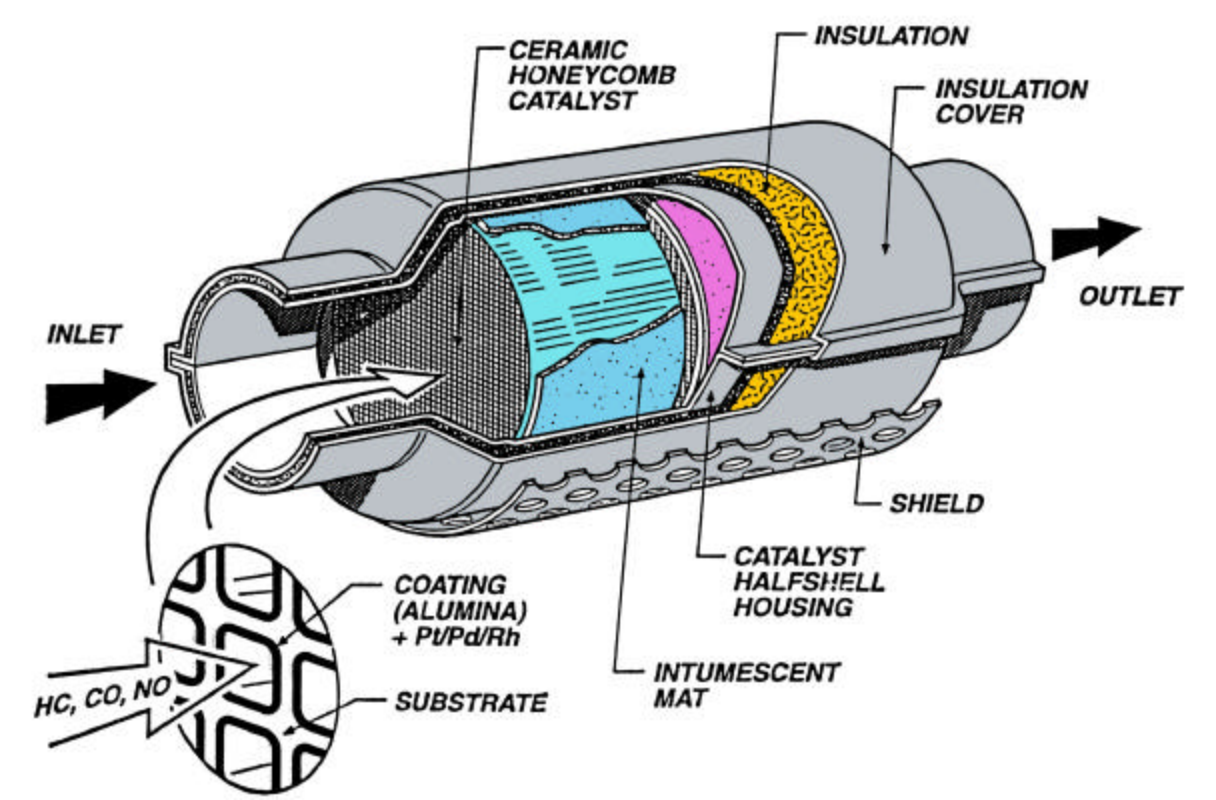
Automotive Emission Control Progress



Confidential

Development of Low-Cost, Rare-Earth Oxide (REO) Emission Control Systems



Introduction

- **Objective**

  Develop a low cost and robust catalytic converter for vehicles which utilizes China's abundant rare earth resources and technologies

- **Agreement**

  Ford and Chinese Government (September 1996)

- **Cooperative R/D partnership**

  Joint research efforts

  Patents and licensing

- **Selection of Research Partners**

  Chinese Institutes (2) to develop REO formula

  Chinese Universities (2) to do basic research

  Catalyst Suppliers - Johnson Mathey and Englehard

  Substrate Suppliers – Corning and Shanghai Institute of Ceramics

Formulation Research & Development

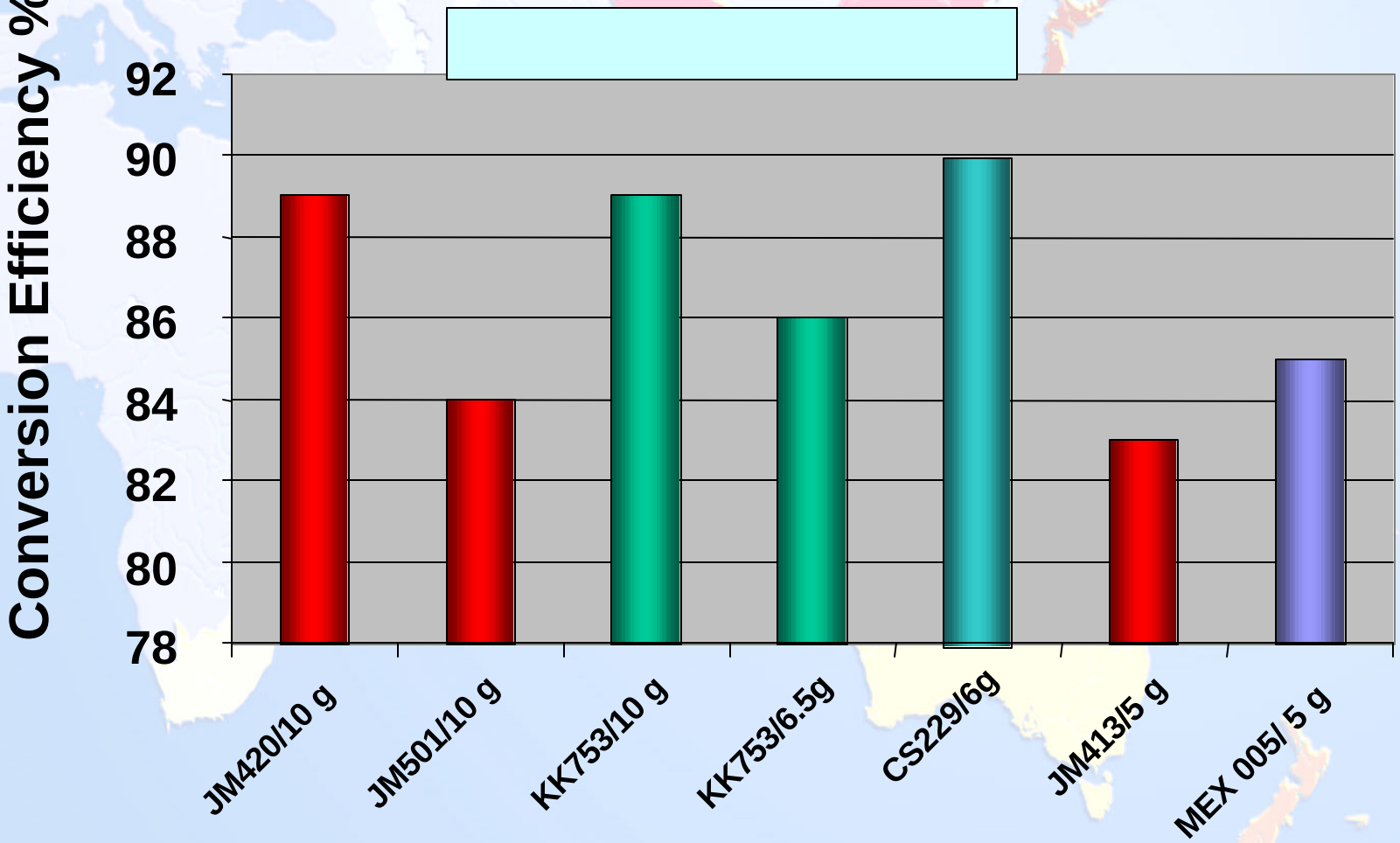
Two Chinese Institutes (out of 12) Successfully Developed Prototype REO Formulas

- Kunming Precious Metal Institute
- Dalian Institute of Chemistry and Physics

Two Institutes (out of 10) Chosen to Carry Out Long-Term Fundamental Research & Development

