Asia-Pacific
Economic Cooperation

2005/EWG/EGNRET24/016

Natural Gas Vehicles in Asia

Submitted by: Asia Pacific Natural Gas Vehicles Association

APEC
2005 KOREA

24th Expert Group on New and Renewable Energy Technologies Meeting
Hawaii, United States
17-19 May 2005

NGVs in Asia

Dr Garth Harris
Secretary General
Asia Pacific NGV Association
and IANGV

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Asia Pacific NGV Association

- Support and promote use of NGVs
- Incorporated in Korea 2003
- 40 members from 10 countries
- President – Rahim (VP of Petronas)
- Member IANGV
- Workshop in Manilla, 2003
- ANGVA in KL July 2005

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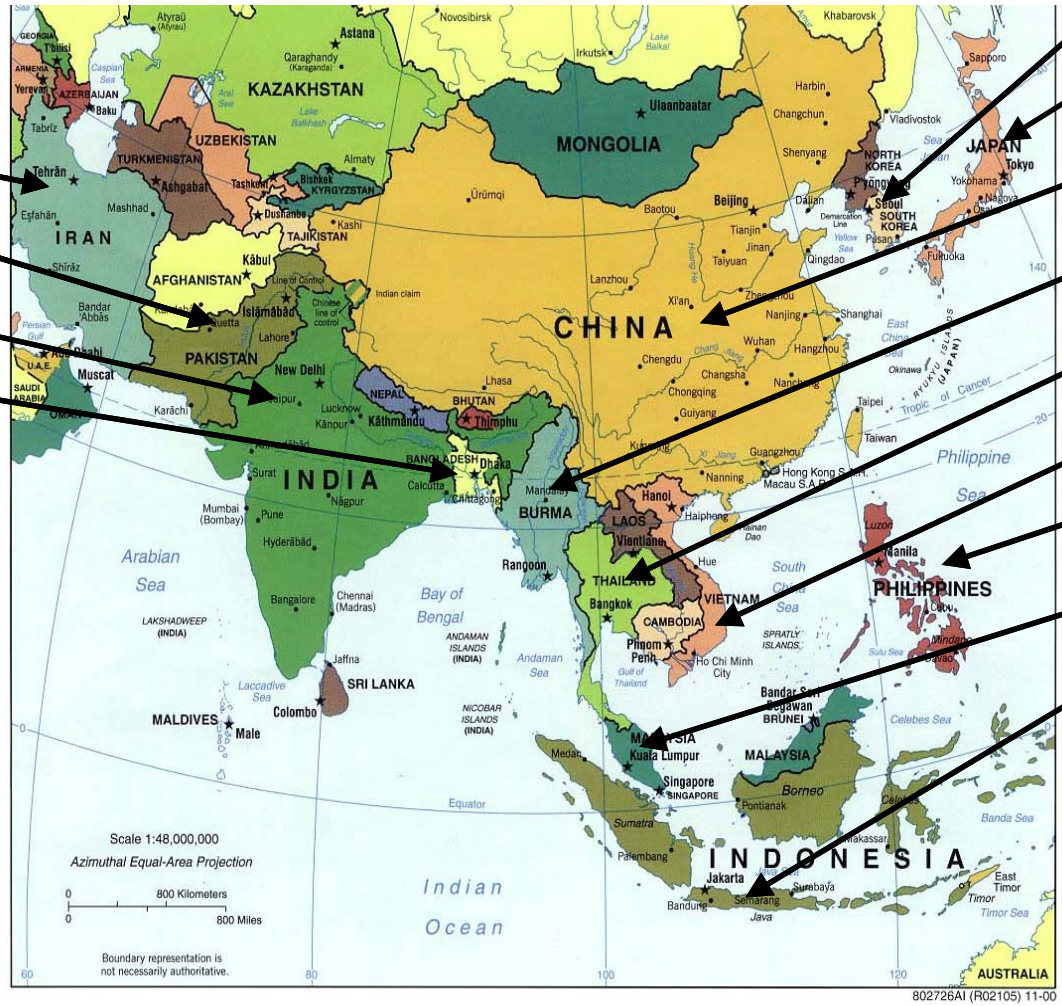
CNG Countries in Asia

- I ran
- Pakistan
- India
- Bangladesh



Korea

Japan

China

Myanmar

Thailand

Vietnam

Philippines

Malaysia

Indonesia

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NGVs in Asia

Country	Vehicles	Ref Stns
Pakistan	600,000	670
India	204,000	198
China	69,300	270
Bangladesh	32,000	79
Iran	22,000	40
Japan	20,600	271
Malaysia	8,000	38
Korea	5600	158
Indonesia	4700	28
Thailand	4500	13

