

**Report on the United Nations International Roundtable on Transportation Energy
Efficiency and Sustainable Development**
Undertaken in Cooperation with the World Bank

**Hosted by
Ministry of Transport, Egypt**

Sponsored by: the Government of Denmark, Scania
the Organization of Islamic Capitals and Cities, Daimler-Chrysler and the Arab Contractors

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This report was prepared with substantial input from Danilo Santini, who served as the rapporteur of the meeting.

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I. Introduction

The International Roundtable on Transportation Energy Efficiency and Sustainable Development was held as part of the United Nations work program in energy and transport in line with its mission to encourage a rational use of energy to contribute to sustainable development. The Roundtable also considered an input to the ninth session of the Commission on Sustainable Development which will consider the themes energy and transport. It addressed the basic difficulty in promoting sustainable development: while energy use is necessary for economic growth, it is associated with health and environmental degradation. Energy use in the

transportation sector is a prime example of this dilemma. The ability to transport increasing amounts of goods and services is a precondition for economic growth and development and contributes significantly to GDP in most countries. However, emissions increases associated with expanding vehicle use have caused environmental and health problems in many of the world's major cities while also contributing to global environmental problems. The demand for transportation services has been a major cause of growing world oil demand during the past 25 years, and this trend is expected to continue in the next 20 years. Transportation demand increased in developing countries by an average annual rate of 5.3 per cent during the 1970-94 period.

The overall goal of the Roundtable was to assist in achieving an integrated and comprehensive sustainable energy policy in the developing world and to contribute to the promotion of greater awareness of the importance of transportation energy efficiency, emissions rate reductions, alternative fuels and alternatively fueled vehicles. The Roundtable sought to demonstrate the linkages of these transport improvements and options to the enhancement of socio-economic conditions, health and the environment. It provided an opportunity to establish an international consensus regarding the need for international, regional, and national initiatives for including transport energy and emissions accounts as part of sustainability indicators. The Roundtable also investigated the need for undertaking an initiative to integrate transport energy issues into energy policies at all levels.

The Government of Egypt, through its Ministry of Transportation, hosted the Roundtable. It was undertaken by the United Nations in cooperation with the World Bank. Sponsors included the Government of Denmark and the Organization of Islamic Cities and Capitals. In addition, the Roundtable benefited from contributions by the private sector including Scania, Daimler-Chrysler, and the Arab Contractors.

One hundred and eighty-six experts participated in the Roundtable. Twenty-eight participants were funded from the project budget and represented a wide range of developing countries from every region. Project-funded participants were associated with governments and NGOs in the fields of transportation, environment and energy. In addition eight governments were officially represented, namely Austria, Canada, Denmark, Egypt, Finland, Italy, Tunisia and the United States. Egypt was represented by officials from the Ministries of Transport, Health, Electricity & Energy as well as from the Egyptian Environmental Affairs Authority and the Foreign Ministry. The private sector was well represented. In addition to businesses providing funding (Scania, Arab Contractors, Daimler-Chrysler) the Roundtable included participants from Mobil Oil (Egypt), BG Technologies (Nile Valley Gas Co) and Shell (which sponsored a speaker) as well as many local Egyptian firms in the transport and energy industries. Other participants represented NGOs and universities.

II. Sessions and Discussions

A. Opening and Welcoming Ceremony

The Roundtable was opened by HE Dr. Ibrahim El Dimairy, Egyptian Minister of Transport, and statements were made by JoAnne DiSano (UNDESA), John Flora (World Bank), Edmund Cain (UNDP), and Ismail Osman (Arab Contractors - Egypt).

H.E. Prof. Ibrahim El Dimairy, Minister of Transport of Egypt, welcomed the participants of the roundtable. He indicated that the primary motivation of the United Nations and the World Bank is to promote transportation efficiency. However, the UN and World Bank now recognize that the accomplishment of efficient transportation systems must be done in a sustainable way – a more efficient system which reduces the health and welfare of the citizens of a nation is not acceptable. A major concern within transportation systems throughout the world is increasing levels of congestion. HE El Dimairy emphasized the importance of this issue to Egypt and highlighted programs undertaken by Egypt to improve its transportation system in a way that is in line with sustainable development goals. The metro system of Cairo is an excellent example of success in this area by Egypt.

JoAnne DiSano of the UN thanked other roundtable sponsors, including the Egyptian Ministry of Transport, the Organization of Islamic Cities, Denmark, and the World Bank. She elaborated on the consideration of energy efficiency and the promotion of cleaner fuels as an important step in addressing the specifics of sustainable transportation in the developing world in the intergovernmental process for the Commission on Sustainable Development. She mentioned “Agenda 21” as a motivating force behind the roundtable. Two major themes will be the quality of transport and the quantity of energy that it uses. She noted that worldwide, transport generates a bit less than a quarter of the carbon dioxide emissions caused by human activities. She further stated that projections imply that the transport demand of those nations now classed as “developing” countries will, by 2025, equal that of countries now classed as “developed.” In addition she affirmed that the Roundtable is the first effort at joint cooperation among governments, international institutions, the private sector, and non-governmental institutions and illustrates the strong commitment by all involved actors to solving transport-related problems.

John Flora of the World Bank stated that the Bank lends over \$5 billion per year for use in the transport sector, which is the largest amount lent for any given sector. He argued that the Bank is concerned about the air pollution effects of transportation, especially by urban transportation systems, and that increases in air pollution have caused a need for greater attention to the emissions and air quality implications of the transport sector projects for which the Bank provides lending. Flora indicated that he is interested in what new technology can do in this regard, but is not convinced that new technology is really what is needed. He suggested that there is a great deal of knowledge about clean energy options and wondered why these known options are not being implemented. Flora stated that the World Bank and the UN will develop joint strategies to reduce air pollution worldwide.

Engineer Omar A Kadi of the Organization of Islamic Capitals and Cities indicated that this organization represents 144 cities across the Islamic World. He argued that, as a rule, these cities suffer from terrible congestion and that transport policies aimed at improving energy efficiency and sustainable development are needed. According to Engineer Kadi, this Roundtable presents an unique opportunity to develop appropriate policies.

Mr. Edmund Cain of the United Nations Development Program, represented by Ms. Samia Guirguis, indicated his organization’s interest in sustainable development. One of the observations that he made had to do with the use of energy as a function of level of development. He noted that a 1998 study of the UN Development Program found that those nations in the lowest 20 percent of per capita income use only 4 percent of world energy. Egypt, on the other

hand, was found to use more energy than most nations at its level of development. Cain pointed out that the UN is working with Egypt to explore use of advanced clean urban bus technology. Electric buses are being field tested on the Giza Plateau, while hydrogen fuel cell buses are to be introduced in Cairo.

Dr. Ismail Osman of the Arab Contractors stated that he had met with Ms. DiSano and hoped that this cooperative effort would be productive. His activities in the area of construction illustrate the need for an efficient transport system in Cairo and he welcomed the efforts of the United Nations, World Bank, OICC and the private sector in assisting to promote energy efficiency and sustainable transport systems in Egypt.

B. Keynote Speeches – Session 1

1. Prospects and Challenges for Promoting Transportation Energy Efficiency in the Developing World. Mr. Kui-Nang Mak of UNDESA, gave an overview presentation observing that developing countries consume 1/3 of transport fuel, while developed countries consume 2/3. Mr. Mak argued that the transportation sector has been the major source of growth for oil demand over the past twenty five years and is expected to continue to be so in the medium term. During the period 1970-1994, world transportation energy demand grew at an average annual rate of about 1.9 percent. In OECD countries, during this period, major transportation fuels demand increased at an annual rate of about 1.4 percent and in developing countries, as is to be expected, considering their currently low levels of consumption, growth rates in major transportation fuels consumption were higher, exhibiting an average annual growth rate of about 5.3 percent. There was a marginal decline in the transportation fuel demand of non-OECD Europe during this period. In addition, the transportation system relies nearly completely on petroleum-based fuels, accounting for almost 60 percent of final world oil consumption; the growing concerns over its environmental impacts, particularly GHG emissions, have stimulated research and development of alternative fuels and technologies. However, alternative fuel vehicles remain a small fraction of the total world vehicle stock.

He noted that environmental impacts of transportation continue to be large, but a few countries have made much progress in reducing some impacts, in particular, vehicular emissions with catalytic converters and cleaner fuels. Carbon dioxide emissions, the major GHG of concern, continue to increase, which is unavoidable, as it is a by-product of fossil fuel combustion. However, the environmental impacts of transportation are not confined to the combustion of transportation fuels but occur throughout the entire vehicle and fuel cycle.

Taking Honk Kong as an example, Mr. Mak argued that megacities can be made to work and indicated that the mass transit system in Hong Kong had been vastly improved allowing residents to travel from home to work much more rapidly and conveniently. A typical mass transit user in Hong Kong uses multiple modes of transport on a single trip, but is able to purchase only one unified ticket to accomplish the trip. The co-ordination among modes and links was very impressive, according to his description. He noted that the distinctive mass transit system was built on time and under budget. He mentioned the construction of two tunnels under the harbor and a new airport. In his opinion, many of the problems of the megacities of the world are due to poor city planning and poor, outdated infrastructure built to inadequate standards. He indicated that cities like Singapore and Stockholm can provide examples of workable transit systems that provide for resident transport needs in a sustainable way.

