

ENGR 597 Session 10

Global Warming - Causes, Impacts and Solutions

Lecture 12

March 23, 2009
7:00 to 8:15 PM, 211 Carrier

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Mobile and Area Sources of GHG and Abatement Strategies

- **Economic prosperity is tied to well-built and maintained infrastructure...**to provide mobility and services **transportation**, water supply, sewage and solid waste disposal, power generation and energy facilities, sports complexes, amusement parks, theatres, hospitals, industrial facilities, communication towers, structures for space programs.
- **Transportation infrastructure built to provide mobility, sustain quality of life, promote economic prosperity, and ...?**
- **Protecting the environment** (not until late 1960's).

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Objective / Goals

Objective: To assess impacts of mobile and area sources of air pollution and greenhouse gases and evaluate abatement strategies

Goals:

- Quantifying traffic and built environment impacts on mobility and traffic congestion
- Evaluation of traffic and built environment impacts on GHG emissions and global warming
- Assessment of traffic and built environment impacts on air quality and public health
- Application of remote sensing and geospatial technologies and air pollution models for traffic visualization, environmental assessment
- Evaluation of abatement strategies

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Transportation Impacts on Society

- Providing efficient public mobility and safety during disasters.
- Commuting to workplace, delivery of goods and services
- Accessing consumer services and other modes
- Creating create new businesses and increase jobs
- Good transportation network is imperative for economic prosperity and growth
- **Paved road density in km per million inhabitants is strongly associated with the gross national product (GNP); above 6,000 km per million inhabitants for high-income economies in industrialized nations**

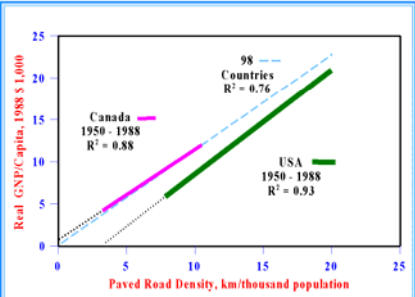
Roads represent the largest public infrastructure investment.

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Sustainable and Efficient Transportation

- The GNP per capita reflects a country's total market value of the goods and services produced annually divided by the population.

World Bank's Research Report

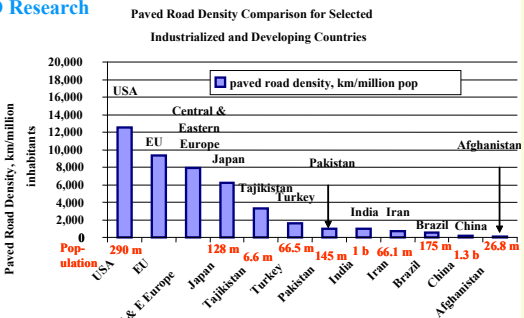


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Transportation Related Economic Benefits

Uddin's Research Papers
USAID Research

Paved Road Density Comparison for Selected Industrialized and Developing Countries

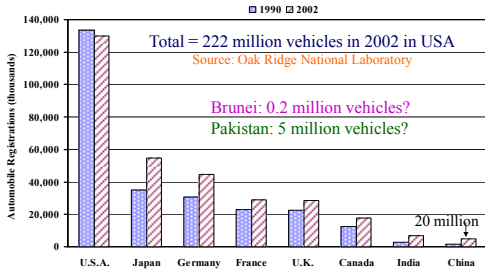


Country	Population (m)	Paved Road Density (km/million pop)
USA	290	~12,000
EU	~600	~10,000
Japan	128	~8,000
Tajikistan	6.6	~2,000
Turkey	66.5	~3,000
Pakistan	145	~1,000
India	1 b	~1,000
Iran	66.1	~1,000
Brazil	175	~1,000
China	1.3 b	~1,000
Afghanistan	26.8	~1,000

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Worldwide Vehicle Statistics

Source: ORNL24-p3-2 (Table 3.1)
Automobile Registration for Selected Countries, 1990 & 2002



- Car ownership rates are highly correlated with per capita income.
- In Europe and Singapore the rates are kept low through providing good public transport and charging for the use of urban roads.