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ANGVA/IANVGV
INDUSTRIAL DEVELOPMENT WORKSHOP

15 - 16 DECEMBER 2003
EDSA SHANGRILA HOTEL, MANILA, PHILIPPINES

A SUCCESSFUL NGV CONVERSION PROGRAMME, CNG TAXIS IN KUALA LUMPUR, MALAYSIA

LEE GIOK SENG
OPERATIONS & SERVICES DEPARTMENT
PETRONAS NGV SDN BHD
KUALA LUMPUR, MALAYSIA

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HOW IT STARTED

- **PILOT PROGRAMME [1986-1988]**
  - TO UNDERSTAND THE TECHNOLOGY INVOLVED AND LAY THE FRAMEWORK FOR A COMMERCIAL PROGRAMME
  - 1 NGV OUTLET (50 M3/HR), 21 BI-FUEL VEHICLES

- **NATURAL GAS FOR VEHICLES PROGRAMME [1991-1994]**
  - TO IDENTIFY AND RESOLVE ISSUES THAT EFFECT THE WIDER USAGE OF NGV IN THE COUNTRY. TO SERVE AS A LAUNCHING PAD FOR A NATIONWIDE PROGRAMME.
  - 1 MOTHER STATION, 5 DAUGHTER STATIONS AND 1 CONVENTIONAL STATION
  - 930 BI-FUEL VEHICLES
  - FIELD DEMO / TESTING OF ONE MONOFUEL NGV CITY BUS (1993)

- **WIDER NGV PROGRAMME [1995 >]**
  - INCORPORATION OF PETRONAS NGV SDN BHD TO SPEARHEAD PROMOTION AND DEVELOPMENT OF NGV IN MALAYSIA
  - CONSTRUCTION OF NGV STATIONS NATIONWIDE
  - MARKETING & PROMOTIONAL ACTIVITIES
  - FACILITATING CONVERSIONS OF VEHICLES TO NGV
  - DEVELOPMENT AND MANUFACTURING OF ENVIRO 2000 NGV TAXIS.
  - FIELD DEMO / TESTING OF ONE DUAL FUEL LORRY.

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CURRENT STATUS

- **VEHICLES**
  - AROUND 8800 NATURAL GAS VEHICLES
  - MOSTLY CITY TAXIS AND AFTER MARKET CONVERSIONS
  - MOSTLY IN KUALA LUMPUR & JOHORE BARU
  - 11 CONVERSION WORKSHOPS

- **STATIONS**
  - 33 PUBLIC NGV REFUELLING STATIONS.
    - 28 IN KUALA LUMPUR, 4 IN JOHORE BARU AND 1 IN PENANG.
  - 2 PRIVATE STATIONS.

- **ON-GOING PROJECTS**
  - CONSTRUCTION OF NGV REFUELLING STATIONS OF AROUND 10 STATIONS / YEAR. TARGET 90 STATIONS BY YEAR 2008/09.
  - TARGETTING 57,000 VEHICLES BY YEAR 2008.
  - POSSIBILITY OF CNG VEHICLES BEING INTRODUCED BY LOCAL CAR MANUFACTURERS.

NATURAL GAS VEHICLES IN MALAYSIA

- **BI-FUEL VEHICLES - AFTERMARKET CONVERSIONS**
  - PROTON (SAGA, ISWARA, WIRA, PERDANA & WAJA)
  - NISSAN (SUNNY, VANETTE, LAUREL, URVAN, C22)
  - MAZDA (626, BONGO)
  - FORD (TELSTAR, LASER, MAXI, ECONOVAN)
  - TOYOTA (LITEACE, HIACE, COROLLA, LANDCRUISER)
  - DAIHATSU (SPACER)
  - MITSUBISHI (PAJERO, GALLANT, L300)
  - ISUZU (PICK-UP, TROOPER)
  - PERODUA (RUSA VAN)
  - INOKOM (PERKASA VAN)
  - HYUNDAI (MATRIX)
  - DAEWOO (TACUMA)
- **DUAL FUEL VEHICLES - AFTERMARKET CONVERSION**
  - ISUZU NPR 58L DIESEL LORRY (5000 KG GVW). 3636 CC ENGINE MODEL 4BE1.
- **MONOFUEL VEHICLES - FACTORY PRODUCTION / OEM**
  - 1000 UNITS ENVIRO 2000 TAXIS.
  - 1 UNIT MAN SL202 BUS.
    - ENGINE MODEL MAN E2866UH. 11.97 LITRES. STOICHIOMETRIC TWC.

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EXAMPLES OF NATURAL GAS VEHICLES IN MALAYSIA

BI-FUEL PROTON PRIVATE CAR

BI-FUEL PROTON PRIVATE CAR

BI-FUEL PROTON TAXI

BI-FUEL TOYOTA LITE ACE VAN

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Industry Development Workshop
Manila, Philippines 17-19 December 2003