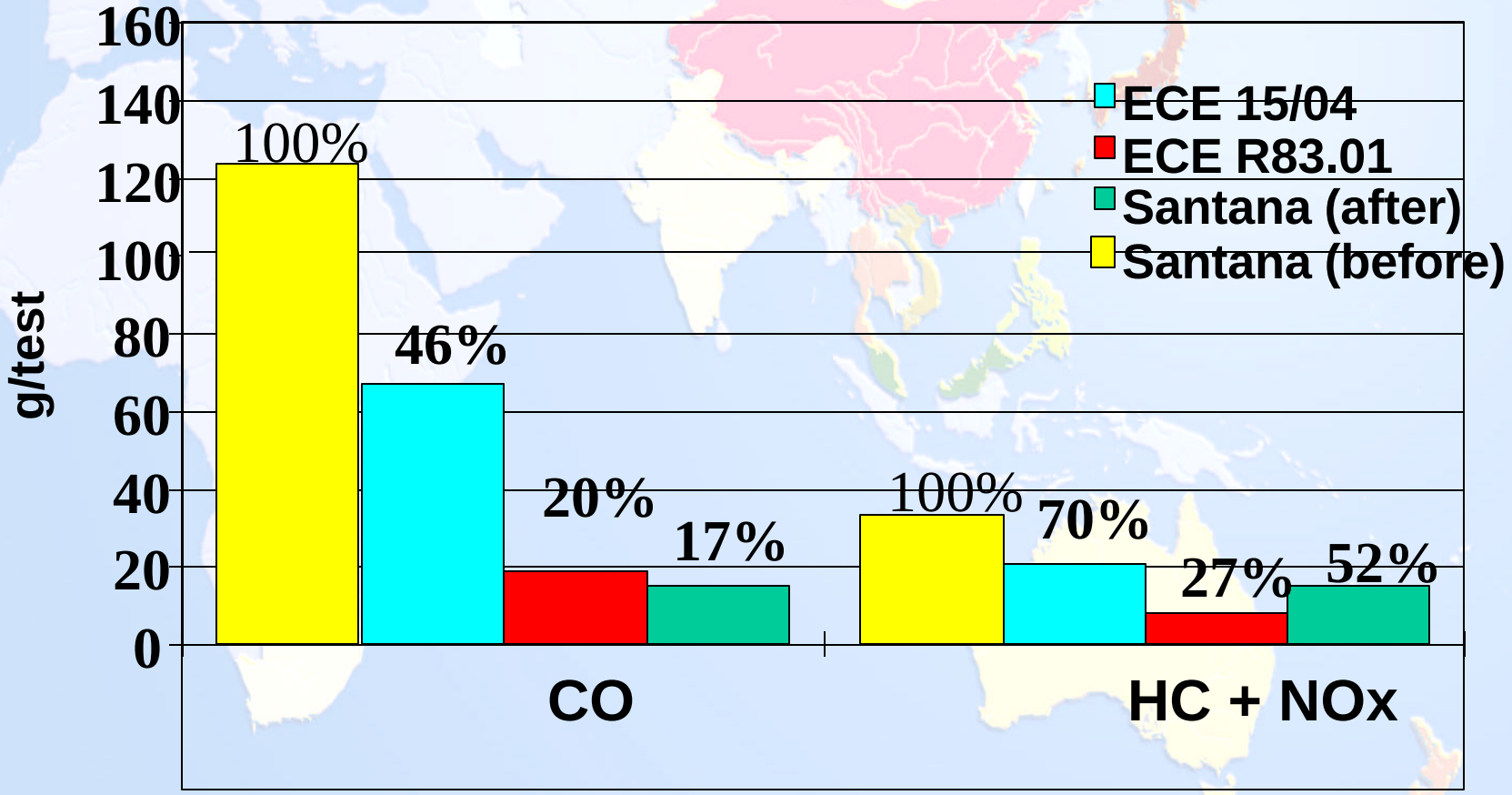
- China University of Science and Technology
- Fudan University

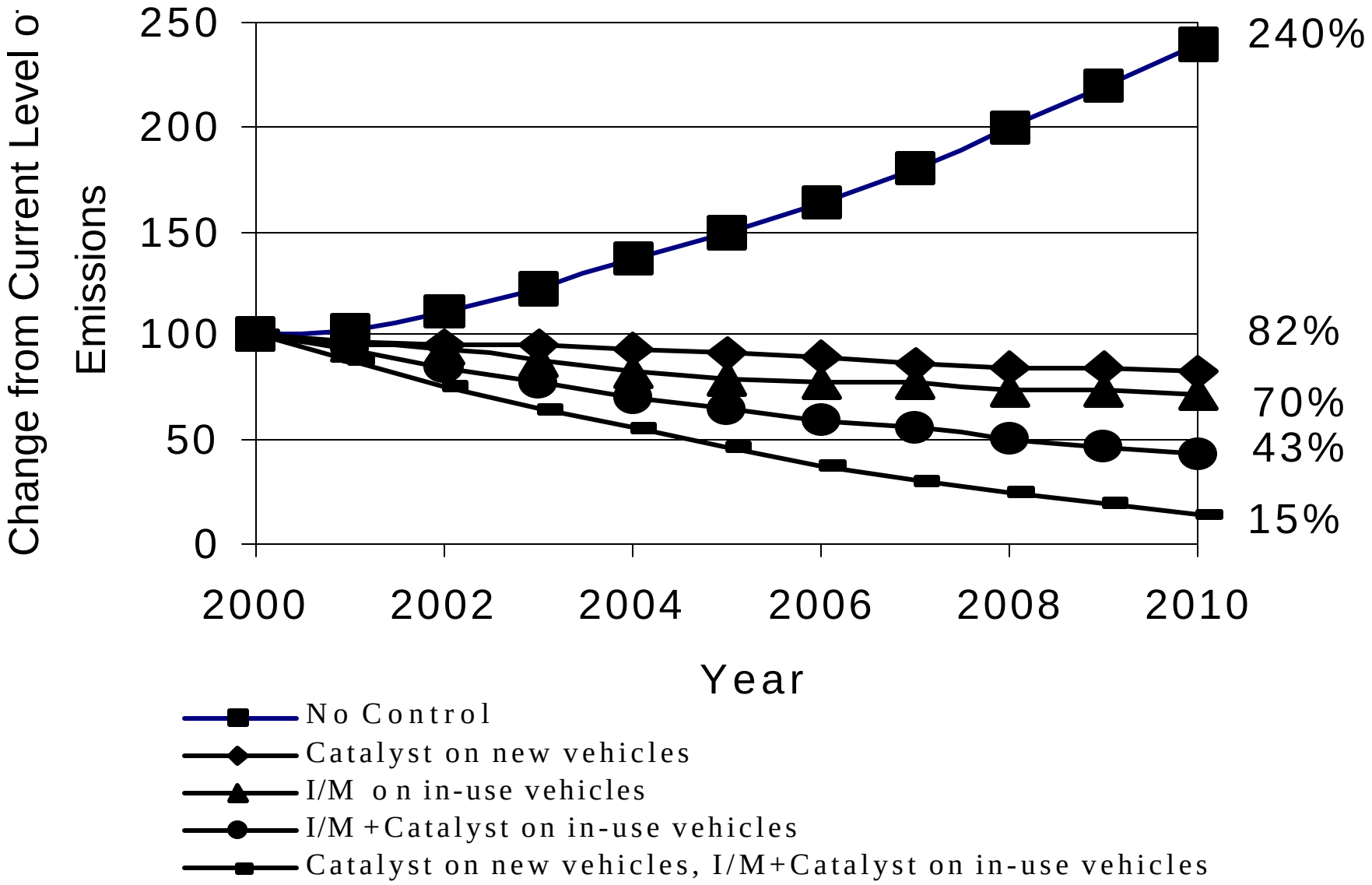
Performance of REO/Low Precious Metal Catalysts for Control of HC Emissions