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Transportation Infrastructure



Cars emit 2-3 times more CO than diesel trucks.
Diesel trucks produce 10 times more NO_x than cars.



CAIT Research on Traffic Flow, GIS, Air Quality, and greenhouse gases

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Idling long haul trucks consume 20 million barrels of diesel and produce 10 million tons of carbon emissions.



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Aviation Related Pollution

1.5 million tons or 24 % of the world's total carbon emission, 1990's



Memphis International Airport

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Space Missions

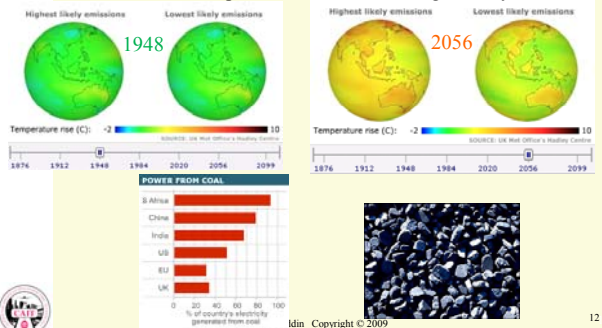


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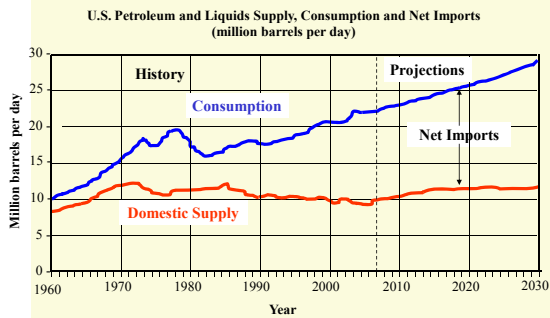
Fossil Fuels Impacts on Global Warming and Climate Change

Source: BBC.com Temperature rise 1.4 – 5.8 degree C by Year 2100



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U.S. Dependence on Imported Oil



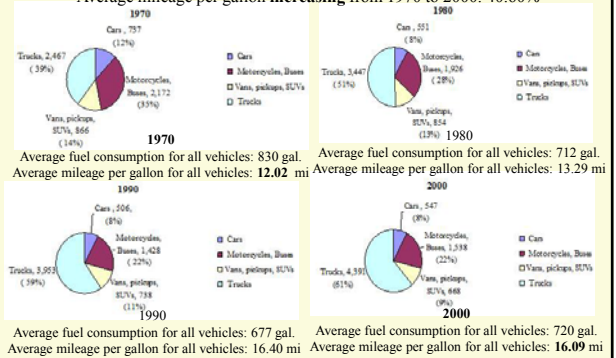
(Source: Energy Information Agency, Annual Energy Outlook 2007)

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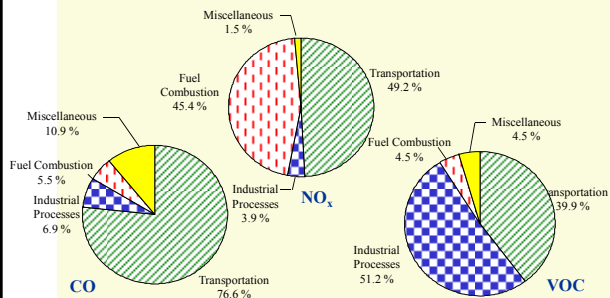
Average fuel consumption per vehicle (gal.)

Average fuel consumption per vehicle decreasing from 1970 to 2000: 13.25%
Average mileage per gallon increasing from 1970 to 2000: 40.60%



Emission and Pollution Sources

- A significant amount of air pollutants comes from transportation-related mobile sources, including highway motor vehicles and aviation activities.



