Sustainable Urban Development Planning

LECTURE 2

Transportation and Sustainable Mobility
Green Building and Architecture
Transportation and Sustainable Mobility
WORLD POPULATION
Source: United Nations Department of Economic and Social Affairs

7b
2011

9.8b
Estimated by 2040
Transport is the Engine of Cities
Urban Transportation Options
Urban Mobility

- Traditional transport planning aims to improve mobility, especially for vehicles, and may fail to adequately consider wider impacts.
- The real purpose of transport is to provide access for the citizens to work, education, friends and family, and goods and services.
- A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable.
- Cities should improve the sustainability of their transport networks to create more vibrant, livable, sustainable cities.
Why Urban Mobility Matters?

- Citizens expect high levels of mobility.
- Urban mobility is essential for:
  - Guaranteeing citizens a high quality of accessibility and life
  - Facilitating economic development of cities, thus helping growth and employment
  - Respecting the environment and ensuring sustainable development.
Transportation Challenges Faced by Cities

- **Congestion**
  - Increase of traffic in urban areas is causing congestion - this costs to citizens and businesses
  - Parking – Major problem – Portion of road is occupied by Parking

- **Energy consumption**
  - Urban mobility - faced by the domination of oil as a transport fuel.

- **Climate change**
  - Urban mobility accounts for 40% of all CO2 emissions of road transport.

- **Health issues**
  - Towns and cities face increasing air pollution and noise problems, which impact on citizens health.

- **Safety and security**
  - Road fatalities take place in urban areas - pedestrians and cyclists are the most vulnerable victims.
Problems of Transport

Road Congestion, and Increasing Traffic Intensity, China

Air Pollution, China

Parking, New Delhi-India

Accidents
<table>
<thead>
<tr>
<th>Region</th>
<th>Trends</th>
<th>Regime</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>Stagnation or slight growth in market share.</td>
<td>Liberalization, increasing competition.</td>
<td>Improved fare box recovery, reduced subsidies.</td>
</tr>
<tr>
<td>High share cities, e.g.:</td>
<td>Growth in trip numbers.</td>
<td>Cities often regulated or run by multi-modal public monopolies.</td>
<td>Tension between authorities and operators may detract from social objectives.</td>
</tr>
<tr>
<td>Zurich, Switzerland 44%</td>
<td>Decrease in suburban areas.</td>
<td>Consolidation of major players.</td>
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<tr>
<td>Vienna, Austria 37%</td>
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<td></td>
<td></td>
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<tr>
<td>Average market share: 50%</td>
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<tr>
<td>High share cities, e.g.:</td>
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<tr>
<td>Warsaw, Poland, 69% but declining</td>
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<tr>
<td>North America</td>
<td>Stagnation or slight growth in market share.</td>
<td>Publicly operated, federal support for infrastructure, local tax co-funding. Some recent private sector involvement.</td>
<td>Slow service delivery improvements in some places. Deficient fare box recovery. Serious financial stress.</td>
</tr>
<tr>
<td>Average market share: Low</td>
<td>Growth in trip numbers.</td>
<td></td>
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<tr>
<td>High-income Asian countries</td>
<td>Continued investment, expansion and more transport demand measures being put into place.</td>
<td>Mainly private operations. Competitive market. Local private players.</td>
<td>Some operators becoming global players. Some major private sector international groups moving in.</td>
</tr>
<tr>
<td>(Japan, Singapore, Hong Kong)</td>
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<td></td>
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<tr>
<td>Average market share: 70–90%</td>
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<tr>
<td>Emerging Asian countries</td>
<td>Strong investment in public transport.</td>
<td>Reform to public sector. Introduction of new regimes.</td>
<td>Reform, increased financial incentives, improvement hampered by political interests.</td>
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<tr>
<td>(e.g., India, China, Republic of Korea)</td>
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<tr>
<td>Low-income Asian countries</td>
<td>Loss of market share.</td>
<td>Weak and floundering public sector. Few private operators outside informal sector.</td>
<td>Renewed political interest but progress slow.</td>
</tr>
<tr>
<td>(e.g., Philippines, Indonesia, Malaysia)</td>
<td>Losing ground to informal sector.</td>
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<td></td>
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<tr>
<td>Average market share: Very low (data difficult to obtain)</td>
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<tr>
<td>Middle East and North Africa</td>
<td>Strong political support. Slow change in perception from low class to lifestyle choice.</td>
<td>Mainly private operations with regulation from newly created bodies.</td>
<td>Ambitious integrated networks being rapidly implemented.</td>
</tr>
<tr>
<td>Average market share: Almost zero.</td>
<td></td>
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<tr>
<td>Sub-Saharan Africa</td>
<td>Almost complete absence of formal public transport.</td>
<td>Informal and ad hoc. Often lacking minimum quality and infrastructure. Quality can be associated with switch to formal.</td>
<td>Public transport dominated by informal sector. New emerging systems include inclusion of the informal sector.</td>
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<tr>
<td>Average market share: &lt;5%</td>
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<td>Latin America</td>
<td>Losing market share with growing car affordability. Significant interest.</td>
<td>Mainly private companies. Strong private owner associations.</td>
<td>Interesting new models and examples emerging that are appropriate for South/South transfer.</td>
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<tr>
<td>Average market share: 70%</td>
<td>but declining.</td>
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Urban Travel Modal Shares in Selected Cities
ITA Academy, 2011; UITP and UaTP, 2010.