TJ7100U
云A·T1457
JS6601

Conversion Efficiency for Retrofit



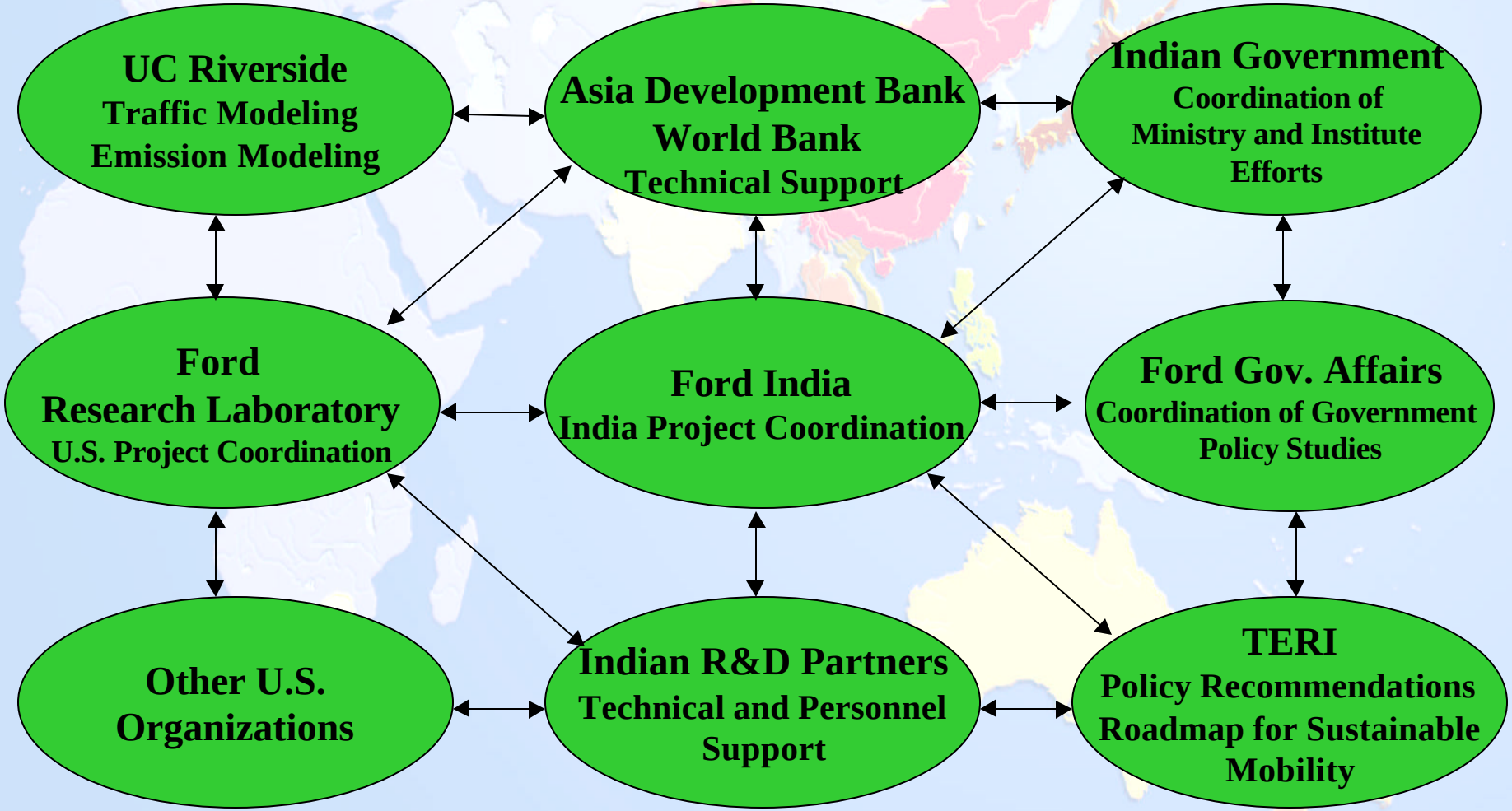

Effect of Various Light-Duty Vehicle Emission Control Strategies in Shanghai
Change from Current Level o
Emissions
250
200
150
100
50
0
2000
2002
2004
2006
2008
2010
Year
240%
82%
70%
43%
15%
No Control
Catalyst on new vehicles
I/M on in-use vehicles
I/M +Catalyst on in-use vehicles
Catalyst on new vehicles, I/M+Catalyst on in-use vehicles

Confidential

FORD RECEIVES THE 2001 PACIFIC BASIN ECONOMIC COUNCIL AWARD FOR THE DEVELOPMENT OF THE LOW COST RARE-EARTH OXIDE CATALYST

Ford Receives the Yunnan China Technology Award for the REO Catalyst (September 25, 2002)