DEVELOPMENT OF CNG AS TRANSPORT FUEL IN PAKISTAN

By

S. Naushab Sarwar

General Manager, Karachi Ops.
Hydrocarbon Development Institute of Pakistan

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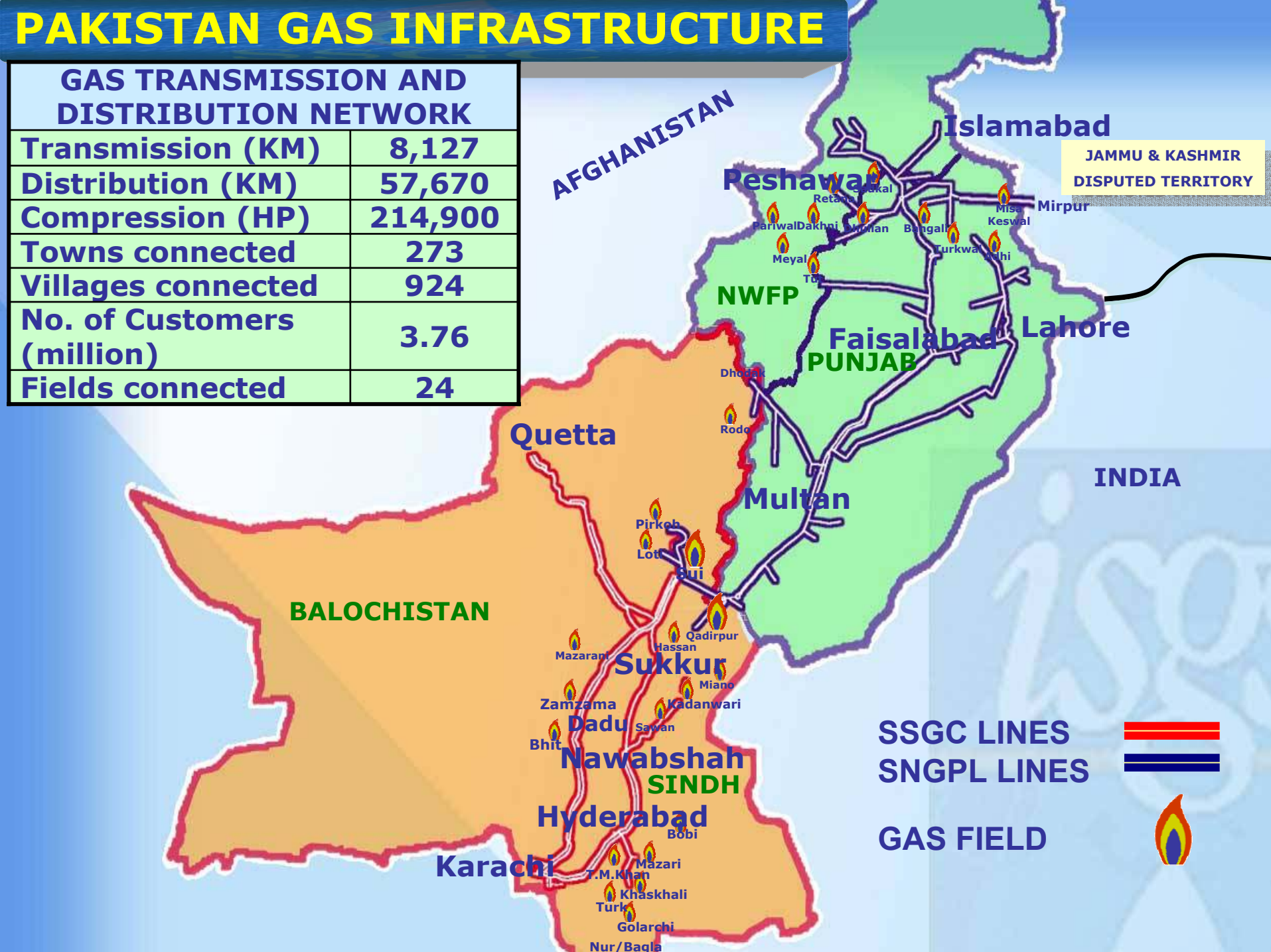
PAKISTAN GAS INFRASTRUCTURE

GAS TRANSMISSION AND DISTRIBUTION NETWORK	
Transmission (KM)	8,127
Distribution (KM)	57,670
Compression (HP)	214,900
Towns connected	273
Villages connected	924
No. of Customers (million)	3.76
Fields connected	24



The CNG Process in Pakistan

- Concept
- Experimentation
- Pilot Programme
- Policy & Regulatory Framework
- Commercialization
- Industrial Development