## Urban Mobility Planning

<table>
<thead>
<tr>
<th>Traditional Transport Plan</th>
<th>SUMP</th>
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</thead>
<tbody>
<tr>
<td>Focuses on traffic and traffic flow</td>
<td>Focuses on people, accessibility and quality of life</td>
</tr>
<tr>
<td>Relies on engineering</td>
<td>Relies on interdisciplinary approach</td>
</tr>
<tr>
<td>Effects are evaluated partially</td>
<td>Monitoring, evaluation &amp; incorporation of lessons learnt: key components</td>
</tr>
<tr>
<td>Main actors from policy and administration</td>
<td>Main actors from civil society</td>
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</table>
Non-motorized Transport Benefits

- The use of NMT in cities generates numerous social, economic and environmental benefits.
- The benefits of expanding NMT use outweigh the related costs by large margins.

<table>
<thead>
<tr>
<th>User benefits:</th>
<th>Increased user convenience, comfort, safety, accessibility and enjoyment as well as savings from reduced vehicle ownership and use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity objectives:</td>
<td>Benefits economically, socially or physically disadvantaged people.</td>
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<tr>
<td>Congestion reduction:</td>
<td>Reduced traffic congestion from private cars on congested roadways.</td>
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<tr>
<td>Roadway and parking cost savings:</td>
<td>Reduced roadway and parking construction, maintenance and operating costs.</td>
</tr>
<tr>
<td>Energy conservation:</td>
<td>Economic and environmental benefits from reduced energy consumption.</td>
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<tr>
<td>Pollution reduction:</td>
<td>Economic and environmental benefits from reduced air, noise and water pollution.</td>
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<tr>
<td>Land-use impacts:</td>
<td>Encourages more accessible, compact, mixed, infill development (smart growth).</td>
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<tr>
<td>Improved productivity:</td>
<td>Increased economic productivity by improving accessibility and reducing costs.</td>
</tr>
</tbody>
</table>

Source: Adapted from Litman, 2013.

- In Amsterdam (the Netherlands) the overall benefit–cost ratio of improving bicycle infrastructure was estimated to be 1.5:1 while similar calculations for Delhi (India) and Bogotá (Colombia) estimated the ratio to be 20:1 and 7:1, respectively.

- A major advantage of NMT is that it reduces energy consumption, greenhouse gas emissions and pollution (air, water and noise) substantially, as it does not rely on fossil fuels unlike other modes of transport in cities.