India Environmental and Mobility Program



New Delhi

Mumbai

South-Central Delhi: Morning of 03/20/02

South-Central Delhi: Afternoon of 03/21/02

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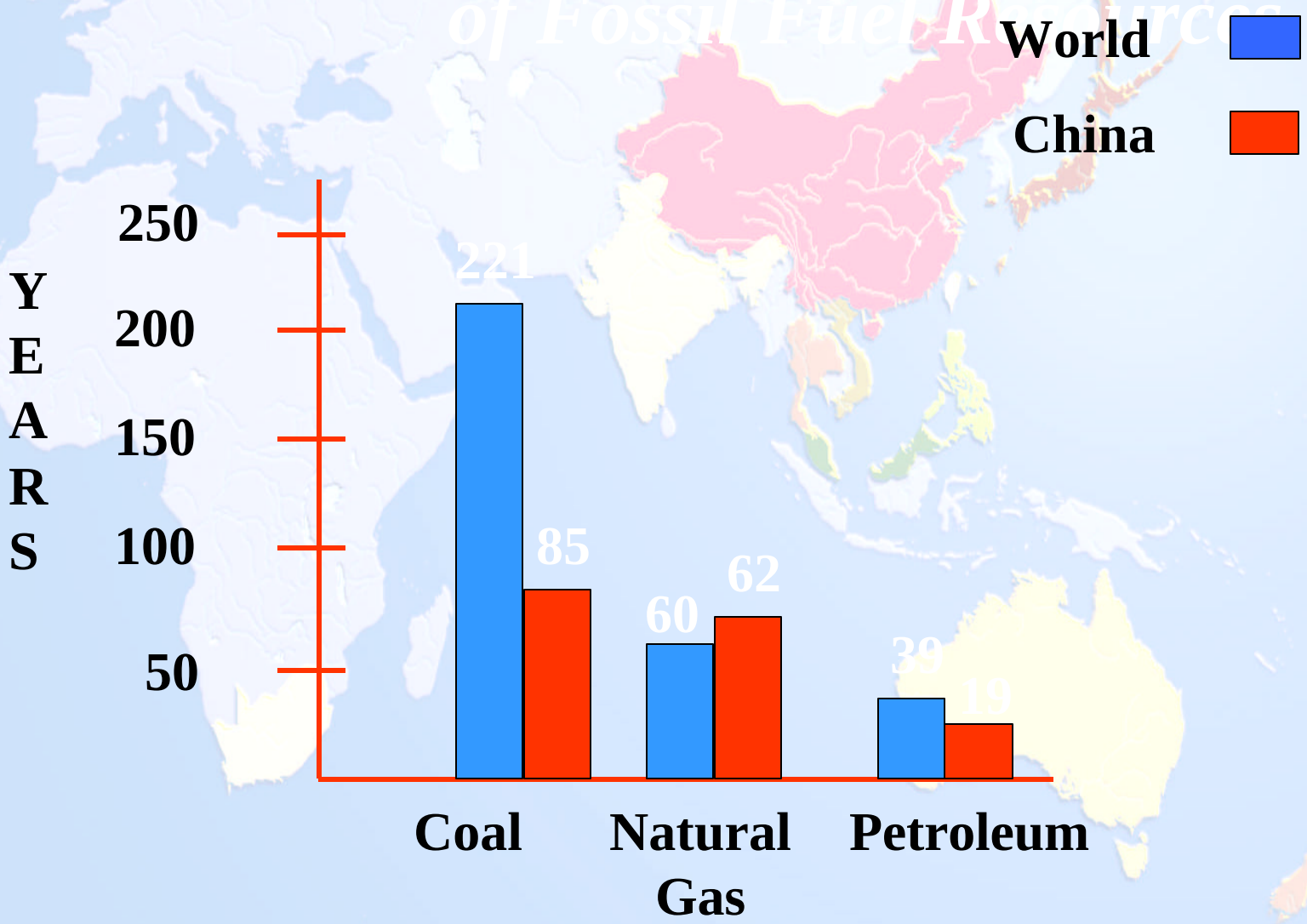
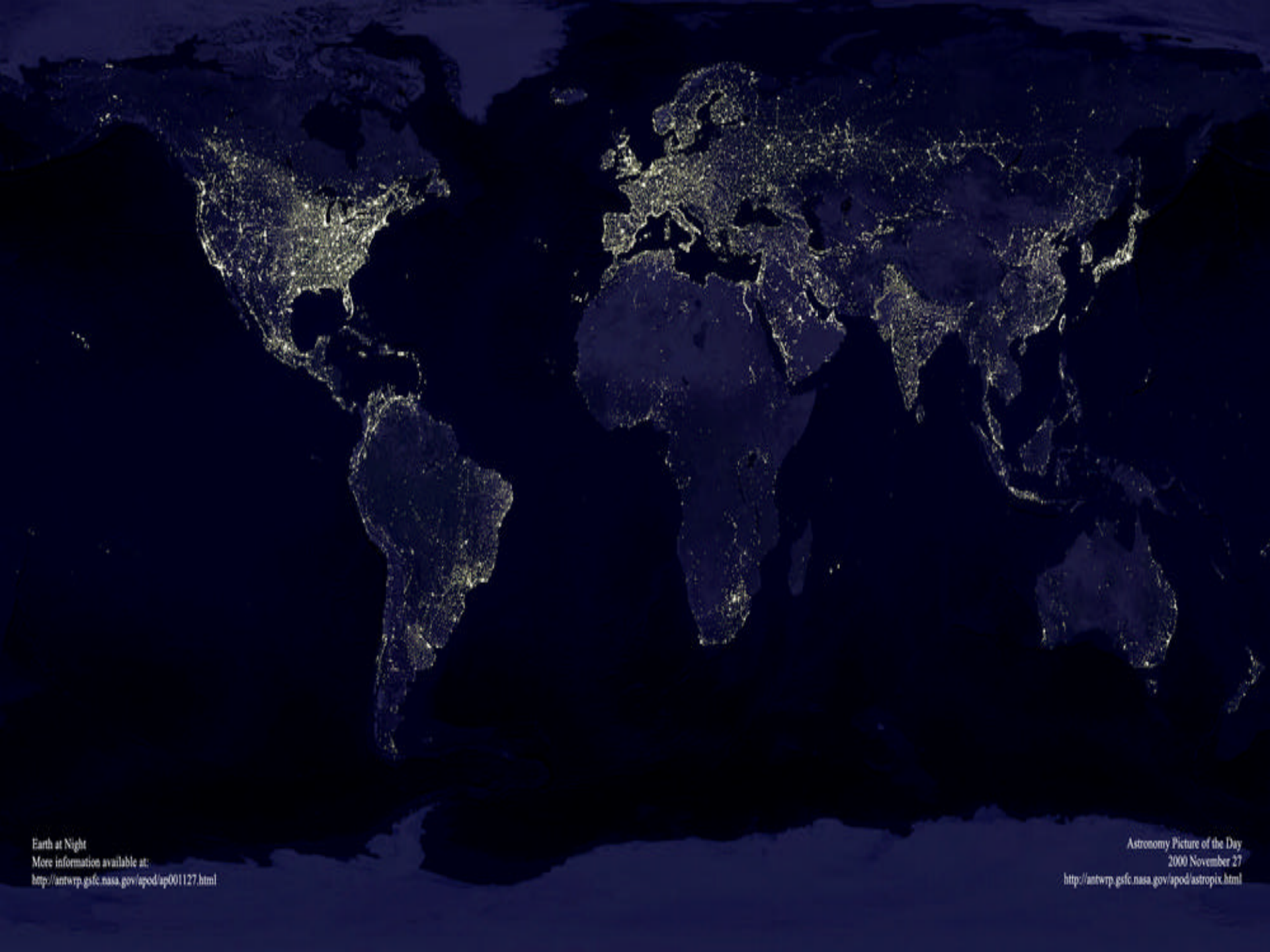
Maximum (Yrs.) of Fossil Fuel Resources




Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap001127.html
Astronomy Picture of the Day
2000 November 27
http://antwrp.gsfc.nasa.gov/apod/astropix.html

Future Clean and Renewable Fuels

Di-Methyl Carbonate (DMC)

Di-Methyl Ether (DME)

NG Fueled Diesel Engines

Hydrogen

FT Diesel & Gasoline

Naturalgen (CNG / H_2)

Bio-Ethanol Methanol

NG Fueled SI Engines

SOLVING FUTURE CHALLENGES - APROACHES

- **Utilize Energy, Environmental and Economic (EEE) Life Cycle Models as a Major Systems Approach Tool**
- **Implement the Most Viable Approaches**
- **Educate the Public and Policy Makers**

Total Life Cycle Costs for Four Alternative Fuels Compared to Gasoline (Chongqing, China)*

FUEL TYPE	ADD VEHICLE COST	FUEL COST	ADD SERVICE COST	TOTAL ADD COST VS BASE
GAS	BASE	$7055	BASE	BASE
CNG	$1600	$2327	$600	-$2477
CH3OH	$500	$5717	$1600	$812
DME	$780	$8310	0	$2085
DIESEL FROM NG	$780	$3969	0	-$2256

*Fuel taxes: 50 % for gasoline and 0% for CNG, MeOH, DME, and NG-Diesel. The fuel costs are for 200,000 km of vehicle operation.

NATURALGEN FUELED FORD FIESTA FOR CHINA

DIMETHYL ETHER (DME)

A Clean and Efficient Fuel for Diesel Engines

•Power Output:	+ 10-15%
•Thermal Efficiency:	+ 2-3%
•Engine Noise (dB):	- 10-15
•Emissions*	
NOx:	- 60%
HC:	- 40%
CO:	- 55%
Particulates:	< 5 mg/mile

*Can possibly meet Euro IV-V Regulations with an Oxidation Catalyst

Thailand Bioethanol Fuels Project
Renewable Fuels from Surplus Crops and Agricultural and Municipal Waste

Thailand Automotive Technology Workshop Recommendations

2–3 April 1998 • Bangkok, Thailand

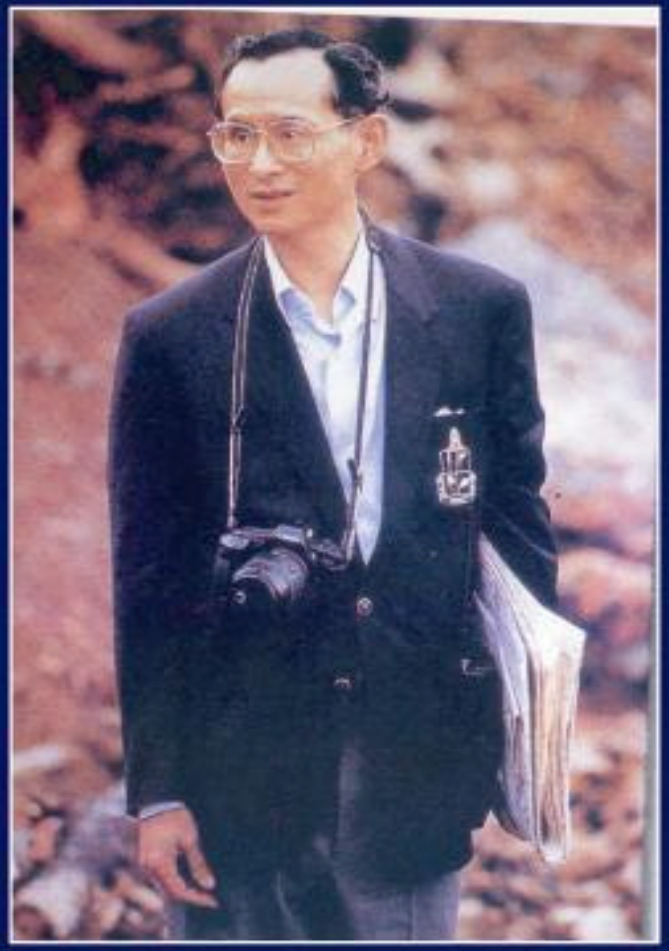
Ford-initiated workshop where approximately 60 U.S. and Thai experts drafted 62 policy and technical recommendations for Thailand.