2. Overall Environmental View. Mr. Rolf Hedberg of Scania argued that the production process should take into account environmental concerns at every stage and that the ISO production standard is very useful in this regard. However, as far as emissions of the vehicle in use, he observed that vehicle owners determine how to operate and maintain vehicles and thus will have an important impact. Hedberg noted the side effects of congestion, stating that when congestion is at its worst, only the gases are moving. Hedberg emphasized the benefits of repowering old vehicles with new engine and emissions control technology, or replacement of old vehicles. Improved technologies can allow both reduced maintenance and emissions. He stated that the fuel consumption of diesel engines had been reduced 50 percent over the last 20 years, while emissions had been reduced by 90 percent. Hedberg argued that diesel buses using diesel fuel are the dominant supplier of urban public transport in the world. Improvement of this fleet of vehicles, making use of this widely available fuel, is therefore one of the most important steps toward making public transport more sustainable with regard to maintenance of vehicles and acceptable levels of emissions.

Hedberg stated that alternative fuels are possible under some circumstances. He noted that Scania is the largest manufacturer of ethanol buses in the world. Four hundred Scania ethanol buses have been delivered, most in Stockholm. He argued that the greatest potential for alternatively fueled vehicles is in urban areas, where the refueling system costs can be lower due to more effective use of the infrastructure. In Stockholm, the ethanol-fueled buses on the “Blue line” are given top priority in traffic, with the buses able to turn stoplights ahead of them green. Information is provided to consumers at stops on the estimated time of arrival of the next bus. Hedberg indicated that the use of ethanol and CNG instead of diesel fuel in urban buses comes at a significant penalty in terms of fuel consumption. He pointed out in his oral remarks that the CNG bus uses a much larger volume of fuel than the diesel bus, and the ethanol bus uses nearly two times the fuel of the diesel bus. In correspondence after the roundtable, Mr. Hedberg provided specific figures, indicating that comparable models of diesel, ethanol and CNG buses require 45, 80, and 4500 liters of fuel respectively to go 100km on a test cycle used by Scania. Since the gas in a CNG bus is actually compressed, Hedberg argued in his correspondence that the net effect for CNG buses is to require three times the size of tanks and three times the weight of fueling systems. The added mass leads to a loss of peak capacity of buses of 12-13 passengers, considering a full load with standing passengers. On the other hand, (authors’ note) the design of many CNG buses places fuel tanks on the roof or under the bus, so peak *seating* capacity generally remains unchanged. Clearly, however, when CNG buses replace buses on routes where the bus is fully loaded on some of the trips made, the use of CNG will lead to a loss of capacity, requiring more buses to provide the same capacity in such a situation. At the roundtable, Hedberg provided a diagram of the emissions rates of particulates (PM) and NO_x for the Scania diesel, ethanol and CNG buses. As an approximation, the figure provided indicated that the ethanol bus reduced emissions of both PM and NO_x by about 20-30 percent compared to the diesel, while the CNG bus reduced NO_x by about 60 percent and PM by about 80 percent. The baseline diesel bus referred to in the diagram met the “Euro 3” emissions limits of 5 g/kWh NO_x and 0.10 g/kWh PM.

In closing, Hedberg said that we should better use infrastructure that exists to address congestion – by improving logistics and traffic flow via better management. He reiterated that emissions can be dealt with by retooling and replacing vehicles which use old technology and are gross polluters.

3. Public Transport, Energy Efficiency and the Environment. Pierre LaConte, former chair of the International Union of Public Transport, highlighted the importance of the “me” attitude in determining the nature of transportation choices today. He stated that the automobile industry is the main beneficiary of the present orientation toward individual transport providing maximum protection for oneself, even at the expense of others. He noted that kilometers driven by personal motor vehicle in recent years have gone up at a rate five times that of the population. Alluding in part to rising air pollution problems, he asserted that motor vehicle owners are not paying the full social costs of ownership. He showed a picture of a portable urinal – which he said was a common piece of equipment in the car in Bangkok, Thailand.

LaConte emphasized the space required to accomplish a 5 km trip, by mode of transport chosen. He asserted that the total space times time needed for moving and parking a car at work is about 90 times that needed for moving a pedestrian using public transport. Modes such as walking, biking, and public transport were cited as space efficient. He cited the example of bicycles being banned from some streets in favor of the automobile in China as a step in the wrong direction. LaConte noted that ozone had made the cover of “Der Spiegel” this past summer in Europe, and had been severe in Cairo a month earlier.

LaConte argued that dense cities use the least resources, that urban form is the problem interacting with transport investment choices. He noted, as a positive sign, that the United Kingdom had chosen to reduce its investment in roads and to no longer allow new shopping centers. He indicated that the high density block in Europe is more efficient. This form allows inside space that can be privatized and closed at night. Miscellaneous positive examples given were: (1) a Copenhagen new town; (2) adoption of a fixed urban boundary by Portland Oregon; (3) an inexpensive, efficient, fast public transport system in Curitiba Brazil, including off-board ticket sales in enclosed stations for buses (to be used in China as well); (4) \$5 fees in Singapore for downtown entry in a single occupant vehicle, but free entry with three or more occupants. LaConte noted that the issue of inefficient transport can be so powerful that even those generally conservative individuals prone to buy and use the car can agree that “socialist” policies to deal with traffic problems can be desirable. He cited the example of Strasbourg France where a “right wing” city voted for a socialist mayor campaigning on the need for traffic reduction.

4. Decoupling Energy Consumption and Economic Growth. Mr. Erling Rask of the Road Directorate of Denmark noted four side effects of transport that need to be controlled to allow sustainable development. These are emissions, noise, accidents, and fuel consumption. He emphasized the importance of harmonization of transport systems when those systems are used to cross national borders. He asserted that the accomplishment of harmonization in the European Union is important. Internally, Danish national policy is to break the carbon dioxide curve by limiting the need for transport, and to fight against transport noise.

In Denmark 77 percent of adults use the car every day; the average time spent in the vehicle per day is 52 minutes; 0 percent of trips are less than 5 km – suitable for bicycling; 13 percent used public transport in 1981, 15 percent in 1994; there were 270 cars/1000 persons in 1980 and 350 cars/1000 in 1994. Denmark’s goals include the reduction of carbon dioxide emissions by 25 percent; the reduction of NO_x and HC emissions by 60 percent by 2010; and the reduction of PM emissions by 50 percent by 2010. To achieve these goals Denmark has adopted policies and strategies to remove lead from gasoline and introduce catalytic converters (this was

undertaken in 1990), adopt a green owners tax, tax vehicles according to mass, require car inspections, develop and introduce alternative technologies, set up an energy information agency, and require use of green balance sheets. These measures have achieved realized results. Noise has been reduced, lead is down, and emissions are down.

5. Discussion. Discussions on the keynote presentations included suggestions that Cairo is a perfect city to adopt high density transport systems. Improvement of the urban bus transit system as in Curitiba would be valuable. Cairo should charge actual costs for transport services. Regarding the issue of affordability – the question of what countries at the lowest end of the income scale should do was raised. Privatization may not be the answer. Small contractors running public transit may not lead to good solutions. Centralized planning and management as in Sweden may be desirable. Curitiba is a solution for a developing country. The use of minibuses in South Africa appears to be far too expensive, requiring use of a high fraction of income for transportation. It was also noted that first car owners have high income and a lot of political power. In addition, traffic must be managed to allow as much compatibility of modes as possible. It is difficult to allow for pedestrians, bicyclists, motor cycles, buses, and motor vehicles.

One comment addressed the key question of how to bend the trend. Fleet turnover to allow introduction of more advanced technology is important to keep reducing emissions as traffic increases.

C. Keynote Speeches – Session 2

1. Air Quality and Pollution Problems from Transportation, and their Potential Solutions. Asif Faiz of the World Bank provided a country by country and pollutant by pollutant summary chart that presented an index of the seriousness of air quality problems throughout the world. His presentation implied that particulate pollution is the most pervasive problem, though there is some variation to this generalization. The chart did not include lead as an air pollutant. Faiz discussed some of the uncertainties in estimating the causes of lead concentration in the body in developing countries. He noted as an example that some cosmetic products applied to provide color can in fact contain significant amounts of lead.

Faiz noted that air quality in many Asian cities is approaching the dangerous levels recorded in London in the 1950s, with particulate concentrations often as much as six times the World Health Organization (WHO) guidelines. Other less deadly pollutants such as NO_x, ozone, and CO, are often two to three times above WHO guidelines. Rapid motorization, absent good urban planning and vehicular emissions control are among the leading causes of poor air quality.