Pakistan is the largest CNG user in Asia and 4th in the world

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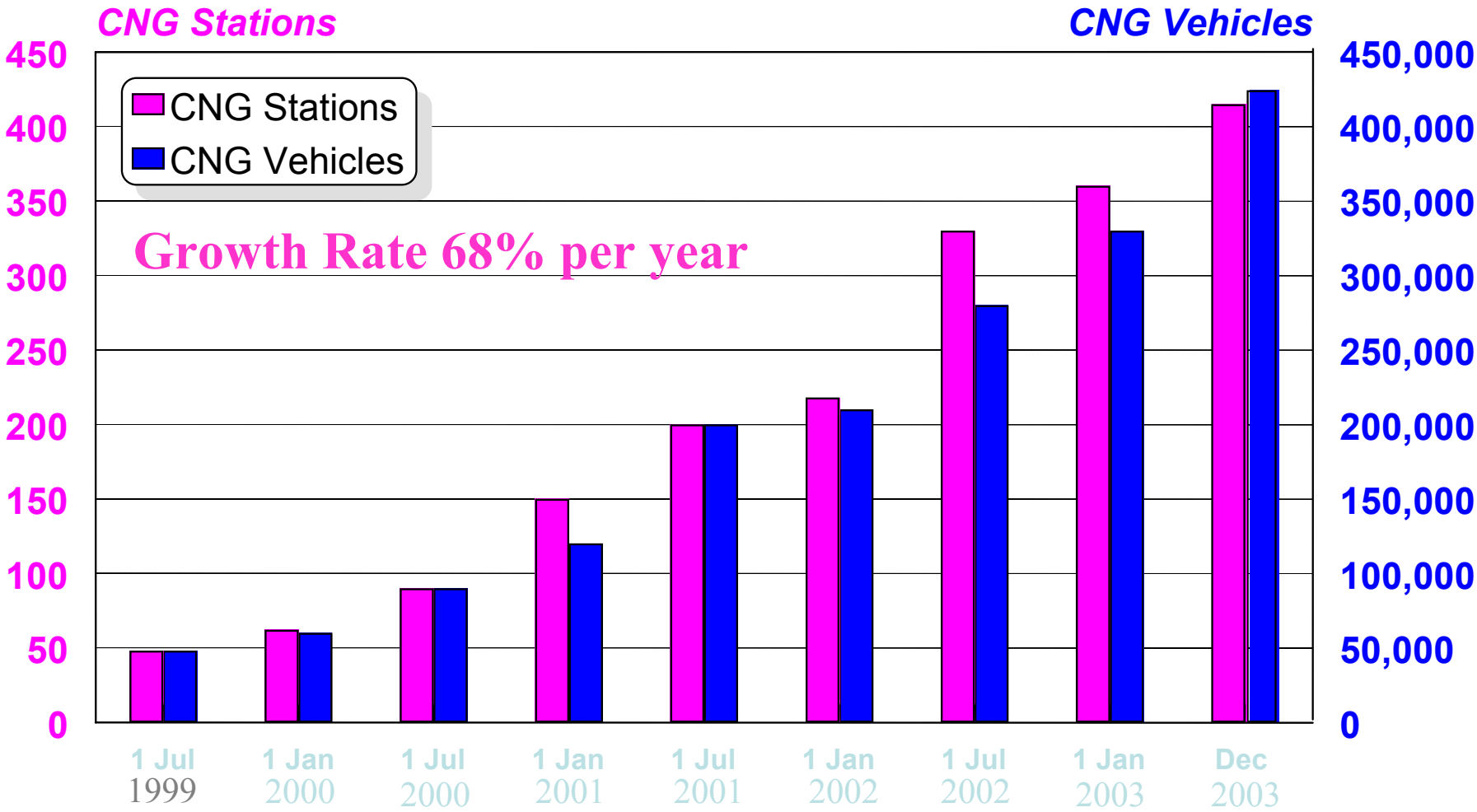
Main Elements of Government Policy

- Strong government commitment
- Liberal licenses for CNG retailing
- Free market consumer price of CNG
- Natural gas tariff for CNG linked to petrol
- Priority of natural gas connection for CNG
- Exemption of import duty and sales tax on import of machinery and kits

Development of CNG Industry



Pakistan is the largest CNG using country in Asia and 4th in the world

Operational CNG Stations at OMCs Outlets and in Provinces

OMCs Outlets

PSO	47
Caltex	24
Shell	35
Others	03
Total on OMCs	109
Independent:	303
Total	412

Provincial Breakup

Islamabad	24
Punjab	232
NWFP	72
Sindh	83
Balochistan	01
	412

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Investment Made in CNG Industry of Pakistan

Investment made:

412 CNG stations and 430,000 CNG kits installed

$ 184.3 million

Investment in pipeline:

200 CNG stations and 150,000 CNG kits

$ 82.5 million

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Safety and Regulatory Institutional Framework

Regulatory Authority (OGRA)

- Licensing
- Monitoring

Technical Support Institution (HDIP)

- Certification of equipment
- Safety Audit
- Training and public awareness

Environmental Benefits of CNG as Compared to Petrol/Diesel

Emissions	CNG	Petrol	Diesel
Carbon Monoxide	1	10.4	1.2
Unburnt HC	1	2.0	1.2
Nitrogen oxides	1	1.2	1.1
Particulates	Negligible	Present	Very high
SO_2	Negligible	Negligible	Very high

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Positive Experience

- CNG as motor fuel has been accepted and gaining popularity as economical and environment friendly fuel
- Investors have found CNG business very profitable
- Financial institutions have shown keen interest
- Car manufacturers are producing factory-fitted CNG-Petrol cars
- 3-Wheelers (Rickshaws) have also been converted on CNG

Negative Experience

- Lack of site availability in urban areas
- Procedural delays from Local Authorities
- Lack of safety consciousness in smaller investors
- Regulatory system could not grow as fast as the industry