Thailand and the United States

A COMPARISON

	THAILAND	UNITED STATES
Population	60 Million	270 Million
Land Area	51 Million Hectares	930 Million Hectares
Population Density	1.18 People/Hectare	0.29 People/Hectare
Number of Vehicles	6.2 Million	210 Million
Transportation Fuel Energy*	0.96 Exojoules	27 Exojoules

**Thailand consumes 100 million barrels ($3.1 billion U.S.) of diesel fuel and 65 million barrels ($2 billion U.S.) of gasoline per year.*



His Majesty,
The King of Thailand,
Bhumibol Adulyadej,
has effectively promoted the technological and social advancement of his country and the protection of its environment. The King has also been a strong advocate for the production of renewable fuels from biomass materials.

Ford/Thailand Biomass Fuels Program

BACKGROUND

- Nearly any Lignocellulosic material can be used as feedstock for renewable fuel production
- Bangkok produces about 3.5 million tons/year of municipal green and woody waste
- Agricultural operations generate large amounts of wastes that could be used as a feedstock for fuel production
- Most plant/crop-based resources are underutilized worldwide
- Concerns are increasing about greenhouse gases and dependency on fossil fuels
- Thailand produces a surplus of starch and sugars which can easily be used to produce ethanol

Ford/Thailand Biomass Fuels Program Participants

Ford Motor Company

The Royal Chitralada Projects

Thai Ministries of Science, Technology, Environment and Agriculture

Thai National Metals and Materials Technology Center

Thai National Ethanol Committee

Thailand Sugarcane Growers Association

Petroleum Authority of Thailand

Bangchak Petroleum Public Company

Thai Oil Company Limited

Kennan Institute — Thailand

Governors Ethanol Coalition

Chulalongkorn University

University of North Carolina

University of California-Riverside

California Energy Commission

Governments of Austria, Australia, Brazil, Sweden and the U.S.

Lubrizol, Akzo Nobel, Zexel

Thailand Institute of Scientific and Technological Research (TISTR)

Ford/Thailand Biomass Fuels Program

Objectives

- Develop economical and efficient production capabilities for bio-ethanol, bio-diesel and other renewable biomass based fuels in Thailand
- Reduce the need to import fossil fuels to Thailand
- Provide additional sources of revenue for Thailand's farming community
- Determine how to best utilize biomass-derived fuels
- Reduce air, water and solid waste pollutants
- Establish Thailand as a global leader in research, development and implementation of biomass fuels

Testing of Biomass Derived Fuels – PPT Lab (Thailand)

Ford/Thailand Biomass Fuels Program

Results

- Approval granted for a 500-million liter/year ethanol plant in Thailand
- Additives developed that allow blending of 10% ethanol with 90% diesel fuels to produce diesohol
- Research demonstrated that diesohol reduces smoke and nitrogen oxide emissions from diesel vehicles without adverse effect on engine and vehicle durability
- New and improved technologies developed to convert waste biomass materials to clean diesel fuels (B2D) that are economically viable, energy efficient and environmentally friendly

Biomass to Diesel Fuel Conversion Process*

Output

- **Electricity**
  - **1.27 MWh/dry ton**
- **Synthetic Diesel**
  - **1.28 bbl/dry ton**
- **Process Heat**
  - **1.82 MWh/dry ton**

Revenue

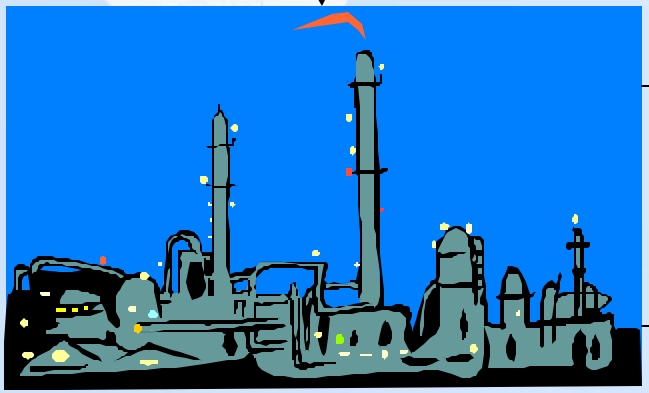
- **Electricity**
  - **$91.11/dry ton**
- **Synthetic Diesel**
  - **$32.24/dry ton**
- **Process Heat**
  - **$9.15/dry ton**
- **Total Revenue**
  - **$132.50/dry ton**

Thermo-Chemical Efficiency = 71.4%

THAILAND CAN POTENTIALLY MEET MOST OF ITS TRANSPORTATION FUEL NEEDS FROM CONVERSION OF RENEWABLE BIOMASS TO CLEAN DIESEL (BTD) AND ETHANOL FUELS (BTE)

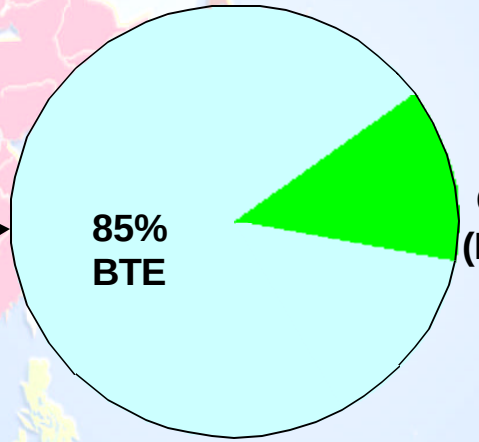
7.8% of Thailand's Unused Arable Land

Cassava Sugarcane

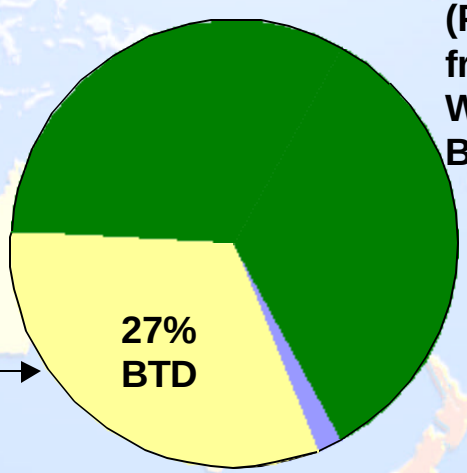


Biomass to Fuel

Biomass to Ethanol



Biomass to Diesel



Ford/Thailand Biomass Fuels Program

Recommendations

- The first priority for Thailand should be to produce ethanol for gasohol (10% ethanol in gasoline). Three ethanol plants will be required (0.5 billion liter/year capacity each). This ethanol can be produced from Thailand's surplus agricultural products. It will take until about 2005 to achieve this level of production
- The next priority will be to produce E85 for flexible fuel vehicles. Another seven ethanol plants will be needed. It could take until 200 to achieve this level of production
- Diesohol should only be considered for fleet use. The risks of general use outweigh the potential benefits, because of possible safety issues associated with the higher flash point of this fuel
- The Thailand government should implement a policy in 2007-200 that encourages vehicle manufacturers to market ethanol flexible fuel vehicles (FFVs) in Thailand

Can California Potentially Meet Most of Its Transportation Fuel Needs from the Conversion of Renewable Biomass To Clean Diesel (B2D) and Ethanol Fuels (B2E)?