What is Sustainable Transportation?

- Sustainable transportation requires using each mode for what it does best, which typically means greater reliance on non-motorized for local travel, increased use of public transit in urban areas, a reduction (but not elimination) of personal automobiles use. (World Bank, 1996).

- Strategies are those that meet the basic mobility needs of all and be sustained into the foreseeable future without destruction of the local or planetary resource base.


Objectives of Sustainable Urban Transportation

- Require the balanced harmonious balancing of three elements (3E → Economics, Environment, Social and Institutional) mobility is to be pursued in a manner consistent with long-term environmental protection and social fairness (other variant is 3P → Poverty, Population, and Pollution).

OBJECTIVES:

- Meet the demand for mobility
- Optimize use of resources
- Improve environmental quality
- Promote social harmony
- Increase level of safety
- Realize the virtuous cycle of society, economy, mobility and environment.
Sustainable Transport and Mobility

ACTIONS

- Parking Management
- Street design, street scape & traffic calming
- Parking
- Cycling
- Public transport
- Car related measures
- Mobility Management
- Freight Management
Framework for Achieving Sustainable Urban Transport

- **Planning**
  - Vision for a livable city and city master plan
    - Land use planning
    - Transport master plan

- **Design Integrated Transport Systems**
  - Public transport – commuter rail, metro rail, mono rail, commuter rail, city buses, taxis, autos
  - Intermodal Transportation Hubs to connect different modes
  - Promotion of Walking and cycling
  - Private vehicles
  - Trucks and freight movement

- **Analyses**
  - Political
  - Economic
  - Social
  - Technical
  - Environmental

- **Implementation and Monitoring**
  - Technical support
  - Stakeholder involvement
  - Institutional setup
  - Capacity
  - Policies
  - Financing
Urban Mobility - Needs

- Increase average speed of public transport buses – Bus priority Lanes, Direction oriented services and BRT systems
- Transit planning / transportation hubs
- Policy and cycling routes (intermodal connectivity)
- Additional parking and development of parking policy
- Use of railways to move large section of urban population – Metro rail, mono rail and commuter rail services to suburban areas
- Use of ITS to optimize the services and occupancy of vehicles
- Need for integrated study for city’s traffic and transportation needs - Creation of Traffic Engineering Cell to collect necessary data
- Increase awareness about Safety on roads to common public
- Improvement of side walks
- Trees on Roads / pavements – Some trees need to be cut for better visibility and mobility.
- Driver education, safety and awareness programmes
New Culture for Urban Mobility

- **SHARED CARS / TRANSPORT POLICIES**
  - Shared taxis/autos
  - Optimization of the use of private cars
    - car sharing/car pools
  - Promotion of walking and cycling

- **SMARTER URBAN TRANSPORT**
  - High quality information for better mobility
  - Intelligent transport systems and traffic management
  - Smart charging

- **GREENER TOWNS AND CITIES**
  - New technologies to increase energy efficiency, increased use of alternative fuels
  - Green procurement
  - Traffic restrictions and green zones
  - Eco-driving

- **SAFETY AND SECURITY IN URBAN TRANSPORT**
  - Safer behaviour, infrastructures and vehicles
  - Cross-border enforcement of traffic sanctions
  - Facing security as a growing threat

- **ACCESSIBLE URBAN TRANSPORT**
  - Collective transport accessible and affordable for all citizens
  - Interconnection of urban and sub-urban networks
  - Co-modality: optimization and integration of transport modes

- **A NEW CULTURE FOR URBAN MOBILITY**
  - Change of behaviour by Education, training and awareness raising, Supported by better data and information about urban mobility
Sustainable Transportation