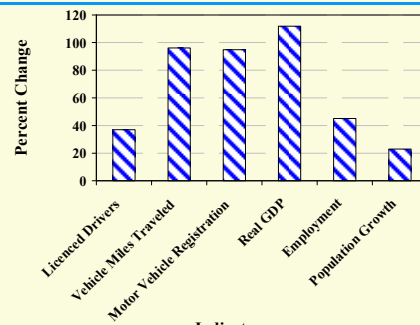
EPA Criteria Pollutant Emissions by Source in USA, 1997

Source: National Air Quality and Emissions Trends Report, 1997

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Percent Change of Transportation, Economic and Population Indicators, 1980 - 2005

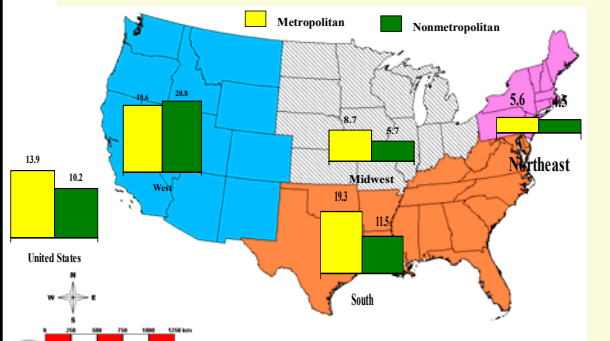


Source: U.S. Government Printing Office. U.S. Statistical Abstract, 2007 and 2006. (Includes inflation adjustment. U.S. DOT, Highway Statistics, 2005.)

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Percentage Change in Metropolitan and Non-metropolitan Populations by Region in U.S. 1990 to 2000

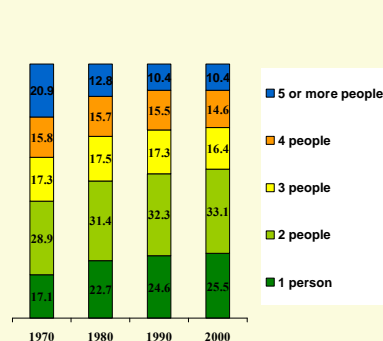


Source: U.S. Census Bureau, Census 2000 and 1990 census.