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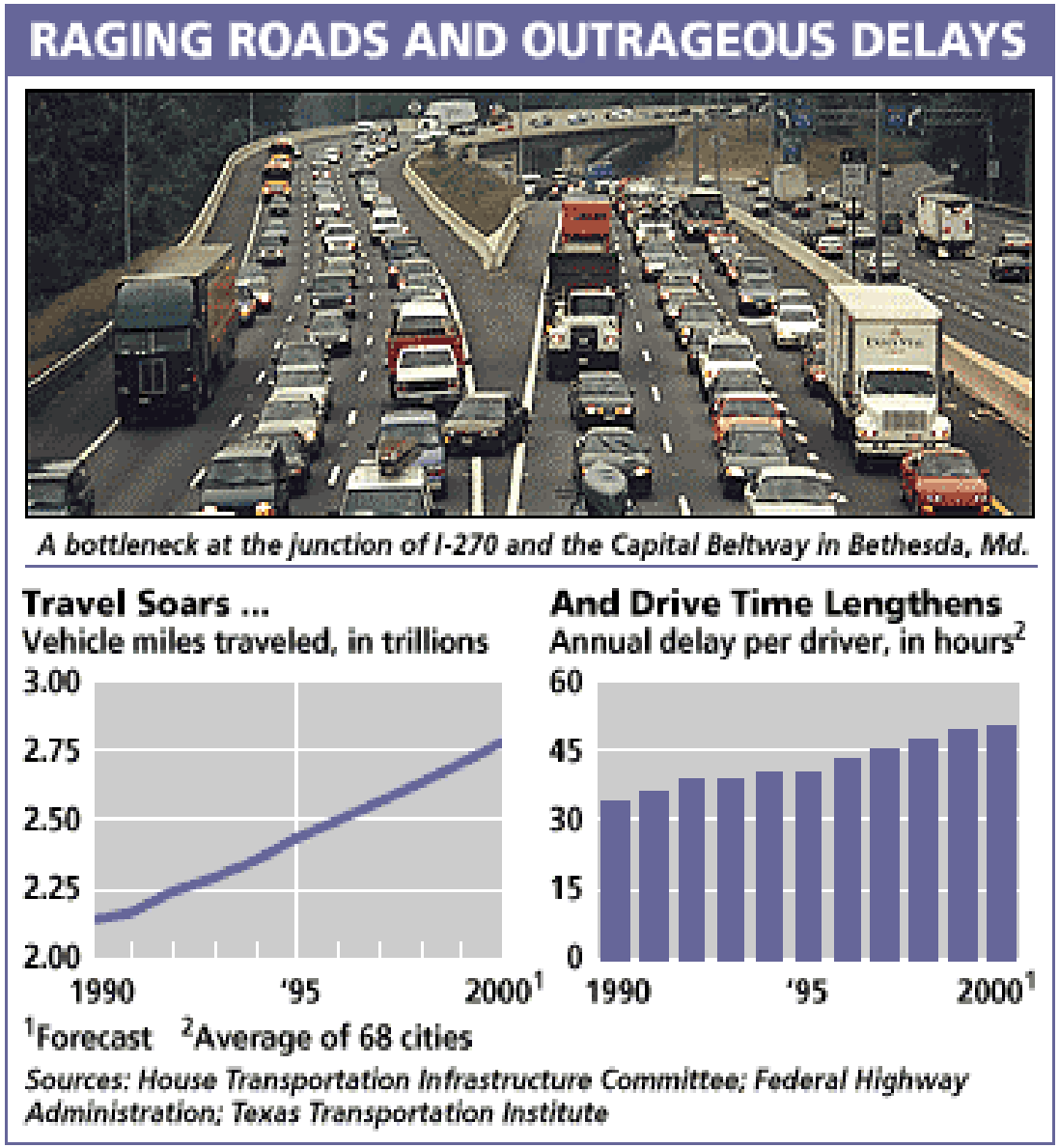
Vehicle Congestion is a Major Global Issue



Vehicle miles traveled have increased 30% since 1990.

Estimated cost of congestion in the U.S. and Thailand is $100 and $25 billion/year, respectively.

PTB 355
VB-355

Efficient Transportation Concept for India?