Future Plan : Options for Diesel to CNG Conversion Strategy

OPTION – I: Conversion of diesel buses

- Dual fuel system
- Dedicated CNG

OPTION – II: Gradual replacement of diesel bus fleets by CNG driven buses

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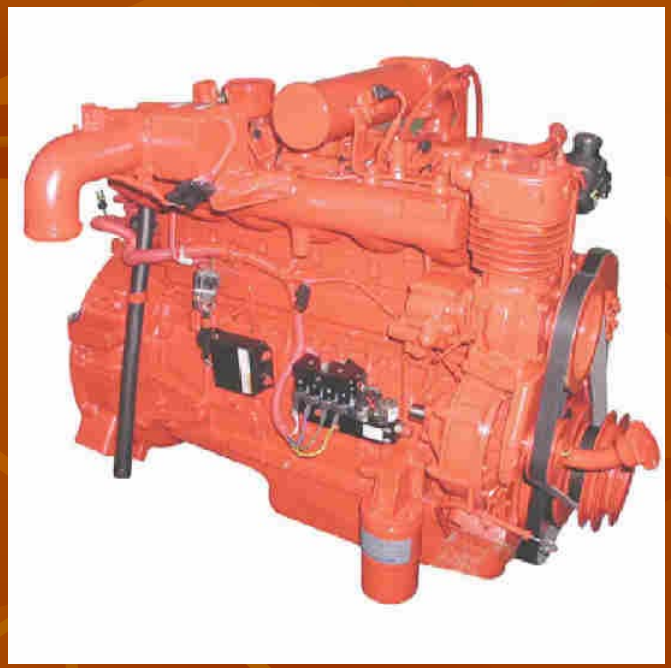
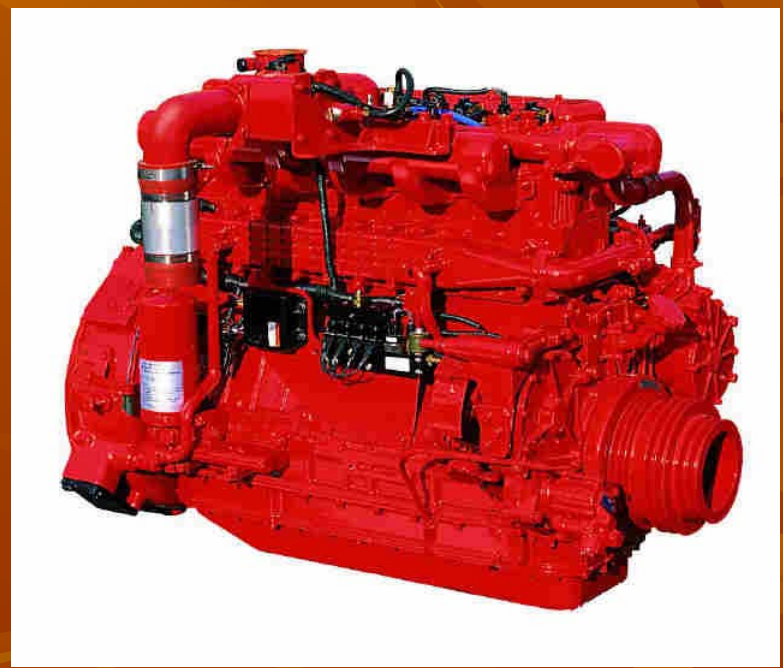
CNG Engine

DHIM's CNG

GE08TI



GE12TI



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DAEWOO
DAEWOO HEAVY INDUSTRIES LTD.

CNG engines for bus and truck application

Engine model	Unit	GE12TI	GE08TI
Comb. system		Spark ignition , Lean burn	
Bore x Stroke	mm	123 x 155	111 x 139
Swept volume	ℓ	11.051	8.071
Aspiration system		Turbo-Inter cooled	
Output	kW(PS) / rpm	250(340) / 2100 228(310) / 2100 213(290) / 2200	192(260) / 2300 177(240) / 2300
Torque	Nm/rpm	1373 / 1300 1226 /1300 1128 /1300	981 / 1300 883 / 1300
Number of cylinder		Inline 6	
Comp. ratio		10.5 : 1	
Fuel system		Injector, Mixer, Throttle	

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DAEWOO
DAEWOO HEAVY INDUSTRIES LTD.

Application of DHIM's CNG Engine

S106 City Bus(GE12TI) - 10.6m

290PS

240PS

BS090 City Bus(GE08TI) - 9m

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DAEWOO
DAEWOO HEAVY INDUSTRIES LTD.

Application of DHIM's CNG Engine

5 buses were operated during the 8th Busan Far East and South Pacific Games for the Disabled.