2. Transport Energy Consumption, the Greenhouse Effect, Promising Solutions. Lee Schipper of the International Energy Agency pointed to the need for a break of the link of GDP growth and energy use (which results in CO₂) growth. He argued that the “ASIF” categorization of points in the energy use chain policies might be developed to break the link of GDP growth and CO₂ emissions growth. ASIF stands for Activity, Structure, Intensity, and Fuel. He noted that modal mix is an important determinant of overall intensity of fuel use per unit of delivered service (ton-km or person-km of movement). He stated that buses and two-wheelers are “booming everywhere”. He observed that solutions to the problem of Greenhouse Gas (GHG) emissions will not be sought for purposes of GHG reduction alone. Schipper indicated that, in order to get people to “buy in” to the need to reduce travel activity, adopt more efficient

technology, shift to less energy intense modes, and/or switch to fuels with lower GHG emissions, those consumers must believe that there are tangible benefits other than GHG emissions reduction which arise from these actions. He believes that tying the ASIF reductions to the reduction of other pollutants can help obtain the needed “buy in”.

3. The Policy Environment, the “Missing Link” Between Transport Policy and Sustainable Development. Thomas Gloeckel of the Ministry of Science and Transport of Austria started his presentation by defining “sustainability”. Sustainable transport, according to Mr. Gloeckel, meets the needs of people for quality of life, an undamaged environment, and mobility. Gloeckel emphasized the need for technical innovation as a tool in transport policy. He mentioned Austrian programs meant to accelerate innovation. One addressed multi-modal freight, combining road, rail, and water movements. A second addressed access to passenger rail. A third was designed to improve inland navigation on the Danube River. A goal of these studies that he emphasized was the analysis of systematic barriers to innovation, so that these barriers might be removed. The focus was also said to be on mobility management rather than supply of more transport. He indicated that Austria was trying to change consumer attitudes – in other words, Austria is committed to what many call “soft” policies rather than construction of new facilities.

D. The Solutions: Options and Barriers.

1. Vehicle and Fuel Options. Monica Saraiva of DaimlerChrysler focused on vehicle technologies being pursued by DaimlerChrysler (DC) within the nation of Brazil. She showed that Brazil has been making heavy use of biomass products for “300” years. In 1736 latex from trees was discovered. As of 1900 the maximum production of rubber, often used in vehicle tires, was reached. Brazil has a \$5 billion/yr. rubber industry. In contemporary vehicles, DC is using jute for thermo acoustic isolation of cars manufactured in Brazil, and uses a coconut seat backrest with natural latex and coconut fibers in combination. Biomass products originally developed for cars have been extended to use in DC trucks, and some of those products are now being exported to Germany for acoustic isolation panels in the E and A-class vehicles.

As far as vehicular fuels are concerned, ethanol, natural gas, diesel, and gasoline fuels are all available in Brazil. Brazil has long blended sugar cane based ethanol into its gasoline. After maximizing the use of ethanol blended into gasoline, and in response to the two oil price shocks of the 1970s and early 1980s, Brazil introduced vehicles capable of running on near neat ethanol. In 1984, 94.4 percent of new cars sold were ethanol-fueled vehicles. In 1996 this percentage had dropped to 0.3 percent. Presently gasoline contains 22-24 percent ethanol, and there are 3.8 million ethanol fueled cars remaining on the road. Like rubber, ethanol is a \$5 billion/yr. industry. It has been estimated that \$27 billion was retained by Brazil instead of going to oil producers because of use of ethanol fuels. It has also been estimated that an ethanol-fueled vehicle reduced CO₂ emissions by approximately 20 percent. (note, this combination follows Schipper’s rule of multiple benefits for buy in).

As a result of expansion of the ethanol industry, research and development was undertaken to improve productivity. New varieties of sugar cane were developed. Productivity of the ethanol industry increased by 0.22 percent/year. Looking forward, a new project to create hydrogen from ethanol for use in fuel cell vehicles is underway. Saraiva provided illustrations of the rapid progress in fuel cell technology that DC had exhibited in its “NECAR” series. Volume

and weight of fuel cell components and systems is coming down sharply. Fuel cell vehicles are promising for their ability to realize very high efficiency, thereby reducing CO₂ emissions, and their clean conversion of energy to motive power, thereby reducing emissions of particulates, hydrocarbons, carbon monoxide, and nitrogen oxides. Cost and packaging in a vehicle are major issues that must be resolved.

With respect to operating efficiency, Saraiva stated that fuel economy tests had been conducted for the fuel cell vs. the diesel. On the NEFZ driving cycle, the fuel cell realized 36.7 percent efficiency while a diesel realized 24 percent. Saraiva noted that multiple fuels are candidates for use in fuel cell vehicles. Methanol and hydrogen from natural gas are options more frequently cited than ethanol. Naptha, made from the refining of petroleum, also is obtaining some interest. The best efficiency of a fuel cell vehicle is realized when it is designed for and uses hydrogen as a fuel. Methanol, a liquid, is also good. Entry markets for fuel cells are expected to be the U.S., Brazil, Europe, Japan, and possibly Mexico.

2. How Can You Know What to do Without Data? Lee Schipper of the International Energy Agency discussed the inadequacy of data concerning implementation of ASIF accounting and policy steps. Necessary information that must be collected is: Modal intensity (based on accurate drive cycles, occupancy [loading] rates, and fuel intensity). Fuel intensity was said to be a function of technological efficiency and vehicle characteristics. Schipper asserted that both a fuel use and emissions inventory are necessary. Though it is costly, collection of this information every five years is recommended. Monitoring of air quality by the World Bank has been very helpful in identifying the worst problems, but it alone is not sufficient to help develop policies to address those problems.

3. Energy Use and Economic Activity Across Nations. Prof. Ben Wah Ang of the University of Singapore gave a presentation that showed the overwhelming trends linking energy use to economic activity, but then discussed why countries tend to consume more or less energy per unit of measured economic output than the norm. Singapore provides an example of one country which is well below the trend. Ang discussed this, including policies that helped keep motor vehicle use low. Singapore is well-known for adopting pricing mechanisms including very high taxes on motor vehicle purchase. Restrictions on rights to own motor vehicles also have been implemented. Ang also mentioned a policy of requiring high tolls to enter areas of Singapore in a single occupancy vehicle, with no tolls if three or more occupants are in the vehicle. Ang pointed out that prices of vehicles had risen sharply in Singapore as higher income caused more people to seek motor vehicle ownership, but a restricted supply led to clearing of the market for motor vehicles through sharp price increases. Singapore is now reorienting its policy from one of ownership restriction to restriction of vehicle use.

In closing, Ang echoed Schipper's call for the collection of good data. He said that data should be collected in detail and have high quality.

4. Transportation Information in Islamic Cities. Ayad Hussein of the Association of Islamic cities indicated that a new approach to data collection was needed. He also asserted that the quality of data that has been collected has not been given enough attention. A major question in his mind was which organizations should be responsible for collecting data. At the present time, a problem is that there has been no establishment of a history of data collection. For most developing countries, he argued that much of the relevant data has been collected only once.

Well designed detailed data collection efforts might be combined with sampling in areas thought to be similar, to test the hypothesis that classifications of similar geographic entities might be used to extend the applicability of relatively limited data. Hussein indicated that the development of appropriate policy requires quality information.

In closing, Hussein emphasized that the glaring deficiency in developing countries is consistently a lack of available transportation and environment/emissions data.

E. Policies and Institutions.

1. Vehicle Emissions and Engine Standards. For vehicle and engine emissions, Christopher Weaver, President and chief engineer of Engine, Fuels, and Emissions Engineering, Inc. of Sacramento, CA, discussed the kind of data that must be collected, and the quality issues involved with that data. One important problem for developing nations, which needs to be quantified, is the emissions of imported used vehicles. Weaver reiterated one of the basic points made by Asif Faiz, that particulate matter (PM) is one of the two leading causes of health problems, the other being lead emissions in those nations that have not yet phased out lead use in gasoline. Weaver reminded the audience that both NO_x and SO_x tailpipe emissions are precursors of nitrate and sulfate particulate matter, which can constitute a significant fraction of particulates in some metro areas. Weaver asserted that direct tailpipe PM and gaseous NO_x emissions have the number one and two priorities for vehicle emissions control, while lead and sulfur removal from fuel are the number one and two priorities for reducing the inherent emissions of fuels.

Weaver argued that CVS (constant volume sampler) and SHED (sealed housing evaporative determination) tests are now standardized and should be adopted by nations not already using them. He also pointed out that present test procedures used for heavy duty (HD) engines rely on engine dynamometers, while test procedures for light duty (LD) engines make use of vehicle dynamometers. Weaver recommended that imported vehicles be tested and that they be required to meet accepted international emissions standards.

Weaver said that inspection and maintenance (I&M) programs for older vehicles are important. He observed that the “politically acceptable” failure rate for I&M programs is up to about 35 percent. The cut-off for failure must be tailored to the local characteristics of vehicles. A testing program to determine the distribution of emissions rates of the fleet of vehicles in the country needs to be completed in order to set the appropriate I&M cut-off point (i.e. the one where no less than 35 percent of the tested vehicles will fail). Since the emissions rates of vehicles deteriorate as the vehicle ages, the damages from motor vehicle emissions increase as the age of the vehicle increases. Accordingly, Weaver recommends higher taxes on vehicles as a function of age of vehicle, in urban areas where air quality problems exist. The tax revenue raised should be used to remediate damages.