**Market Point of View - Supply**

**Supply** provision of transport facilities and services

**Increasing/decreasing infrastructure capacity**
- Traffic calming
- Parking restriction

**Technological improvement**

**Innovative Services**
- Car-sharing
- Rent-bike facilities

**Integration of transport services**
- Single ticket system
- Transport schedules
- Transportation modes

**Increase/decrease the attractiveness of specific transportation mode**
- Prioritize the Transit systems by "right-of-way“ management, flexible busses
- Promote car sharing by preferential lines, parking, employment benefits
Sustainable Transportation

Market Point of View - Demand

Demand
Aim at reduction of traffic volumes, their better temporal and spatial distribution (Transport Demand Management)

Substitutes to transportation
Telecommuting work at home Internet shopping

Land use
Density
Diversity
Job-housing balance

Urban Design
Design of public space

Education
Sustainable Transportation

Land use

Transport Infrastructure

Land use

Human behaviour
Sustainable Transportation

Mobility and Accessibility

**Mobility** = the quality of moving freely

**Accessibility** = number of reachable activities: such as services, products, sites, meeting other people or to join other activities.

\[ A_i = \sum_{j}^{J} \frac{O_j}{f(c_{ij})} \]

- \( A_i \): accessibility from house \( i \)
- \( O_j \): opportunity \( j \)
- \( f(c_{ij}) \): cost of transportation between \( i \) and \( j \)
Sustainable Transportation

Assumes 5ha of communal area/400 dwellings – DETR (LDW) land use study – at 2.2 persons per dwelling is 42ha of communal space/7,500 persons

1. **Gross development density of 50 people per hectare**
   - 7,500 people
   - No clear centre
   - 59% are over 500m from centre so land to drive for local trips
   - Difficult to justify bus
   - Large land take
   - Dispersed facilities – no centre
   - Bus may not be viable

2. **Gross development density of 100 people per hectare**
   - 7,500 people
   - Distinct centre
   - 31% are over 500m from centre and may tend to drive for local trips
   - Bus service begins to be viable
   - Reduced land take
   - Clear central facilities
   - Bus should be viable

3. **Gross development density of 150 people per hectare**
   - 7,500 people
   - Everyone can walk
   - Usage of local facilities increases
   - Bus routes are more regular

- Shca
- Shops
- Post
- Pubs
- Schools
- Doctors
Sustainable Transportation

Density and Resource Efficiency

Chart showing how as density elevates car use reduces.

Source: Newman & Kenworthy 1989

Urban density in persons per hectare

Annual gasoline use per capita

adjusted to US MJ (1980)

United States

Australia

Europe

Far East
Sustainable Transportation

Concentrated Decentralization

[Diagram showing urban areas and their development with concentric circles representing different levels of density and centralization.]
Sustainable Transportation

Copenhagen-Urban Growth

1. The medieval city (until mid 19th century)
   130,000 hab., 3km²

2. The tram city (20th century)

3. S-train city (pre-WW2) In 1930th pop 1mil.

4. Fingerplan city (post-WW2)

Growth of Metropolitan region while decreasing of Copenhagen population.
Sustainable Transportation

Copenhagen-Metropolitan Planning

**Finger Plan Objectives**
Reduce travel distances and times (maximum length of journey to work 45 minutes) Minimize traffic congestion in the central city
Co-locate the jobs and housing
Preserve open landscape

1948
- Provincial towns
  - Hillerød
  - Frederikssund
  - Roskilde
  - Køge

1960s
- Roskilde and Køge fingers built under Special National legislation

1970s
- Regional plan propose links to provincial towns
- Motorway ring planned

1980s
- Decentralization
  - development of tangential bus links

2001
- Regional plan
- Sixth finger – Island of Amager: Ørestad + Airport + Øresund bridge
Sustainable Transportation

Copenhagen: Limitation Directives

Limitation directives issued by National Ministry of Environment

Station Related Core Area

High density
Compact housing development
Large office and service sector companies (>1,500 m²) Visit intensive institutions
Shops

Station Related Land Use

Medium-high densities
Compact housing development
Smaller office and service sector (<1,500 m²)
Exceptionally large office and service sectors companies local institutions
Shops

Non-station Related Land Use

Compact low housing + detached houses
local institutions
Extensive crafts, warehouse and production business
Sustainable Transportation

Copenhagen- Herlev
Sustainable Transportation

Copenhagen: Høje-Taastrup
Sustainable Transportation
Copenhagen- Høje-Taastrup
Sustainable Transportation

Copenhagen - Evaluation

Office building completed 1980-2004: by station related (blue) and station non-related (red) buildings.