OxFord Utility SULEV Vehicle

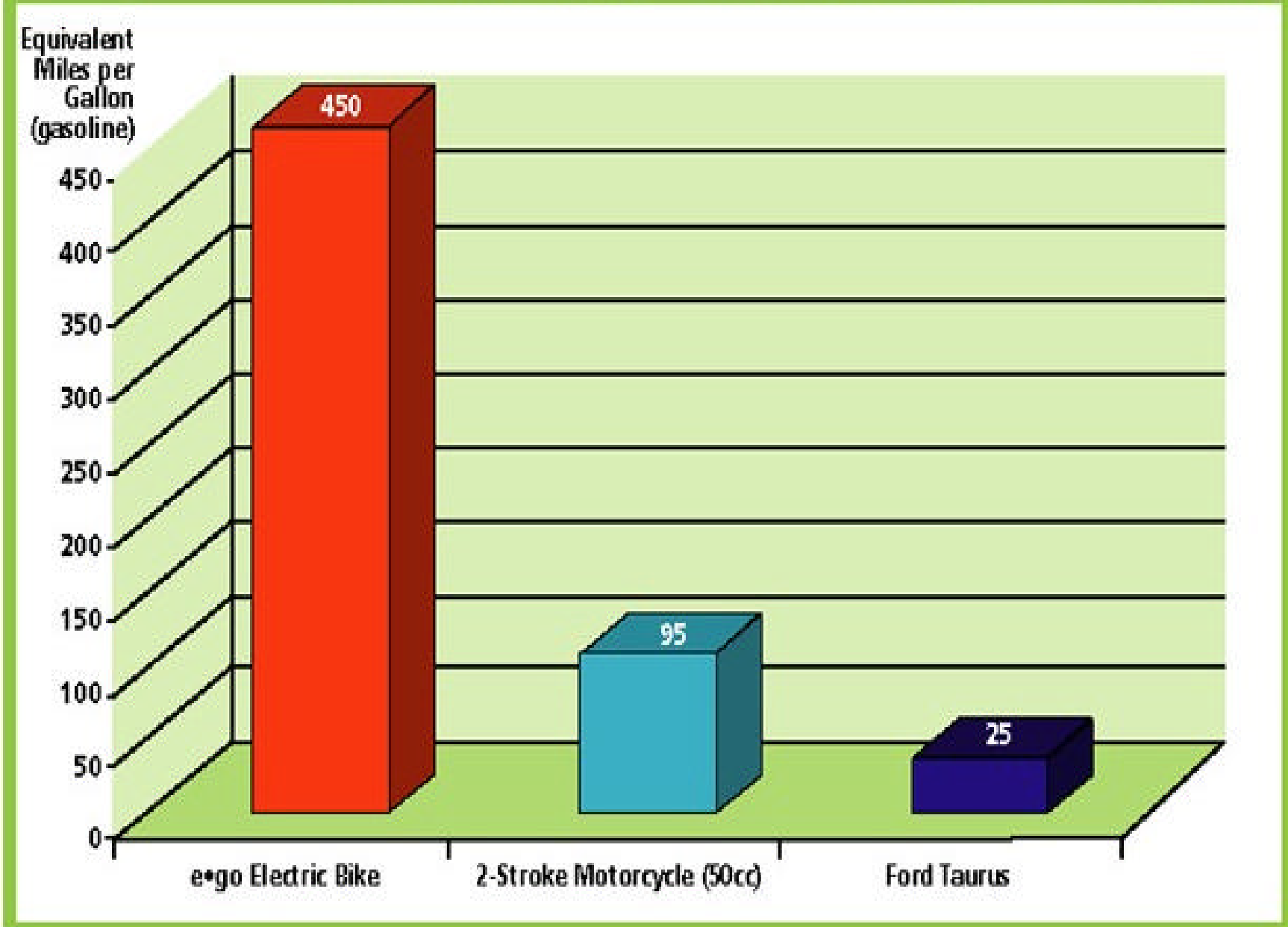
China

India

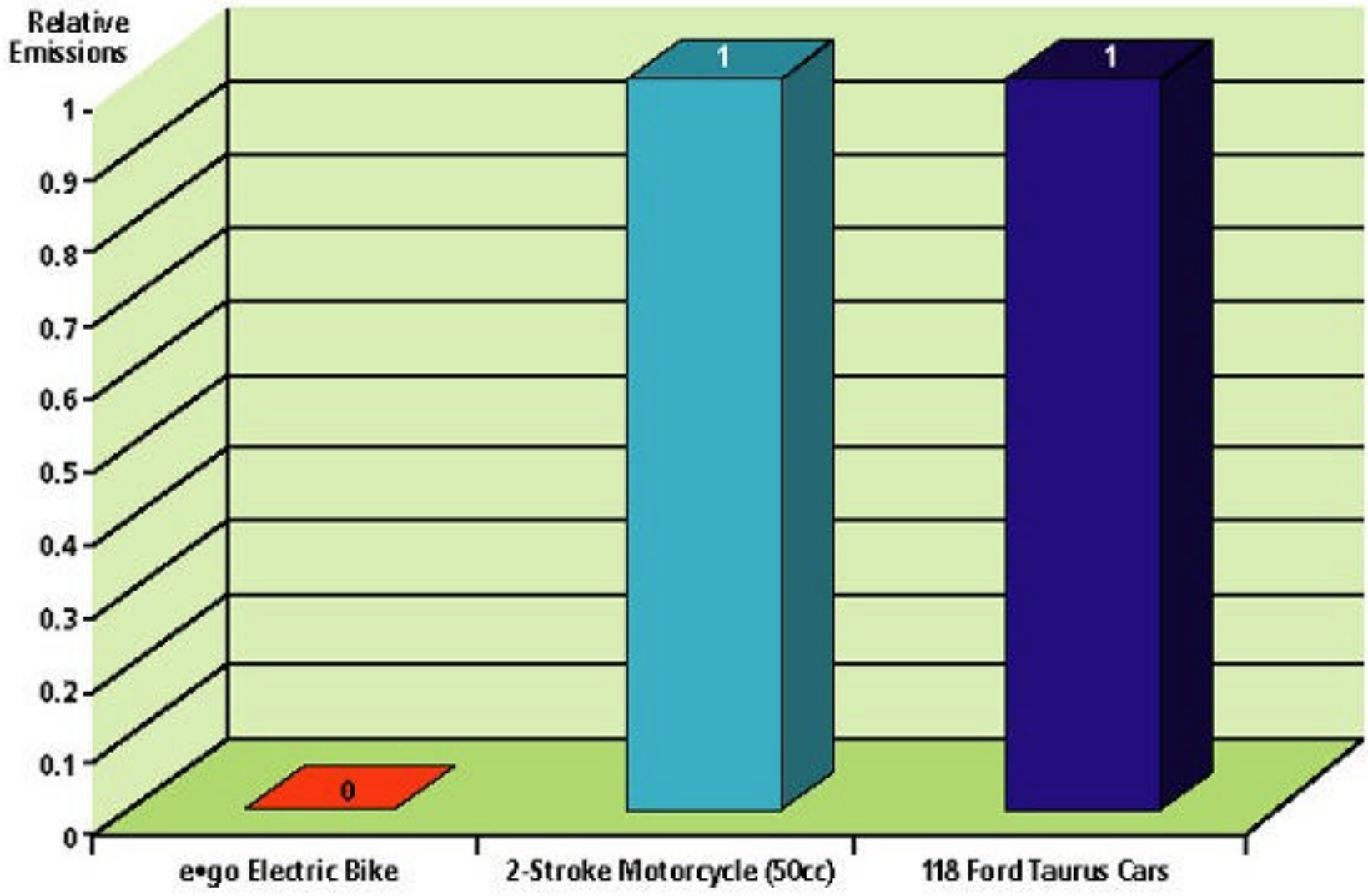
Laos

Indonesia

An Energy Efficiency Comparison



A Life-Cycle Comparision of Smog Forming Emissions



features of the TH!NK bike
e•go is the easy removal of
the battery to facilitate
charging at the owner's
residence, for exchange at
a convenience store, connection
to city-supported charging
stations or charging by solar
cells in the countryside.
The TH!NK bike e•go is a
specially designed 6-speed
electric bicycle powered by a
patented 24-volt direct drive
system. It has a range of up to
30 km and its maximum speed
is 30 km/h.
asia

CHINA AND U.S. ACADEMIES OF ENGINEERING PERSONAL URBAN VEHICLE STUDY TEAM

PERSONAL URBAN TRANSPORTATION (PUV) SYSTEMS PROGRAM

Develop Recommendations for Future Approaches To Personal Use Vehicles that are Available to All Socioeconomic Levels in the 21st Century which:

- Maximized Mobility (Minimize Travel Time)
- Minimizes Environmental Impact
- Maximizes Energy and Resource Efficiency
- Minimizes Economic Impact

Focus on a Systems Approach

- Integration of Current and Future Modes of Private and Public Transportation
- Consider City Planning and Infrastructure; Economics and Incentives; Demographics, etc.

Future Capability of Chinese Middle Class Families to Afford a Personal Urban Vehicle (PUV)

Year	Average Family Income ($U.S.)	Vehicle Cost ($U.S.)
1913	$1,050 (U.S.)	$750 (Ford Model T)
2005	$6,750 (China)	$5,800 (Ford Pegasus)

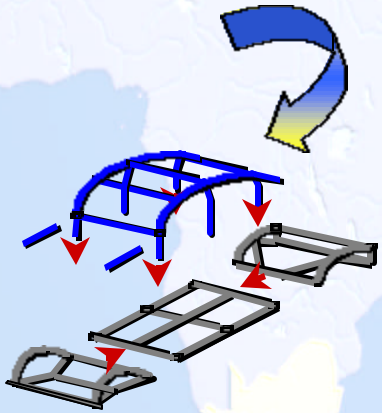
SOLVING FUTURE CHALLENGES - APROACHES

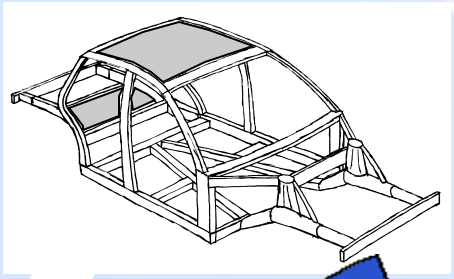
- Utilize Energy, Environmental and Economic (EEE) Life Cycle Models as a Major Systems Approach Tool
- **Implement the Most Viable Approaches**
- Educate the Public and Policy Makers

Customer-orientated Production: Mass-customization

Vehicle Design for Market Customization

Reconfigurable Body Architectures
&
Intelligent Assembly Process





Future Personal Transportation Systems

Future Vehicles

- **Light Weight Space Frame Construction**
- **Composite Exterior Panels**
- **Intelligent Vehicle Concepts**

Future Powertrains

- **High Efficiency Diesel and Spark Ignition**
- **Hybrid Electric**

Future Personal Transportation Systems

Future Fossil Fuels

- **Synthetic Diesel and Gasoline**
- **Dimethyl Ether and Dimethyl Carbonate**
- **Natural Gas**
- **Methanol**
- **Naturalgen (Hydrogen/Natural Gas)(H1-H30)**

Future Renewable Fuels

- **Alcohols**
- **Methane**
- **Hydrogen**
- **Electricity**

FUTURE AFFORDABLE PERSONAL URBAN VEHICLE (PUV) CONCEPTS INCORPORATING LEAP-FROG TECHNOLOGIES

- Vehicle
  - Base Price: U.S. $5,800
  - B/C Class Vehicle
  - Weight: 650 Kg (IC Engine)
  - 4 Passengers
  - Economical: 35 km/Liter (Liquid Fuels)
  - Top Speed: 110 km/hr
  - Safe
  - Durable
  - Easily Serviceable

FUTURE AFFORDABLE PERSONAL URBAN VEHICLE (PUV) CONCEPTS INCORPORATING LEAP-FROG TECHNOLOGIES

- Chassis
  - Aluminum Space Frame Technology
- Interior and Exterior Panels
  - Molded Composite, Color Imbedded
- Multi-Configuration
  - Sedan, Pickup, Van, etc.
- Climate Control System
  - Flow-Through, Filtered Ambient Air
  - Heater for Glass Defogging
  - Climate Controlled Seats

FUTURE AFFORDABLE PERSONAL URBAN VEHICLE (PV) CONCEPTS INCORPORATING LEAP-FROG TECHNOLOGIES26

Assembly Plant

- ~ $15 Million/Plant
- Green Manufacturing Concepts
- Plants Strategically Located in Local Communities

PERSONAL URBAN VEHICLE CONCEPTS
CALIFORNIA DESIGN STUDIO

Ford Escape Hybrid Electric

Escape HEV

- SULEV/Stage IV emissions (PZEV)
- 50% - 55% fuel economy improvement over V-6
- 400 - 500 miles range
- Uncompromised interior package
- 4 x 4, Regenerative Braking, Electric Power Steering

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ENHANCE COMMUNICATION AND EDUCATION