2. Evolving Knowledge about Emissions Rates of Vehicles. Zissis Samaras of Greece provided some guidance on the types of tests that might be useful (and those that would not) for developing nations. He first discussed one of the problems that developed countries have been lately addressing, – that of higher “in-use” emissions than tested emissions. What has happened in developed countries is that the test equipment used interacted with the test design. In particular, rates of acceleration were limited by the vehicle dynamometers that were available.

Accordingly, tests were necessarily designed not to exceed the acceleration capability of the equipment. This led to “stylized” tests in Europe and the U.S. that did not actually reproduce the effects of actual driving, since people actually drove the vehicles more aggressively than the test equipment could simulate. In both Europe and the U.S. this problem has been recognized and is being quantified, with the U.S. ahead of Europe. New vehicle dynamometers and other sophisticated types of equipment are now available and are being used in both the U.S. and Europe to characterize and regulate “real world, in-use” emissions.

Yet, developing nations cannot at this time make use of the expensive, sophisticated equipment available to the developed countries. So Samaras, using his years of experience and the research conducted at his institution, discussed the cheaper techniques that work, and those that do not. He pointed out that the tests that he had conducted over the years clearly showed that vehicles without three-way catalysts were consistently higher polluters than vehicles with three-way catalysts.

For those nations adopting the simplest of inspection and maintenance (I&M) techniques, Samaras indicated that a high idle test could be very effective in identifying vehicles with problems in engine calibration. He indicated that low idle tests were not effective. Carbon monoxide measurement was suggested as a “flag” to identify high emitters. The high idle tests could lead to savings of 3-5 percent in fuel efficiency per vehicle that is identified to have a problem, which then corrects the problem. Samaras noted that PM emissions degrade (increase) a lot as a vehicle ages and/or falls out of calibration. He said that the opacity (or smoke) test for diesel vehicles has no correlation with emissions by any other test, and has nothing to do with reality. A nation that has more money and/or a more serious air quality problem will have to go to a transient test rather than simple idle tests. Samaras indicated that a relatively new technology allows “remote” sensing, which can help catch “gross” polluters.

3. The U.S. Clean Cities program – Management Structure and Tools for Future Visions. Dan Santini of Argonne National Laboratory’s Transportation Technology Research and Development Center presented information on the U.S. Department of Energy’s Clean Cities program. Santini described how the program had come to exist, described a bit about the procedures for being designated a Clean City, and the information clearinghouse called the Clean Cities hotline. He touted the advantages of the consolidated program and sharing of information and ideas at the annual Clean Cities Conference. A graphic on the presently designated Clean Cities in the U.S. was included. The Clean Cities website home page is at <http://www.ccities.doe.gov/>

Santini pointed out that his research institution’s role was to provide standard tools for evaluation of the effects of technologies being implemented in the Clean Cities. Also, Santini discussed three models that Argonne National Laboratory’s Center for Transportation Research has developed for the DOE Office of Technology Utilization, the Office managing the Clean Cities Program. The first of these is the Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation (GREET) model. Fuel and energy use and emissions (on a gram-per-mile basis) for the full fuel-cycle (from well to wheels) are estimated in the model. Percentage differences from a baseline gasoline vehicle are estimated for each technology. Santini provided selected graphical comparisons. He made the point that the full fuel cycle emissions of electric vehicles (EVs) vary a lot, depending on the mix of fuels and technologies used by the electric utilities providing power to the vehicle. He noted that the full fuel cycle GHGs and nitrogen

oxides emissions of EVs are far lower in California and the Northeastern U.S. than in the rest of the U.S. This helps explain the greater interest in these vehicles in those regions of the U.S. Santini provided estimates for near-term technologies such as hybrids, advanced diesels, electric vehicles, natural gas and LPG vehicles.

Santini also briefly discussed the “AirCred” and Integrated Market Penetration and Cost of Transportation Technologies (IMPACTT) models, explaining that the former included per vehicle emissions estimates tailored to each Clean City. The GREET model is available as shareware and can be accessed at the following website: <http://www.transportation.anl.gov/>

4. Clean Development Mechanism and Sustainable Transport. Bill Dougherty of the Stockholm Environment Institute discussed the “Clean Development Mechanism”. The presentation focused on ways (“mechanisms”) to meet the targets of the Kyoto Protocol, including issues of trading across sectors (i.e. motor vehicles vs. industry vs. agriculture vs. residences vs. commercial buildings) and nations.

5. Cairo Air Project, an Innovative Partnership. Samir El-Mowafy of the Egyptian Environment Affairs Authority discussed Cairo’s efforts, under the “Cairo Air Project” to reduce emissions and improve air quality in Cairo. Egypt’s strategies include adoption of emission standards for new vehicles, enforcing emissions standards for in-use vehicles, and encouraging cleaner alternative fuels. He indicated that testing of on-road vehicles in the fleet had begun on Feb. 7 of 1999. The Ministry of Environment has coordinated stakeholder views and obtained official approval to adopt EURO 2 European Emission Standards for new vehicles, effective Jan. 1, 2002. The Cairo Air Improvement Project (CAIP), conducted jointly by the governments of Egypt and the U.S., includes the following transportation efforts: implementation of a vehicle emission testing (VET), tune up, and certification program; introduction of compressed natural gas (CNG) fueled public buses and taxis; and monitoring of ambient lead concentrations as a follow-up to the elimination of lead from gasoline.

The ongoing on-road testing program will establish a baseline for a more sophisticated vehicle testing program to be implemented soon. Test centers will be located throughout the Cairo area. Operators will be private contractors selected in an open bid process. Those selected will be trained and certified. Facilities will collect testing fees. Tests of approximately 2500 on-road vehicles to date indicate that 63 percent meet the present test standards. 23 percent fail to meet the CO emissions limits and 21 percent fail to meet the HC emissions limits. The long-term goal will be to reach 80 percent compliance. Motorcycles are included in the tests. Lower emissions and higher fuel efficiency of on-road vehicles is the goal of this program.

Dedicated CNG buses are being deployed. Rolling chassis are being imported and a local manufacturer is building and integrating the bodies of the buses. Training for improved maintenance will be provided and a public education program will enhance public awareness.

6. Intelligent Transportation Systems. Robert Hicks of Public Technologies Inc. discussed intelligent transportation systems (ITS), which is in fact a broad categorization. He indicated that ITS steps are not an end in themselves, but need to be linked to other strategies. He indicated that ITS cannot guarantee a positive result – it can, under some circumstances, cause higher fuel consumption or emissions while increasing speed. Reduced travel time, not emissions or fuel consumption reduction, is a common goal of ITS.

He noted that \$1 billion is being spent on ITS in the United States. One type of ITS that might provide reductions in motor vehicle use would be the provision of better information to transit riders. Better information on actual bus arrival times could lead to more use of transit. To reduce vehicle search time in a metro area, better information on locations of available parking should be effective. He noted the use of “traffic calming” in Sweden, a means to automatically slow vehicles down, as necessary. Electronic gates, as used to smooth flow on U.S. urban interstates, might be used to limit access to downtown areas when congestion becomes severe or parking depleted. He mentioned road pricing but indicated that it is hard to implement. The Public Technologies Inc. website address is: <http://www.pti.nw.dc.us/>

F. Parallel Sessions on Promising Methodologies and Technologies:

i. Alternative Fuel Vehicles.

1. Survey of alternative fuel vehicles. Roger Gorham of the World Bank gave a presentation on the technological options available for dealing with full fuel cycle emissions from motor vehicles. He utilized the GREET model (Greenhouse Gases, Regulated Emissions and Energy Use in Transportation) to illustrate how advanced and alternatively fueled vehicles can provide varying opportunities to change full fuel cycle emissions rates and energy use.

2. Sustainable transportation after Kyoto – transportation energy and environment. Dr. Gerhard Isenberg of DaimlerChrysler indicated that transportation is the most important user of oil. He cited the IEA as having indicated that OPEC will achieve 60 percent of the world oil market, and world oil production will peak in about 2014. He indicated that more than 65 percent of well-known economically exploitable oil reserves are in the Middle East, and more than 70 percent are in OPEC nations. He asserted that there will be no technical shortage of transportation fuel in the next two decades or so, but also no guarantee of inexpensive, consistently available oil.

Isenberg noted a difference between the Kyoto goal of reduction of GHG emissions to 1990 levels by 2008-2012, vs. anticipated European Union transport energy use growth of 39 percent over that period (note that this number is far smaller than the number that Prof. Suchorzewski estimates for Poland). Isenberg notes in his proceedings text that the European Automobile Manufacturers’ Association (ACEA) made a voluntary commitment to reduce CO₂ emissions from the ACEA new car fleet to 75 percent of the 1995 value by 2008.

Isenberg asserted a logical sequence from oil based fuels (gasoline and diesel) to natural gas-based fuels (methanol and hydrogen) to renewable fuels (methanol, ethanol and hydrogen). In order to accomplish this switch, a new type of drivetrain – electric drive – would be adopted in conjunction with fuel cells as the source of power. Isenberg indicated that fuel cell vehicles *may* become competitive in the next decade. He mentioned DaimlerChrysler’s cooperation with the state of California in its fuel cell program using hydrogen and/or methanol and with the nation of Brazil in its fuel cell program using ethanol.