Central municipalities,

Metropolitan area
Copenhagen: Workplace Location and transport behavior

Number of employees who use car for work based on the location of workplace:

- City centre: 10-25%
- Station related workplaces: 40-60%
- Non-station related workplaces: 75-85%

Sustainable Transportation
Sustainable Transportation

Copenhagen - Urban Growth

- Public
- Administration
- Insurance companies
- Advisory engineering companies

Share employees who use public transportation to and from office jobs dependent on distance from the station
Sustainable Transportation

Copenhagen
Sustainable Transportation

Curitiba
Sustainable Transportation

Human Behaviour

Transport Infrastructure

Land use

Human behaviour

SUSTAIN
Sustainable Transportation

Car-free communities

Former town
waterworks 3 km from
city centre Built 1996 -
600 housing units
50% of flats – private ownership, 50%
public Limited ownership of cars:
0,17 car per habitant
0,25 parking places per flat

Benefits:
Larger, pleasant and safe open
space Car-sharing facilities
Basic services directly in
locality Final stop of tram +
buses Larger flats
Sustainable Transportation

Car-free communities
Sustainable Transportation

London congestion charge - Introduction

Daily charge £8; later £12: mezi 7:00am-6:30pm. No charges for weekends and holidays.
Sustainable Transportation

London Congestion Charge - Elasticity of Demand

Congestion = economically inefficient transport system and the city
The social costs of traffic congestions estimated between 2 and 3% GDP

Value of working time £\textdollar \text{c per hour} Private (perceived) costs = £26 Social costs = £\textdollar \text{\textdollar}

Travel time

2 h

1 h
Sustainable Transportation

London Congestion Charge - Elasticity of demand

Demanded number of trips

The congestion charge
Sustainable Transportation

London congestion charge - Elasticity of demand

In London:
£6 charge → -10% trips
£6 → £6† charge → -4% trips
Sustainable Transportation
London Congestion Charge- Evaluation

Changes in the counts of cars and taxis in London at October 2008 compared to October 2001. Red dots show reductions and blue dots increases.

Changes in the counts of bicycles at October 2008 compared to October 2001. Red dots show reductions and blue dots increases.
CASE STUDY
SUSTAINABLE TRANSPORTATION AND MOBILITY IN MUNICH
Facts and Figures about Mobility in Munich

- 1,35 million inhabitants in Munich
- 300.000 commuters every day
- 3,7 million visitors every year
- Over 600 million passengers in public transport in 2008
  - Extensive and growing municipal network of buses (464 km), trams (71 km) and underground railway (100 km) operated by Munich Transit Ltd. (MVG)
  - S-Bahn rail network in the Munich Region which connects suburban areas (442 km)
- Increasing Bicycle Traffic
Transportation Planning Design and Corresponding Coherent Policies (1)

- 3 Strategic Objectives in the general transport plan:
  - 1. Reduce traffic
  - 2. Deflect traffic
  - 3. Control traffic

- Every measure to reduce or to avoid traffic has the highest priority

- In order to reach these objectives public transport net will be extended to deflect individual motor car traffic in favour of commercial traffic

- Establishment of a comprehensive mobility management in order to influence the individual choice of transport towards more sustainable modes
Transportation planning design and corresponding coherent policies (2)