This bus is running for the handicapped in Seoul

BS120CN City Bus for the handicapped (12M) – GE12TI

290PS

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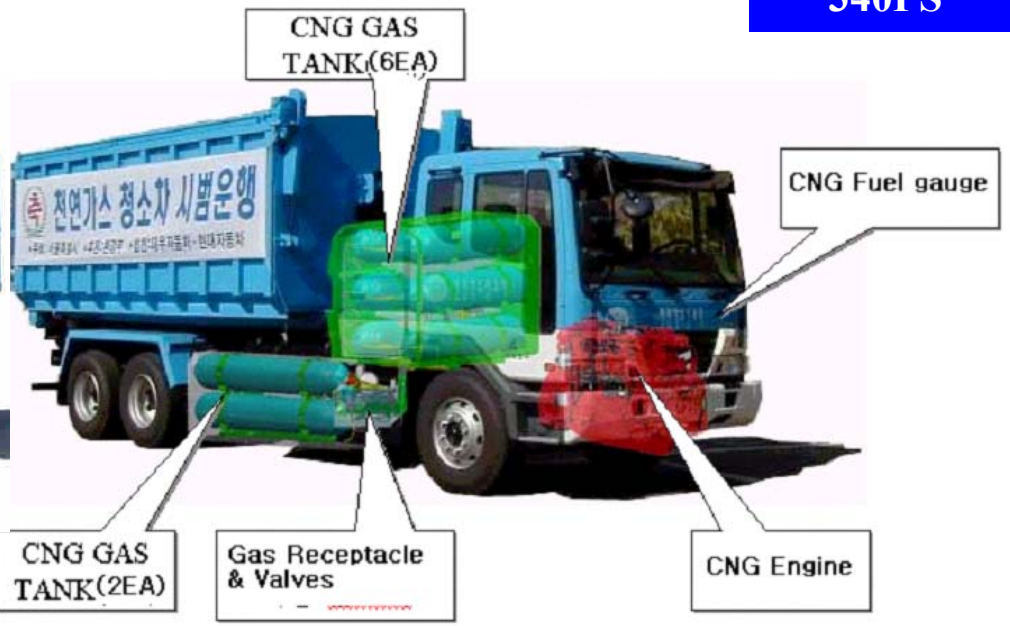
DAEWOO
DAEWOO HEAVY INDUSTRIES LTD.

Application of DHIM's CNG Engine

11ton Garbage Truck - GE12TI

340PS



310PS

BH116 Inter-City Bus (GE12TI) - 11.6m

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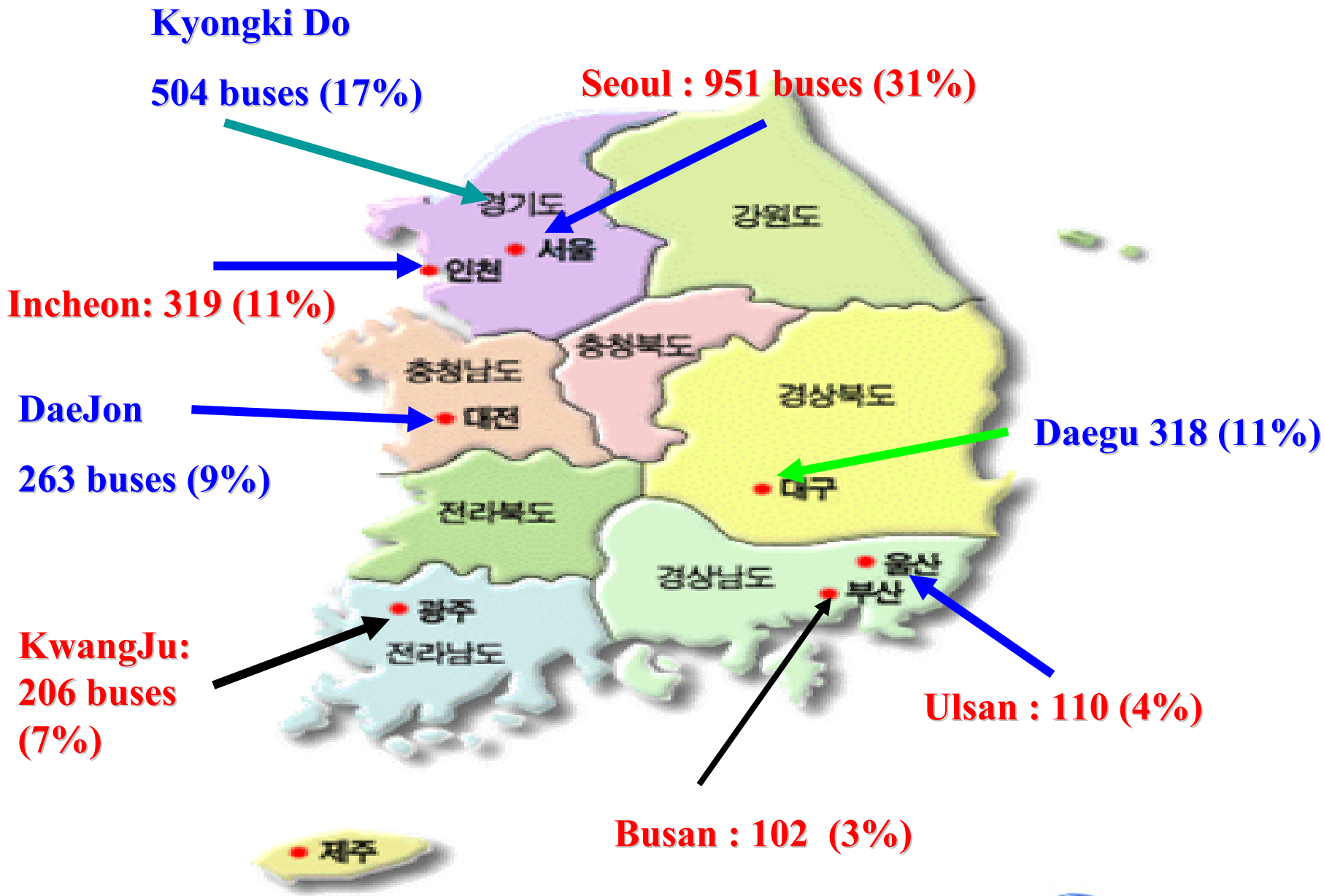
Kyongki Do
504 buses (17%)
Seoul : 951 buses (31%)
경기도
강원도
서울
인천
Incheon: 319 (11%)
충청북도
충청남도
DaeJon
263 buses (9%)
대전
경상북도
Daegu 318 (11%)
대구
전라북도
경상남도
울산
부산
광주
KwangJu:
206 buses
(7%)
전라남도
Ulsan : 110 (4%)
Busan : 102 (3%)
제주