3. Environmental benefits of alternative fuel vehicles. Bill Dougherty of the Stockholm Environment Institute gave a presentation on the comparative emissions of alternatively fueled vehicles which might be used in the Northeastern U.S. He noted that one of the findings of their

study was that light duty vehicles contribute a very small share of the PM and SO₂ emissions from the transport sector.

ii. More Conventional Technology.

1. Diesel engine development. Marcela Petkov of Scania discussed present efforts to improve the diesel engine in order to both meet increasingly strict emissions standards in developed countries, while keeping the option of taking advantage of the diesel's high efficiency and commensurately low CO₂ emissions. According to Petkov, the modern diesel engine can be as much as 46 percent efficient. One pound of diesel fuel burned will produce 3.17kg of CO₂, so the less fuel consumed, the better. The most desirable outcome of research will be to discover technology that both reduces emissions and improves fuel efficiency. Unit injectors have been introduced in modern diesel engines. This has reduced emissions and improved fuel efficiency. Nevertheless, for any level of technology there can be trade-offs between emissions and fuel consumption. For the diesel, the most important present trade-off is between NO_x and fuel consumption – as fuel consumption is reduced, NO_x rises. Thus, establishing the proper balance between NO_x and CO₂ emissions is a challenge.

A very important aid to the diesel engine manufacturer that can be provided by diesel fuel refiners, probably only with the insistence of governments, is the reduction of fuel sulfur content. The diesel, until recently, did not use after-treatment devices such as catalysts (long used by gasoline vehicles in developed countries). Catalytic after-treatment devices to reduce NO_x and PM are being developed. The most promising of these are quite sensitive to sulfur in the fuel. The maintenance of in-use efficiency of reduction of NO_x and PM by these catalysts will require low sulfur fuel. The European Union will require sulfur levels in diesel fuel to be reduced from a present average of 350 ppm to 50 ppm, to enable catalytic conversion technology to meet much stricter diesel exhaust standards.

Petkov also discussed an EU directive called the EEV (Environmentally Enhanced Vehicle). For the diesel, the coming sequence of Euro standards was listed as follows. We presume that these are in g/kwh.

	NO _x	PM	HC
Euro 1	7.5	0.2	0.5
Euro 2	6.6	0.07	0.3
Euro 3	4.7	0.09	0.3

Petkov discussed four ways of possibly meeting the above standards: (1) system optimizing, (2) exhaust gas recirculation (EGR), (3) after-treatment devices, (4) new engine technology. In closing, Petkov discussed intelligent transportation systems.

2. Advanced technologies for reducing carbon emissions from the transportation by Fenton Carey, Jr. and K. Thirumalai and delivered by Joel Washington of the US Department of Transportation discussed intelligent transportation systems (ITS), advanced and fuel efficient vehicle technologies, and alternative fuel technologies (AFT). The major U.S. program to promote advanced and fuel efficient technologies is the Partnership for a New Generation of Vehicles (PNGV). The paper focused on electric vehicles, fuel cell vehicles, hybrid electric

vehicles, and advanced diesel engines. Lightweight materials were also mentioned. Alternative fuels named were CNG, LNG, LPG, RFG, ethanol, and gasohol.

3. Retrofitting diesel vehicles for natural gas dual fuel operation. Doris Pincombe of Technology Transfer International discussed a 1989 model diesel bus that had been converted to burn both diesel fuel and natural gas. This technology should work in developing countries which have abundant natural gas, relatively old bus engine technology (relative to developed nations) and limited capital to purchase new dedicated diesel or CNG buses. Pincombe described the technical details of the conversion, providing illustrations to the audience.

Questions and discussion. Questions were raised about the emissions characteristics of CNG and ethanol buses. Dedicated original equipment Scania ethanol and CNG bus engines can meet Euro 3 and Euro 4 emissions requirements. Another question addressed the issue of standards and/or protocols in ITS to measure emissions changes.

It was also noted that one problem with retrofitting diesel technology is that in typical urban transit bus driving cycles it tends to run mostly on diesel fuel, thus providing little emissions or diesel fuel savings. However, at steady speeds with few stops, this technology will run mostly on natural gas.

iii. Clean Fuels.

1. Phase-out of leaded gasoline by K.W. James Rochow, emphasized the importance of replacing leaded fuels not only for the sake of reducing lead toxicity, but also to allow the implementation of much more advanced emissions control technology and advanced fuel metering systems for greater efficiency. There is little doubt that needed sharp reductions of the precursors of ozone – nitrogen oxides and hydrocarbons – requires use of catalytic converters, which in turn require elimination of lead. Further, participants indicated that reduction of carbon monoxide is an important environmental issue to many of those in attendance. Sharp reductions of carbon monoxide are made possible with three way catalytic converters using unleaded gasoline. Thus, lead removal is strongly consistent with the sustainability goals for transportation of the roundtable participants.

G. Presentations by National Experts

Special sessions were held for presentation of transport energy problems and solutions at the national level and UN-sponsored participants were strongly encouraged to participate in these sessions as speakers. There was great interest in these sessions both by potential speakers and by Roundtable participants and additional speakers from developing countries were accommodated. An additional session was added to those originally planned and three separate sessions were held for presentations on national experiences. These sessions also generated lively discussions and comments, and ideas brought forward were incorporated in the Cairo Declaration and the GITE follow-up program.

i. Session 1

1. Traffic management strategies to improve air quality in the greater Cairo metropolitan area. Prof. Atef Garib of Zagazig University of Egypt emphasized the importance of the speed

and flow capabilities of the transport network. He noted that a breakdown from smooth steady to congested intermittent flow can lead to both higher emissions per vehicle per kilometer as well as a slower speed and longer duration to complete the desired trip, both of which can elevate total emissions. The causes of breakdown of smooth flow, as well as measures to promote smooth flow were discussed. The opinion was expressed that the cost of measures to assure smooth efficient traffic flow can be offset by the value of emissions reductions obtained.

2. Energy efficiency in the transport sector of Iran. Mr. Massih Mohammadian of the Ministry of Energy of Iran reviewed the energy consumption patterns in Iran with a special focus on the transport sector. He noted that the demand for transport energy amounts to 24.6 percent of total energy demanded in Iran and that the transport sector accounts for 98 percent of the gasoline consumed, 48 percent of gas oil consumed. Seventy percent of the pollution in cities is caused by the transport sector as a result of use of outdated technologies, inadequate maintenance and repair programs, low portion of rail transport, lack of comprehensive city planning resulting in traffic congestion, low load factor especially in urban areas, low utilization of telecommunication and mechanized links for traffic control, lack of adequate information and low fuel prices.

Mr. Mohammadian indicated that Iran has undertaken concrete measures and policies to solve these problems. These include encouraging mass transit in larger cities. To this end, 700 new buses, amounting to 27 percent of the total fleet, have been introduced in Tehran. Special buses and express lanes on major roads and highways have also been introduced. Also, efforts have been made to encourage alternative fuel use and currently 95 percent of all taxis in Tehran use CNG. In addition, training and education programs to encourage energy efficiency are underway. Proposals to be included in the 2000-2004 Five Year Development Plan include 19 energy efficiency projects aimed at reducing vehicle energy use, 19 projects to better manage manpower, fleets and traffic to reduce energy consumption, the strengthening of rules and regulations regarding energy consumption in vehicles, and six infrastructure development projects.

3. Possible uses of energy consumption in assessing urban transportation policies. Dr. Danang Parikesit of Gadjah Mada University of Indonesia emphasized the implications of the travel time budget, drawing from his study of the Vienna Austria area. If, as evidence indicates, travel time budgets are relatively constant, then the development of transport networks capable of high speed will lead to lower urban density and longer distances between activities. Dr. Parikesit asserted that energy use per unit of time would be one of the best performance indicators to evaluate the ability of transport modes to provide sustainable transport services. He indicated that an energy use per unit time indicator will direct transport planners to focus on public transport and non-motorized transport. He also indicated that school trips in his studies proved to be important, noting that parents did not select the nearest school but chose the best school that they could afford. He further observed that many motorized vehicles attempted to improve the air quality within the vehicle but not outside of it.

4. Strategies for GHG emissions reduction from transport in Poland. Prof. Wojciech Suchorzewski of Warsaw University asserted that the goal of reducing GHG by 25 percent by 2020 could not be accomplished unless there were a decoupling of transport growth from economic growth. He asserted that this would require that industrial lobbies – motor vehicle producers, highway construction firms, and fuel producers – be fought. Dr. Suchorzewski

provided a full page summary in the roundtable proceedings. In it, he indicated that projections of GHG emissions had been developed for Poland for the period up to 2030. The work that he cited implied that carbon dioxide emissions would increase from 100 to 300 percent in Poland over that time period, depending upon rates of economic growth and policies to reduce energy use by transportation. Plausible strategies for reduction were not found to be powerful enough to offset the anticipated effects of economic growth.