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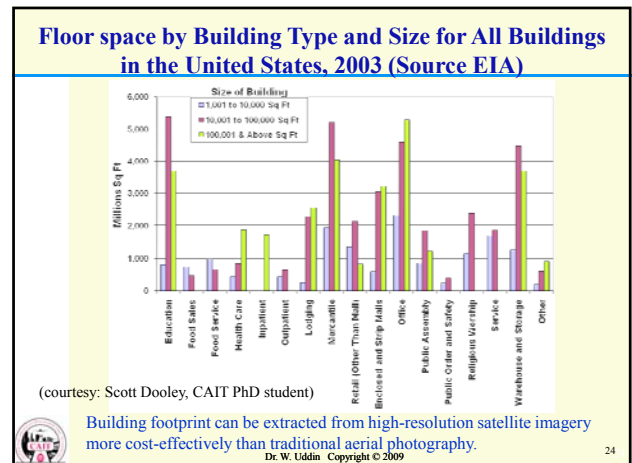
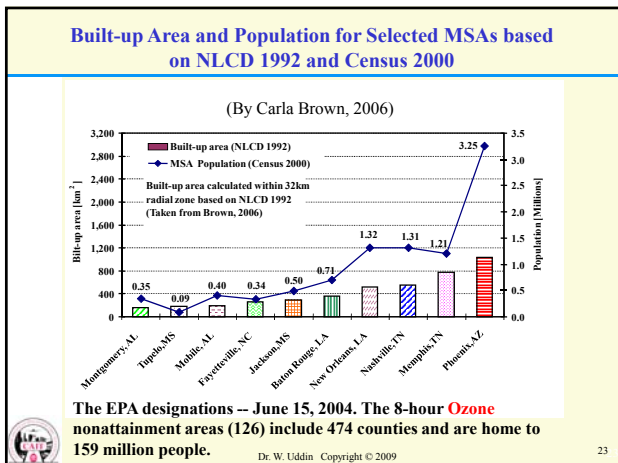
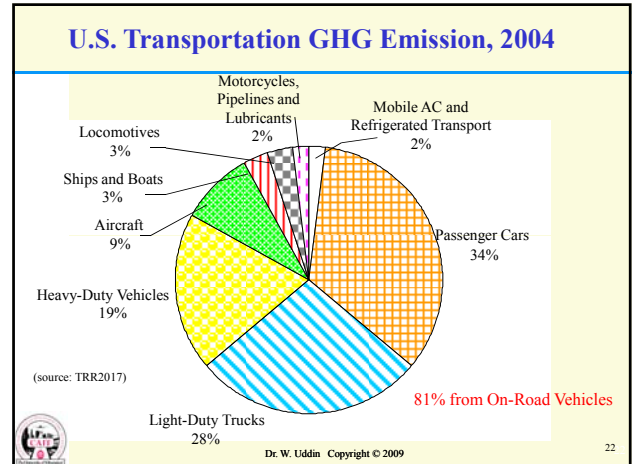
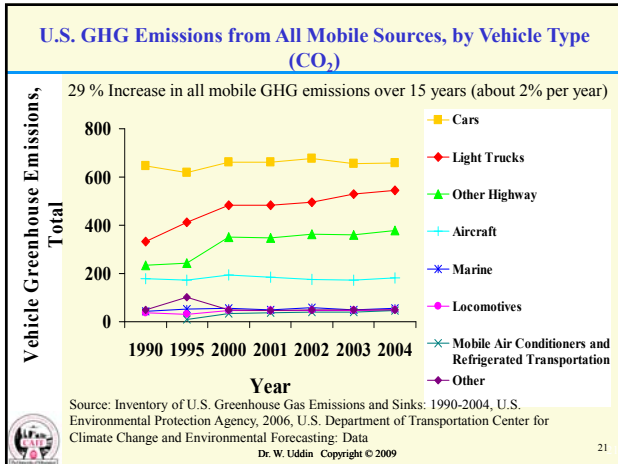
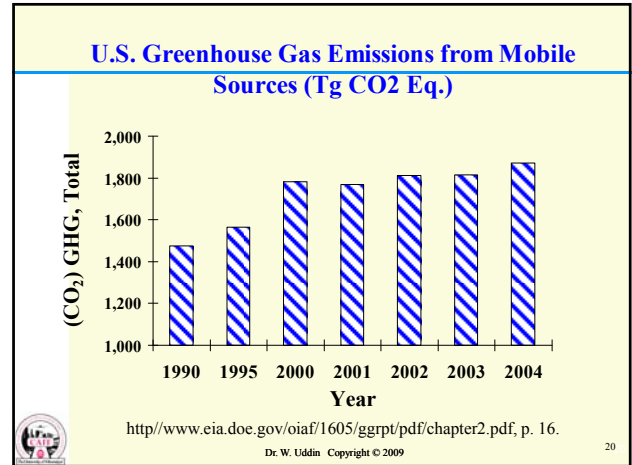
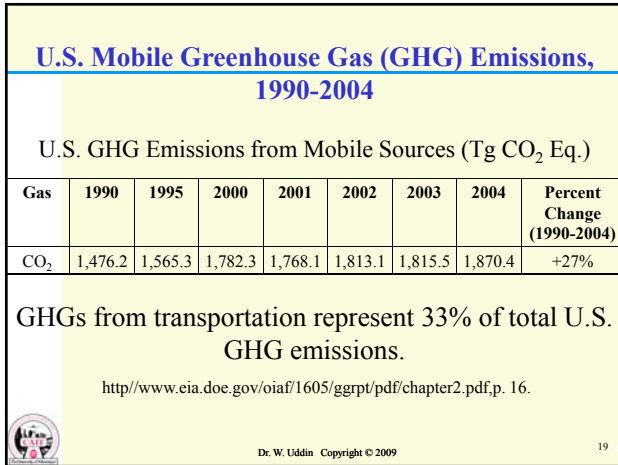
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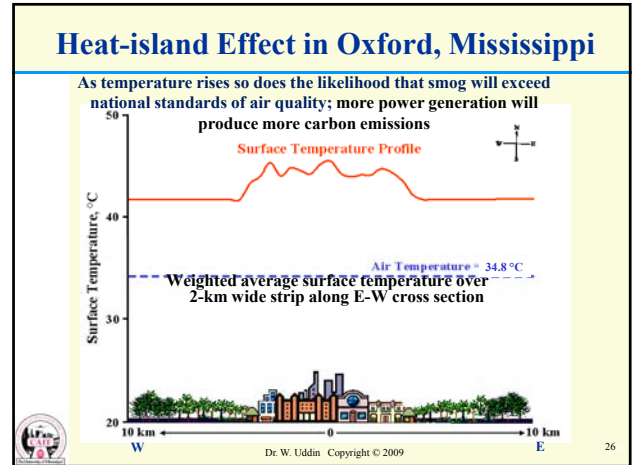
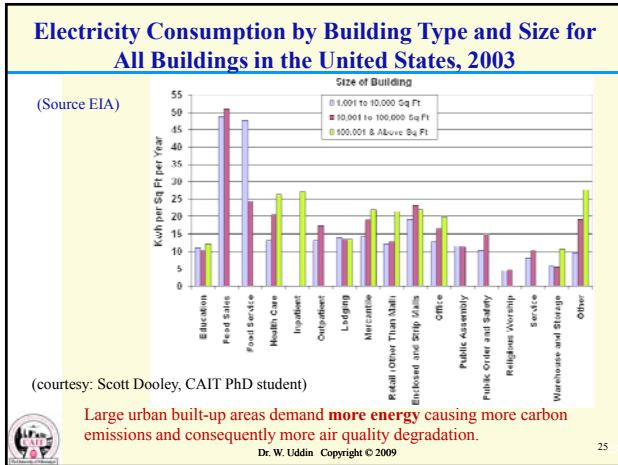
U.S. Households by Size: 1970 to 2000 (Percent Distribution)