ADB Funding Opportunities and Review of Multilateral NGV Programs

Charles Melhuish
Lead Transport Sector Specialist, Asian Development Bank
Cornie Huizenga
Consultant, Asian Development Bank

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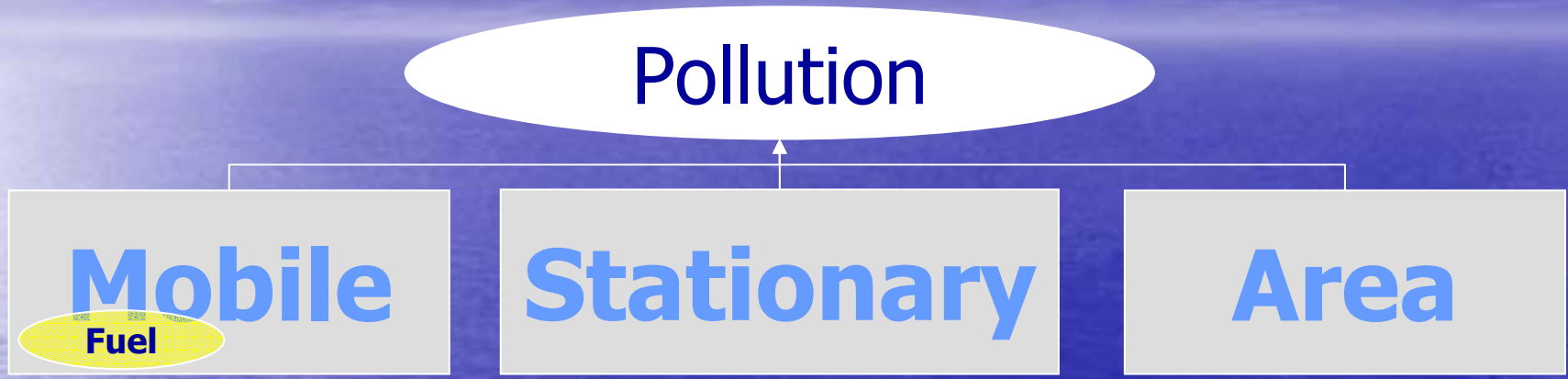
Major Sources of Pollution in Asia



In most cities, mobile sources are the main contributors of SPM, PM_{10}, NOx and CO:

- In Manila (2002), 100% CO, 83% NOx, 10% SO_2 and about 15% PM of total emissions are from mobile sources

In Delhi (2001), 67% of total emissions from Mobile & 25% from Stationary; CO & HC account for 58% and 25% of total Mobile source emissions and ONLY 2% for PM

- In Bangkok (1997), 80% Nox, 75% CO and 54% PM of total emissions are from mobile sources

- In Shanghai (1995), mobile sources account for 40% of NOx, 75% of CO and 90% of non-methane hydrocarbons (NMHCs)