5. Transport energy efficiency, the Zambian case. Geoffrey Musonda of Zambia did not seem to think that his country had the economic ability to consider replacement of vehicles in order to reduce emission rates. Rather, he was of the opinion that the best that could be done would be to assure proper maintenance of the existing stock of vehicles so that the efficiency of combustion could be kept at the best level possible for the vehicle fleet in operation in Zambia. He indicated that control of importation of used cars is difficult, and conceded that the fuel consumption and emissions rates of such vehicles may be well above values when the vehicles were new. Mr. Musonda asked representatives of companies to visit the country and to adapt their marketing strategies to what the country needs. In Zambia's case, this might be the provision of quality parts for used vehicles.

6. Transport energy efficiency, the Kenyan case. Wanjohi Ndirangu, Chief Government Electric Engineer of Kenya reminded the audience that not all of the transport energy use problems are those of major urban areas. Perhaps 70 percent of Kenyans live in rural areas. In Kenya the use of animal power in rural areas provides freight transport and personal transport. This is renewable energy and should be studied, encouraged, and made as efficient as possible. Further, human power is also used to move goods. The nature of the movement of goods by trail might be worth study to see if simple improvements are possible. Can the bicycle be adapted to conditions particular to Kenya's patterns of use and the terrain of its rural areas?

Discussion. Discussions on the above national presentations focused on the concept of strategic environmental assessment (SEA). Its application in transport corridors was mentioned. Also, there was discussion of the importance of transfer of information among nations on policies adopted, technologies deployed, and institutions created. Development of new information for nations to consider was cited as a purpose of the roundtable. Options such as electric drive vehicles, biomass-based fuels, and natural gas fueled vehicles can be considered, as local conditions dictate. A mix of policies and technologies can move the transport sector toward a more sustainable state, with constant or lower emissions of at least most pollutants (CO₂ being more problematic than other emissions).

ii. Session 2

1. Venezuela. Noberto Barboza of Petroleos de Venezuela (PDVSA), manager of the Venezuelan Natural Gas for Vehicles Project (Proyecto GNV), discussed this program. As background, he noted that Venezuelan transport fuel use breakdown is 18 percent cargo and products movement, 6 percent public transport, and 81 percent household vehicle transport. Gas production in Venezuela is 110 million cubic meters a day, much of it associated with oil production. This makes Venezuela the seventh largest gas producer in the world. The gas is in need of a market if oil is to be produced while avoiding gas re-injection or flaring. A gas

distribution network is in place, allowing delivery of gas to major cities. No market for gas liquids from Venezuela presently exists.

170 NGV stations have so far been installed, with compressors producing 1000 cubic meters per hour, using 200 hp each, and with 400 cubic meters of storage capacity. Presently the natural gas vehicles are conversions. 30,000 vehicles have been converted to date (90 percent in the last three years) and sales have reached 14 million cubic meters per month. To date, conversions have been from gasoline to CNG. Diesel conversions or replacements with CNG vehicles remain a future opportunity. It is anticipated that the program will continue to grow for many years.

2. Chile. Gerardo Muñoz Chacon of the Chilean Gas Association stated that natural gas had been available in Santiago since 1997. The gas is transported by pipeline from Argentina. During the last year testing of vehicles had taken place. Estimates are that transportation accounts for 93 percent of HC, 79 percent of NO_x, 42 percent of PM, and 69 percent of SO₂. Most of the buses are diesels, undoubtedly using relatively high sulfur diesel fuel. This explains how transportation can account for 69 percent of SO_x emissions.

The Chilean environmental authorities commissioned a study on diesel bus emissions damages, conducted by local university professors, who had been trained at some of the leading universities in the world. This study estimated that the social benefits of emissions reductions that could be provided by natural gas buses would more than offset the added capital costs of those buses (fuel costs were reported to be 10 percent less for CNG than diesel). An estimate of \$27,000 net benefit per CNG bus substituted for diesel buses was obtained. This study, given its considerable local credibility, led to new legislation in support of natural gas buses, including subsidies to offset the added capital costs of the buses. The primary motivation for the CNG bus program was the dollar value of reduced PM emissions. Fine PM is a serious problem in Santiago.

The cost of the natural gas pipeline from Argentina was reported to be \$500 million. The cost per CNG bus was reported to be \$153K per bus, vs. \$114K for diesel buses.

One participant noted that Santiago faces a unique situation. Nine thousand buses operate providing 65 percent of all trips to 7 million people. The authorities annually replace 800 -900 buses. Santiago has a huge PM problem, with 60 days of exceedances, including 10 emergency days when industry has to shut down and 50 percent of the light duty vehicles with no catalysts are forbidden to drive.

3. Mexico. Diana Ponce of the Environmental Policy and Planning Office provided information on achievements in transport emissions reduction in Mexico City. She said that on average about 80 percent of emissions in Mexico City are due to transport. She said that 50 percent of ozone precursors are from transport, and 90 percent of CO emissions are from transport. Improvements that have been made include ongoing elimination of lead in fuel by introduction of an unleaded fuel (1987) and phase-out of leaded fuel. The removal of leaded gasoline has been successful in reducing population exposure to lead. Since 1993, lead in the blood of children and adults have been below the standard. The availability of unleaded fuel makes possible the introduction of catalytic converter equipped gasoline vehicles. Older cars, which do not have catalytic converters (pre '85) account for 60 percent of emissions, though

undoubtedly a far smaller share of vehicle miles of travel. Corruption in the Inspection and Maintenance program is a major problem. Bribes to the private facilities doing I&M are common. The I&M program is a success in the sense that it teaches owners to maintain vehicles. Vapor recovery systems at gasoline stations have now been installed.

New cars have no restrictions on use. Old cars, however, are restricted in use and must not be used for 1 to 2 days per week.

Ambient air concentrations of CO, SO₂ and NO₂ are now below standards. Ozone, however, remains a problem and continues to be above standards, although it is coming down. PM was a problem in 1998, when fires in the countryside increased concentrations considerably. In 1999 the number of days above the ozone standard were 111, while for PM, the standard was violated 16 days.

Alternative fuels of interest to Mexico City are LPG, CNG, and electricity. Thirty thousand vehicles presently use LPG. Natural gas use in vehicles is beginning. Mexico, a major oil producer, is flaring a lot of natural gas in order to produce associated oil. There have been a couple of major accidents in gas fields. Publicity about these accidents appears to make people wary of natural gas vehicles, leading to concern over explosions. Electric public transport is being expanded. Another route is being added and overall, 200 more kilometers of electrified line is planned.

Other measures for the future include reduced sulfur content in gasoline – down to 60 ppm by 2005, and removal of power plants from the valley in which Mexico City is located. At the present time, Mexico requires automobile manufacturers to certify only that vehicles coming off the assembly line satisfy required emissions tests. Perhaps in the future, Mexico will require the manufacturers to certify the performance of the vehicle over a specified number of miles, as is done in the U.S.

In closing, Ponce noted that “dirtier fuels are cheaper fuels”.

4. Tanzania. Hosea Mbise of the Ministry of Energy and Minerals indicated that Tanzania’s population is still mostly rural, but fast urbanization is occurring. There are 32 million people with an average annual income of less than \$300 per person. Most in the nation still depend on animal and human power, though energy use in urban areas is rising rapidly. Tanzania does not have any domestic oil, but does have natural gas. The presentations on natural gas vehicles were intriguing to Mbise, who said he would now examine their consideration. Road transport uses the most oil in transport, rail is next. More than half of the oil products in Tanzania are used outside of transport (55 percent). Tanzania encourages the use of diesel engines and public transport. 75 percent of transport fuel is diesel fuel - a very high proportion compared to more developed countries. The primary conservation motivation is to save oil to save money.

Tanzania has poor roads, with many potholes. Mbise noted that those who can afford new vehicles purchase big vehicles – for no reason in his view. There are cars over 40 years of age still running in Tanzania. Fuel quality control is a problem. Oil smuggling is a problem. Tanzania is increasing the price of gasoline in order to encourage the use of diesel fuel. Use of larger engines is being discouraged by implementation of higher taxes on larger engines.

Parking is being taxed. There is an established national institute of transport. Methods to improve traffic flow are being studied and implemented when desirable.

5. Transport energy efficiency, the Tunisian case. Engineer Yousseff Bahri presented statistics on the energy supply situation for Tunisia. Oil reserves were shown to be declining, while gas reserves are increasing. This is a pattern already seen in Egypt. Recently, Tunisia has seen a 3-5 percent growth in energy use per year. While Tunisia had previously been self sufficient (on a net basis) in oil production, this will no longer be the case in the future. Oil imports will be required and/or use of natural gas in transportation will need to be considered. Thirty two percent of national energy consumption was for transport in 1998. Of that, 76 percent was for road transport, and 50 percent of road transport was in private cars. LPG is being used in taxis. Diesel is the leading fuel. Cooperative trading arrangements for petroleum products have been set up with other nations in the Mediterranean. Ship owners come to Tunisia to purchase bunker fuel. Policies have been adopted to decrease energy intensity in transport. Duties on smaller, high efficiency passenger cars have been lowered to encourage purchase of more efficient passenger cars. Energy management courses are taught in the schools.