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- ### Societal Impacts of Built-Environment
- Sustainable transportation & development must consider all these factors.
- Landuse, Urbanization and Social Integration
 - Built-up Area Effects on Environment (air, water)
 - Built Environment Impacts on Physical Inactivity
 - Traffic Fatalities and Injuries
 - Traffic Related Emissions and Air Pollution
 - Traffic Related Pavement Noise Impacts
 - Construction Process and Material Resources
 - Energy Demand and Diminishing Natural Resources
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Air Quality Management

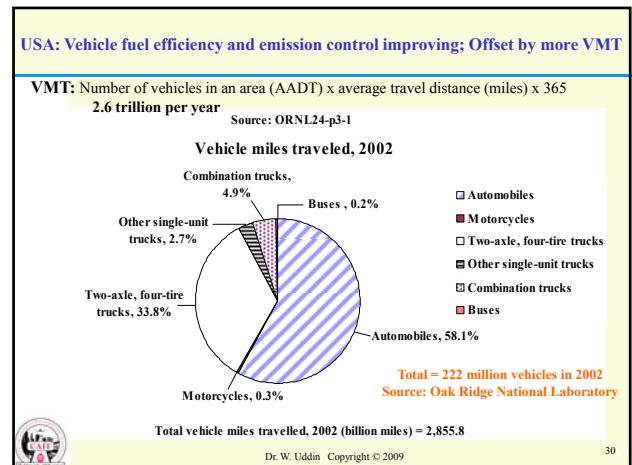
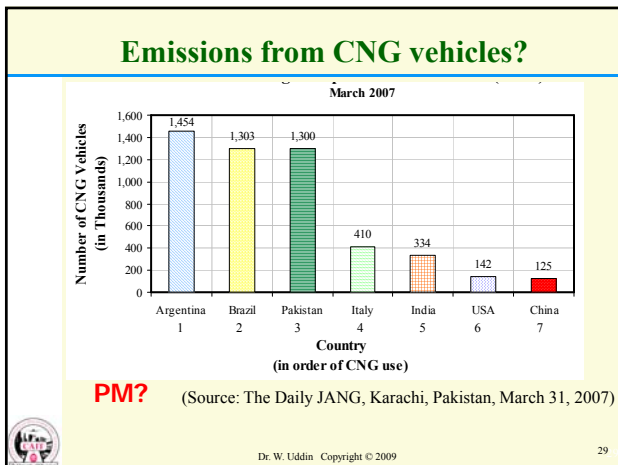
- CAIT air quality models implemented in Pisa, Italy
- Air pollution should be a concern in rural areas and many emerging urban areas.