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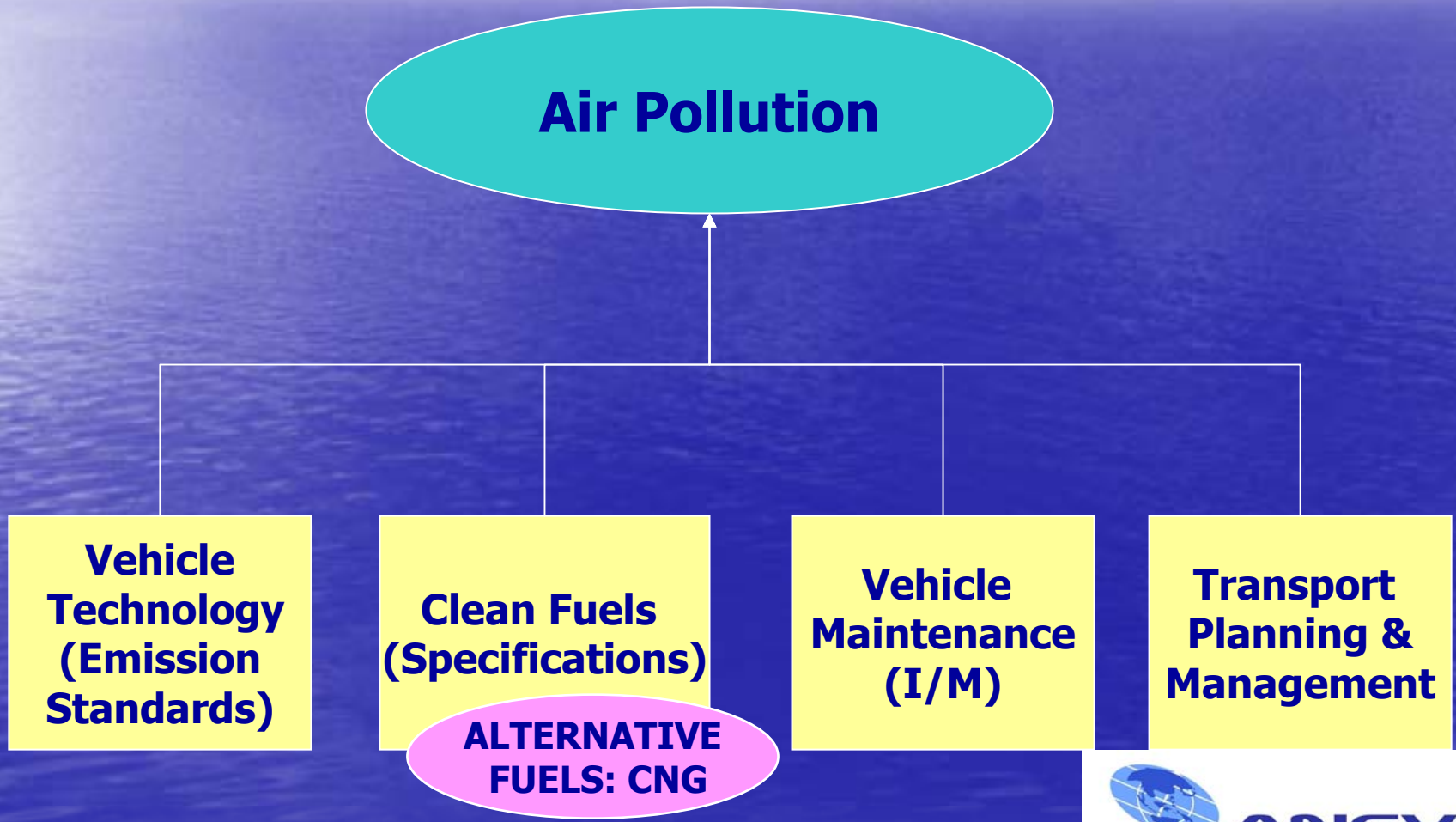
Comprehensive Approach to Reduction of Vehicle Emissions



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Context for CNG in Asia

- Growing concerns on environmental impact of mobile sources of pollution
- Growing pressure on conventional fuels in the region, several (large) countries growing dependence on imports
- Several countries have considerable proven resources of Natural Gas
- Use of natural gas frees up oil for export or other uses in those countries that have both oil and gas
- Considerable lobbying for the use of Natural gas, as a clean fuel, by range of groups

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Role of development agencies in promoting CNG and NGV

- Promote the formulation of integrated fuel strategies
- Capacity building to regulate fuel sector
- Promote exchange of information among regions and countries and support awareness raising
- Promote and facilitate studies on environmental performance of different types of NGVs
- Financing development of infrastructure
- Financing initial NGV fleet

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ADB involvement in CNG/NGV programs

- ADB involved in CNG/NGV programs in China, Bangladesh, India, Indonesia
- Involves support for provision of infrastructure, setting up filling stations, initial fleet, policy development, capacity building etc.

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Criteria for decision makers in Asia

- ADB only supports projects requested by Governments. These governments need to take into consideration
- - Availability: is it there and what are competing uses of Natural Gas?
- - Cost:infrastructure (pipelines and filling stations), NGVs and their operating cost
- - Environmental impact: will environmental benefits be realized?
- - Energy policy considerations
- - Practicability –ease of use - safety

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Alternatives to Natural Gas to reduce mobile source emissions

- **Governments and ADB will always need to consider alternatives to CNG to reduce pollution:**

1. **Diesel powered vehicles: lowering of sulfur and equipping vehicles with advanced emission control devices**
2. **Gasoline vehicles: cleaner fuel and advanced emission control devices**
3. **All vehicles: better maintenance**
4. **Step change in technology move away from internal combustion technology to advanced vehicle technology**
5. **Influence modal split in favor of public transport**
6. **Effective Transport management and Transport Demand Management**

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Concerns regarding stimulation measures

- **Banning (diesel) vehicles**: public transport capacity concern and no guarantees that environmental benefits are captured – *in stead of banning technology issue stricter emission standards*
- **Conversion incentives**: no guarantees that environmental benefits are captured – *in stead of banning technology specify emission standards*
- **Pricing – subsidies**: this will endanger sustainability of fuel switch
- **Infrastructure provision**: can be perceived as indirect subsidies of CNG

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