6. Indonesia. Laksmi Dhewanthi of the Indonesian Strategic Environment Assessment provided information on Indonesia. An emissions inventory had been developed. According to that inventory, 69 percent of NOx emissions are from motor vehicles, and 26 percent from factories. For PM, it is estimated that 40 percent of emissions are due to motor vehicles, 57 percent are from factories, and 3 percent from households. Of transport related PM, 35 percent is from buses and 28 percent from cars. The “Blue Sky” emissions control program was introduced in 1996. Both mobile sources and stationary sources are controlled under this program.

7. Transportation Energy Efficiency and Sustainable Development in Malaysia. Mohamed Zarif of the Energy Section of the Economic Planning Unit noted that Malaysia has adopted a “National Depletion Policy” and a “Four-Fuel Diversification Policy” with objectives of ensuring adequate, secure and cost-effective energy, promoting efficient utilization of energy, and ensuring that environmental protection is not neglected. He indicated that energy demand growth in 1998 was 2.3 percent, which was much lower than the 8.7 percent during the 1995-1997 period due to economic contraction. However, it is expected to increase to 4 percent by 2000. The transport sector consumes 27.2 percent of total energy in Malaysia and this share is about the same as in 1980. However in absolute terms it has grown by over 400 percent during that period. Gasoline and diesel oil accounted for 60 percent and 24 percent of total transport energy consumed in 1998, with alternative fuels accounting for 16.5 percent. Malaysia is undertaking strategies and measures to manage energy resources on a sustainable basis including the promotion of energy efficiency and the development of improved public awareness programs.

8. China. Luo Renjian presented “China’s Toll Road Development Experiences and Future Policy Recommendations” and “Experiences in China on Improving Vehicle Fuel Efficiency”. He noted that a fundamental problem in China is rapid growth of vehicles and vehicular traffic without commensurate road building, leading to severe congestion and an inadequate road infrastructure. One of China’s solutions is to build toll roads. Toll road mileage as of 1998 totaled 75,154 kilometers. Funding was provided by the World Bank, the Asian Development Bank, foreign and domestic banks, and by fund raising efforts. This accelerated

road development, especially of expressways. Toll roads are both for profit (private funding) and not-for-profit (government funding). It is anticipated that, through 2020, expressway construction will be funded through borrowing, with repayment commitments from projected tolls. Renjian indicated that “too many” toll roads had been built, and, essentially that a national highway system of (a limited number of) toll roads be implemented. China has also responded to increasing vehicle traffic by increasing and upgrading public roads. During the 1985-1998 period 336,000 km of new roads have been constructed and 8,700 km of roads have been upgraded.

Increasing vehicles and vehicular traffic have led to a significant increase in the demand for transport fuel. Other policy measures to address transport problems have included improving vehicle technology, improving the quality of fuel, adopting up-to-date planning methodologies, introducing fiscal measures such as fuel oil taxes, strengthening vehicle emissions standards, and encouraging alternative fuel vehicles.

9. Egypt. Khaled N. Helali of the TCB/AET (an Arab Contractor) indicated that traffic control measures (TCM) are needed in addition to emissions control of vehicles. Traffic demand management was touted as having potential to reduce vehicle emissions. A framework, evaluated for the Toronto Canada metropolitan area was to be discussed. The framework includes a data assembly module, traffic assignment module, air pollution module, and a TDM module.

H. Research and Development of Innovative Transport Systems

1. Station car mobility systems. Martin J. Bernard III, president of the U.S. National Station Car Association, discussed the station car concept being evaluated and developed in the San Francisco Bay Area of the United States. The concept is similar to the car sharing concept widely used in Europe. The on-going field tests use electric cars located at a commuter rail station, thus called “station cars”. Using that location as a base, the vehicles are rented out and/or used as taxis to provide service primarily between residences and commuter rail stations. This market is one that electric cars can serve because the trips involved are relatively short, so the limited range of the electric vehicles is not a significant concern. Conceptually, in the long run, any high activity center might use a fleet of such vehicles – high density housing, airports, university campuses. Emissions and energy benefits and net social costs and benefits of a 40 car demonstration fleet were discussed. The need for and nature of intelligent controls were also discussed.

2. Intermodal transport and sustainable development planning. Clifford Bragdon, Director of the U.S. National Aviation and Transport Center, discussed the transportation system from a holistic point of view. He asserted that mobility is the key to progress for a civilization. Density is important to consider in transportation modeling and understanding the transportation system. Time and space are also important, because they are non-replaceable. The space concept (three dimensions) should be used when we plan cities, not surface land use. In city planning those who plan should be aware of the need to satisfy the needs of city dwellers to satisfy all five senses (or at least not to displease any of the five).

3. Impact of highway maintenance decisions on air quality. Esssam Sharaf of Cairo University presented his definition of the function of a highway, that is to transport people and goods in a safe and economic manner. We should see an infrastructure system as a complex and

integrated system and we should aim for an environmentally friendly decision support system. He proposed the extension of the normal Highway Maintenance Management System (HMMS) to take into account environmental effects. The system should include (1) the amount of air pollution arising from different types of maintenance activities; (2) emissions changes resulting from variations in highway condition, and (3) effects of lane and road closure on congestion in other lanes and roads, and thereby on emissions. The purpose is to enhance decision making on maintenance timing and type.

4. Natural gas vehicles and infrastructure in Egypt. Abdel Wahad Barakat of the Ministry of Petroleum Organization for Energy Planning of Egypt gave a presentation on the status and plans for a program to implement natural gas vehicles in Egypt. The program is underway. Conversion of taxis to natural gas is proceeding rapidly and successfully. Challenges are the balancing of tax and subsidy policies for vehicles and stations in such a way that the two grow steadily and in balance. The program to convert gasoline vehicles to natural gas has, like the one in Venezuela, recently expanded rapidly into the tens of thousands of vehicles. A program to introduce dedicated natural gas fueled buses is underway, as also discussed earlier by Samir El-Mouafy.

III. Roundtable Discussion on Financing Pilots and Initiatives.

1. Clean Air Initiative for Latin America. Asif Faiz of the World Bank argued that adverse local effects of air pollutants included welfare effects, health effects, and vegetation damage. He indicated that the road transport systems and urban air pollution conditions in developing countries are characterized by concentration of vehicles in large metropolitan areas, aging and poorly designed diesel engine vehicles operated on fuels with high sulfur content, indigenous production of obsolete vehicle models, poor gasoline quality with high lead content, insufficient urban road space, ineffective traffic management, inadequate mass transit systems and inadequate investment in transport infrastructure. He noted the increase in motorization and correlated that trend with economic growth and increase in per capita incomes. Statistics on the pollutant emissions from motor vehicles in Latin American Cities were provided and a model of analyzing the impacts and costs of air pollution was presented. Measures to reduce motor vehicle pollution included the utilization of cleaner vehicles and cleaner fuels as well as improved infrastructure and demand management.

2. Opportunities for GEF Financing. Noreen Beg discussed the nature of funding opportunities from the UN's Global Environment Facility (GEF). The clear focus of the GEF appeared to be on carbon dioxide emissions which is clearly a global problem, where PM, lead and CO are very localized pollution concerns. According to Beg, the Facility appears to be taking the long-view (since CO₂ is, after all, a long-term problem), and is therefore supporting very advanced technologies such as hybrid and electric buses. It would appear from the discussions and the Cairo Declaration, that the local pollutants PM, lead, and CO will be given emphasis by the GITE, and transfer of existing, proven technology from developed to developing nations will be pursued. She noted that the focus of the GITE is near-term, while the GEF focus appears to be long-term. Since the GEF appears oriented toward the worldwide global warming problem, it is reasonable that advanced technology for mass implementation within a few decades is of interest. In response to a question, Beg noted that, with respect to natural gas buses, the GEF is not supportive of projects implementing this technology. The only case where

natural gas buses got GEF funding was in Algeria, where it was clearly demonstrated that the natural gas used would otherwise have been flared. Under this circumstance, a natural gas bus can significantly reduce CO₂ emissions. However, if the gas would not otherwise be flared (the more frequent case), then Beg's remarks *imply* that a substitution of a natural gas bus for a diesel bus will increase CO₂ and "CO₂-equivalent" (methane) emissions. The sum of CO₂ and "CO₂-equivalent" emissions is often referred to as greenhouse gas emissions. (Note, however, that Chris Weaver indicated from the floor that he had once estimated a greenhouse gas benefit for a CNG-for-diesel switch, so the question of relative greenhouse gas emissions of conventional diesel buses vs. conventional CNG buses should be regarded as subject to further examination. Hybrid diesel buses, according to U.S. test results published after the roundtable, will have considerably lower greenhouse gas emissions than either conventional diesel or conventional CNG buses. These tests imply that PM emissions can also be sharply reduced by a diesel hybrid bus. As previously noted, present day natural gas bus technology, when substituted for a conventional diesel bus, can sharply reduce PM directly emitted, and NO_x emissions as well, which contribute to indirect (secondary) PM. So, CNG buses as an alternative to conventional diesel buses are likely to be evaluated in a positive light under the GITE and Cairo Declaration PM pollutant reduction priorities and orientation toward proven technology. However, given GEF greenhouse gas priorities, CNG bus for diesel bus substitutions are apparently regarded in a negative light, though Weaver's comment indicates that this may not always be warranted. Evidence from U.S. tests does imply that the hybrid buses favored by GEF could sharply reduce both greenhouse gases *and* particulates, but the technology is relatively new and costly. The GREET model referred to by Roger Gorham and by Danilo Santini implies that there is a great deal of certainty that a substitution of a natural gas automobile for a gasoline automobile, if done properly, can reduce PM, NO_x, HC, and full fuel cycle carbon dioxide as well. Attention to technology specifics is critical. Finally, GREET also implies that ethanol buses using biomass-based ethanol will sharply reduce greenhouse gases when compared to conventional diesel buses. The GEF financing discussion did not address ethanol buses or light duty gasoline vehicles.