August 3, 2004

Abu Dhabi

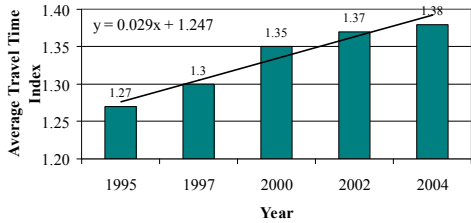
Dubai

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Traffic Congestion and Gridlock

U.S. Average Travel Time Index for All Urbanized Areas, 1995-2004



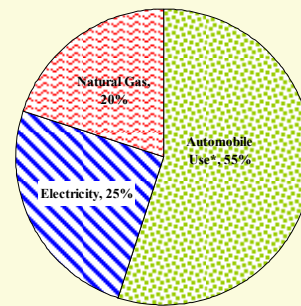
Commuters spend 46 hours annually stuck in traffic and waste 5 billion gas annually.

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The Automobile is the Largest Contributor to a Household's Carbon Footprint

Household Carbon Emissions



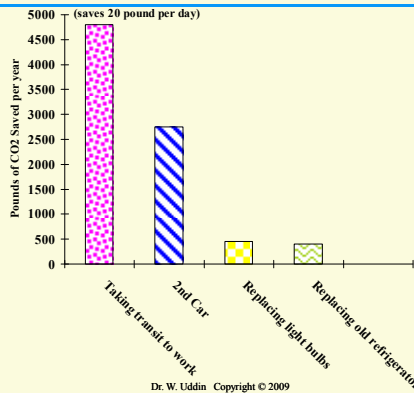
*Typical two car household

*30% Saving due to Public Transportation

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Public Transportation – one of the most significant Actions to reduce household carbon footprint

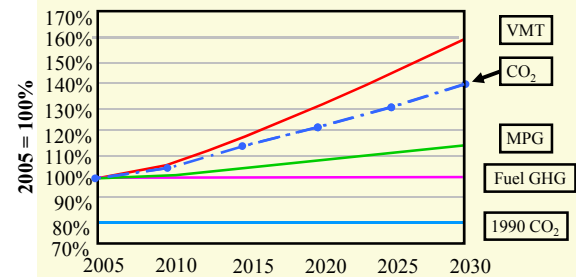


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Projected Growth in CO₂ Emissions from Cars and Light Trucks Assuming Status Quo Vehicle and Fuel Standards

Source: EIA 2007



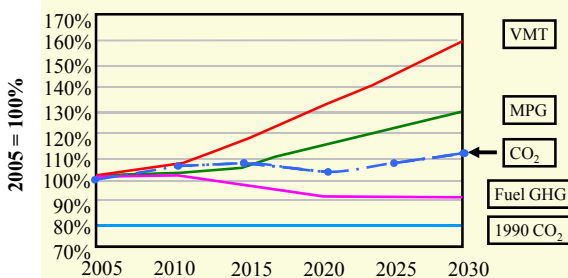
Source: EIA AEO 200

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Projected Growth in CO₂ Emissions from Cars and Light Trucks Assuming Stringent Nationwide Vehicle and Fuel Standards

Source: EIA 2007.