CHINA SUCCESSFULLY DEVELOPED A LEAPFROG DIGITAL WIRELESS COMMUNICATIONS CAPABILITY

September 5, 2001

September 5, 2001

CONTEXT-BASED SVCS
3
25
Navigation
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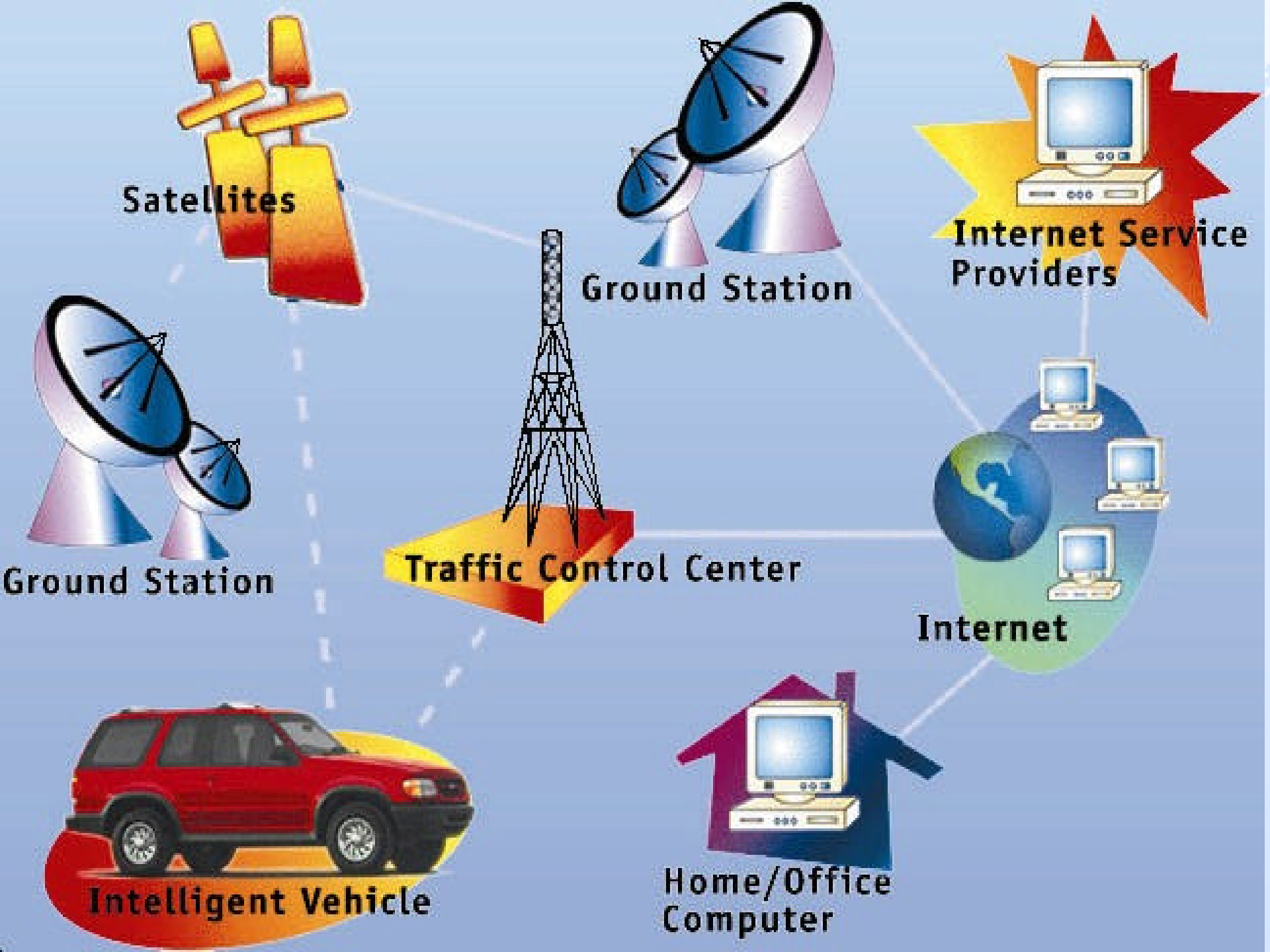
Microsoft
BILL GATES
IN CAR COMPUTING
KEY IS CONNECTIVITY
PARTNERING FOR SUCCESS
XML
QUESTIONS/ANSWERS


Satellites
Ground Station
Internet Service Providers
Ground Station
Traffic Control Center
Internet
Intelligent Vehicle
Home/Office Computer

SOLVING FUTURE CHALLENGES - APROACHES

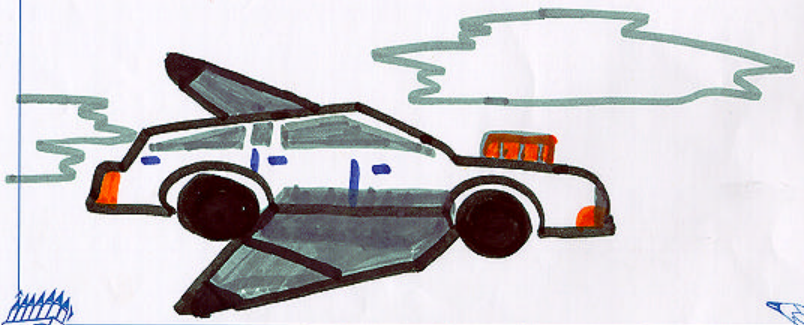
- Utilize Energy, Environmental and Economic (EEE) Life Cycle Models as a Major Systems Approach Tool
- Implement the Most Viable Approaches
- **Educate the Public and Policy Makers**

Minister Xie – Chinese Ministry of the Environment 1999 Meeting in Beijing to Discuss Cooperative Environmental Programs

Transportation 100 Years From Now

Sketch or write your ideas on what it will be like to get to school or Vacation or the store 100 years from today

The best ideas will be displayed in the "Future Exhibit" at the Automotive Hall of Fame



Deposit Entries in the slot or send them to
Automotive Hall of Fame 21400 Oakwood Boulevard, Dearborn Michigan 48124

Give us your name, age, and address

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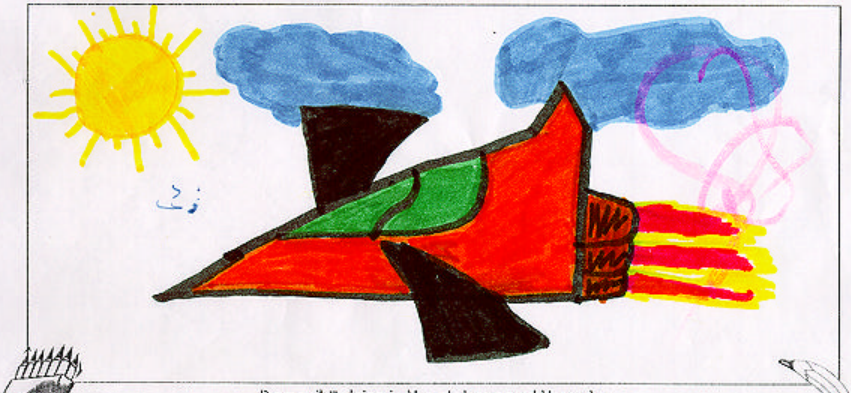

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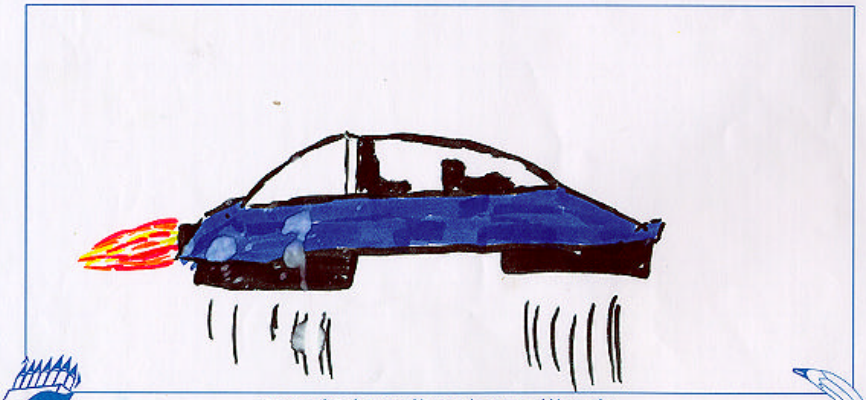

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