3. Transport Project Financing. Erling Rask of the Road Directorate of the Government of Denmark discussed the policies that had allowed Denmark to achieve a 25 percent increase in GNP over the last six years, without increasing the consumption of energy. He provided specifics on how examination of life-time-cycles of products, use of the polluter pays principle, and strong preventive measures had achieved these results. He noted the willingness of Denmark to use taxes on fuel and to divert revenues raised both to non-transportation purposes of the government (social services) and to modes of transport other than the one taxed (funds from road fuel taxation to public transportation).

IV. Panel Presentation on the Global Initiative on Transport Emissions (GITE) and general discussion of the GITE

1. Overview of the GITE. George Tharakan of the World Bank introduced the specifics of the programs named the Transport Emissions Knowledge Initiative (TEKI); the Partnership for Vehicle and Fuel Technology Modernization (PVFTM); and the Small Initiatives Clearinghouse (SIC). He noted that GITE is being created as a partnership among the World Bank, the United Nations, other international agencies, developing countries and private industry

in order to promote long-term, ongoing strategy development and actions to reduce pollutant emissions attributable to the transportation sector of developing countries. The GITE aims to promote a framework at the international and national levels to target the benefits of these activities where they are most needed: reducing emissions and increasing the fuel efficiency of the rapidly growing fleets of developing countries. The GITE will seek to marshal the already substantial activities of its members in the area of transport efficiency and emissions control, to address the growing problems of developing country vehicle fleets. A fundamental tenet of the GITE is that win-win cooperative arrangements between developing countries and international firms in the automotive/petroleum industries can achieve significant reductions in transport emissions. The focus of the GITE, therefore, is not technological innovation, but overcoming the institutional, legal, financial and policy barriers which prevent existing technology from rapidly reaching the developing country fleets where it is most urgently needed.

He noted the consequences of success in providing transport infrastructure and in increasing vehicle use in developing countries so that transport has grown faster than GDP, transport demand averaging an estimated annual rate of growth of 5.3 percent from 1970-94, with considerably greater growth rates in the Middle East and Asia. However, the results are health problems from motor vehicle related pollution, and rapidly growing CO₂ emissions. The growth in transport demand in developing nations is expected to continue, with estimates of 40-100 percent increases by 2025, with the possibility of transport demand in developing nations exceeding that in developed nations. The GITE vision is to satisfy the need for expanding transport demand while simultaneously reducing emissions.

The GITE hopes to develop a framework at the international and national levels to target the benefits of private, national government, and international agency efforts to cooperatively put appropriate technologies and policies into place where they are most needed. The Cairo declaration is motivated by the need to establish the initial goal structure for this broad framework. The focus of the GITE is not technological innovation, but overcoming the institutional, legal, financial, and policy barriers which prevent existing technology from reaching developing countries where it is most urgently needed.

2. The UN's role in Transportation Energy Efficiency and Sustainable Development.
 Kui-Nang Mak of the UN Department of Economic and Social Affairs continued the discussion of the GITE with a detailed explanation of how transport issues will be considered at the ninth session of the Commission on Sustainable Development in 2001 as well as the importance of emissions reductions in achieving the goals set forth in Agenda 21. The ninth session of the Commission on Sustainable Development will consider energy and transport as one major theme, and energy and atmosphere as the other major theme. An Ad-Hoc Open-Ended Intergovernmental Group of Experts on Energy and Sustainable Development will meet in March 2000 to begin work on these issues. Mr. Mak noted that the results of this Roundtable would be reported to this Group of Experts in March as well as to the main CSD body in 2001.

The importance of energy in achieving the goals of Agenda 21 is well-recognized. The Special Session of the United Nations General Assembly held in June 1997 highlighted the special role of energy in achieving both development and environmental goals. It is hoped that industry, which has been involved in this meeting, will continue to be involved going forward in this entire effort and assist in the goal of technology transfer, which is presently not moving fast enough. The UN can play a role as an organizer and facilitator. At CSD9 there will be

negotiations, and input from political groups, stakeholders, and technical experts will then be considered.

3. Structure of UN/World Bank/private sector cooperation. John Flora of the World Bank attempted to put the Cairo roundtable, the Cairo Declaration, and the cooperative UN/World Bank efforts on transport into perspective. He noted that this is not a group that can or will impose standards. He lamented that, with respect to rising transport emissions, there is no driving force to restrain emissions increases, and measures tend to be taken only as the result of a crisis. Regrettably, if there is no possibility of enforcement of standards that might be put on the books, nothing can be done to abate emissions. He noted that one driving force causing rapid emissions increases is the jump of some developing countries past the “bus phase”. Instead of expanding use of public and/or private transport by buses, citizens of many nations are using relatively inexpensive 2-3 wheelers to obtain flexible mobility, switching from walking to use of these vehicles. In discussions throughout the Roundtable participants agreed with this, insisting that there be added a specific reference to 2-3 wheel vehicles in the Cairo Declaration.

Flora felt that planned GITE workshops designed to allow the transfer of information and methodology could help a great deal. Action plans, developed at or after workshops would be very valuable. When there are action plans, the money flows, companies get involved, and banks get involved. Flora believed that the private sector is looking for good initiatives. The flow is – information – ideas – money. It was argued that the consequences of transport emissions had to be incorporated into the transport planning process. Human health consequences, property damages and vegetation damages all need to be considered. Flora made the general statement that at the present time, developed countries emit more than developing countries, which is true for CO₂, but probably is not true for PM and lead, the two leading pollutants of concern according to presentations at the roundtable. (note: a surprise finding of a poll of those attending the roundtable was that carbon monoxide was regarded as an important pollutant also requiring mention and attention by developing countries).

In brief, the challenge is that developing nations need more and better transportation to support economic development, but at the same time they need lower emissions. Major choices must be made for the next few decades. For example, in China, should a much improved rail network be developed, or should China seek to have a highway system like the U.S. In general, investors, planning organizations within nations, and the World Bank, all need to pay more attention to infrastructure construction, and the determination of the right mix of financial support for roads, bridges, signals, and software supporting the operation of the system.

Flora has the strong opinion that privatization is one of the best strategies for development and operation of infrastructure. He noted that many airports in several nations are being privatized. Flora ticked off a few policies and points linked to particular nations. In the case of Poland, it has been recognized that energy efficiency and fuel efficiency must be added to policy. Taxation of vehicles with larger engines was therefore attempted. Flora mentioned Brazil as one nation where some constituencies have decided that it is impossible for the entire world to adopt an automobile dominated society. This constituency advocates design of cities that satisfy transportation needs without heavy reliance on the automobile. (note: the city Curitiba Brazil received considerable attention at the roundtable as an example of a city where bus transportation is extremely well designed, with an economical, effective system).

V. Cairo Declaration (Declaration of the International Roundtable on Transportation Energy Efficiency and Sustainable Development)

The Declaration of the International Roundtable on Transportation Energy Efficiency and Sustainable Development, also referred to as the Cairo Declaration, (see Annex IV) was introduced by the Government of Egypt during the first day of the Roundtable in an effort to highlight major issues and recommendations brought forth and agreed upon by the participants. There was considerable effort to generate discussion of the details of the Declaration and specific items and proposals during relevant sessions. Also, written comments were requested from all participants and efforts were made to ensure that all participants had ample opportunity to express their opinions. The plenary session on this topic involved discussion in which everybody had a chance to speak and many opinions and views were aired. Agreement on the issues was reached by consensus, and the Cairo Declaration was passed unanimously.

VI. Conclusion

The International Roundtable on Transportation Energy Efficiency and Sustainable Development provided a forum for the consideration of issues relating to transportation, energy efficiency and sustainable development. It was widely attended with participants from developed and developing countries, national governments, international organizations, non-governmental organizations and the private sector. Experts spoke on a wide range of relevant topics. Varying opinions on many topics were heard and many participants were exposed to new and innovative points of view. Feedback received by the United Nations from the participants has been very positive.

The participants of the Roundtable put forth a list of recommendations to the international community set forth in the Cairo Declaration. They also endorsed a comprehensive follow-up program (GITE) to be undertaken jointly by the United Nations and the World Bank.

The Roundtable represented a first-time effort at cooperation on an issue of mutual interest by the United Nations, the World Bank, non-governmental organizations and the private sector. The GITE follow-up program will continue and build on this initial success. In addition to the original sponsors of the Roundtable, a number of governments and organizations including the Governments of Austria and Brazil, the International Energy Agency and Shell have expressed interest in cooperating with and funding GITE activities.