Source: EIA AEO 200

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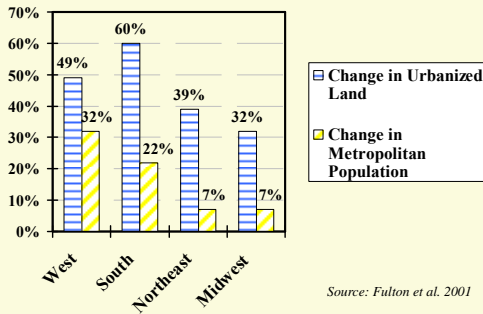
GHG Abatement Strategies

- The transportation sector accounts for 28 percent of total greenhouse gas (GHG) emissions in the United States and 33 percent of the nation's energy-related CO₂ emissions (EIA 2006, p. xvi; EIA 2007a, p. 15).
- The United States, in turn, is responsible for 22 percent of CO₂ emissions worldwide and close to a quarter of worldwide GHG emissions (EIA 2007b, p. 93).
- It is hard to envision a "solution" to the global warming crisis that does not involve slowing the growth of transportation CO₂ emissions in the United States.

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Growth of Population and Urbanized Land Area by Census Region between 1982 and 1997



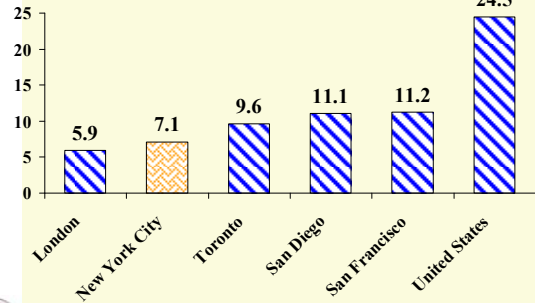
Source: Fulton et al. 2001

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New York Today on the Sustainability Scale

Greenhouse Gas Emissions Per Capita



Source: NYC Mayor's Office of Long-Term Planning and Sustainability

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Transport and Development—Challenges and Impacts



(Source World Bank)

- CO₂ Emission per ton km (grams CO₂ per ton-km)
Train: 25 Barge: 35 Road: 130
- Urban populations in developing countries are rapidly expanding
China: 300 million more urban dwellers by 2020
India: 200 million more urban dwellers by 2020

- Improve spatial management and urban transport options
 - Structure urban development with adequate transport policies and systems
 - Manage efficiently the urban/rural/regional interfaces
 - Develop and implement enhanced GIS-based transport infrastructure asset management systems



CHINA



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California's Abatement Strategies

- California's Climate Action Team (2007) expects "smart land use and intelligent transportation system (ITS)" to make the second – largest contribution toward meeting the state's ambitious GHG reduction goals.

Compact Development	Sprawl
Medium to high densities	Low densities
Mixed uses	Single uses (residential, commercial..)
Centered development	Strip development
Interconnected streets	Poorly connected streets
Pedestrian – and transit – friendly design	Auto – oriented design

Source: Ewing 1997; Ewing, Pendall, and Chen 2002

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Abatement Strategies to Protect Clean Air and Reduce GHG Emissions

Energy only 4 % from clean sources – not applicable for transportation; how to reduce transportation emissions?

- Conservation and compact urban growth... by all government levels and by public
- Efficiency in vehicles and traffic flow... by vehicle manufacturer, consumers, transport agencies
- Better commercial truck fleet management... by transporters
- Public mass transit, HOV, car pooling, flexible work hours.....
- Non-motorized transport..... by government levels and by public
- Equity in road user charges for pollution and VMT
- Clean fuel and energy sources (LPG, CNG, Hydrogen, Hydraulic, Nuclear)... By all

Win-Win (for society and environment)

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Sustainability

- Enhancing health, Safety and Security.
- Conserving Energy and Enhancing the Environment.
- Creating Equitable and Livable Communities.
- Promoting Economic Prosperity.

'Sustainable Transport' (World Bank 1996)

- Economic
- Financial
- Environmental
- Social



Sustainable Development

- Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

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