- **Coherent Policies to…**
  - …integrate urban development und public transport planning from the beginning
  - …create inter-modality, that means easy access by foot, bike + ride and park + ride facilities
  - …create a safe environment and mixed use of functions to reduce travel distances
  - …create services that enable people to travel without car even for complex trip chains
  - …create the right taxation and legal framework to strengthen public transport
  - …integrate people’s feedback to the suggested measures to sustain it
Transportation planning design and corresponding coherent policies (3)

- **Incentives to alternative modes to car (Pull)**
  - Availability of public transport at all parts of the city
  - 24h network for public transport
  - Affordable tickets for public transport
  - Public bikes (Call a Bike)
  - Large pedestrian sidewalks free from obstacles
  - Clean public space for enjoyable walking and cycling
  - Car-pooling, Car Sharing and car-rental at high availability
  - Combined tickets for public transport, public cars, taxis, …
  - High priority of alternative modes expressed by politicians and media
Transportation planning design and corresponding coherent policies (3)

- Disincentives to reduce car use (Push)
  - Restricted or “taxed” construction of car parking facilities on private land
  - Taxation of car ownership
  - Taxation of car use
  - Restrictions for private on-street car parking
  - Strict Parking fee policy
  - Restricted lanes for private cars
  - Special lanes for intensively used private cars only
  - Restrictions due to traffic, congestion or air quality
  - Creation of pedestrian zones by reducing street space for cars
  - Creation of cycling lanes by reducing street space for cars
Sustainable Mobility in Munich (1)

- In comparison with other German cities, Munich has today the highest modal split of public transport per capital.
- In comparison with other German cities, Munich has the highest share of bicycle transport in the modal split.
- In the Munich traffic management policy, public transportation plays an outstanding role.
- Munich is in the process of taking a leadership position in mobility management on a Europe-wide basis.
Sustainable Mobility in Munich (2)

- Walkability of almost all the city (design and security) as major pre-requisite for high acceptance of PT
- 1200km of complementary cycle network
- Inter-modality of PT with cycling, parking, car-sharing means…
  - … 22,000 bike racks in downtown Munich
  - … 25,000 Park+Ride facilities in the metropolitan region
  - …soon 10,000 Car Sharing users
- Restricted parking policy (restrictions to build parking)
- Restricted parking policy (pricing to park)
MVG’s Mobility Management

- Change from a conventional transport company to a Mobility Service Provider
- Creation of a sustainable mobility-awareness in population, politics and economy
- Projects:
  - Mobility management for New Residents: “A Relationship Marketing Campaign in Munich”
  - Autonomous use of PT through school children: “Mobi-Race”
  - Strengthening of cooperations in Eco-mobility – New forms of collaboration with Car Sharing provider
  - Mobility Management for companies (e.g. cooperation with Bavarian Broadcasting Company, BMW Group, HypoVereinsbank, Siemens)
  - Park + Ride powerful bargain to switch from motorized traffic to PT
    Financing in large parts through MVG/SWM
  - Bike + Ride Bicycle traffic as an important partner in eco-mobility
Best Practice: Mobility management for New Residents

- 20% of all inhabitants change their residence at least every year
- 10% of all inhabitants move to and from the city every year
- MVG and the City of Munich would like to actively involve the residents of Munich in an open decision-making process with the aim of more environmentally friendly made trips (PT, walk, cycle)
- Interactive telephone marketing process on the basis of the distribution of informational materials

Effects on 85,000 new residents (every year)

- + 7% customers for PT
- - 3.5% reduction in car use means 80 Mio. avoided car-km/a
- Reduction in CO2: 12,000 tons/a
- Savings and costs (according to EWS): €16 Mio./a
Trends and Future Development

• Fight against global warming (reduction of greenhouse gas emissions, i.e. carbon dioxide)

• Rising energy prices (fuel, gas, electricity, water, etc.)

• Spatial development: back to the city/regional population decreasing = growth in urban areas

• Demographic Change (growing number of elderly people)
References


SMART TRANSPORTATION: Planning and Designing Highways and Streets that Support Sustainable and Livable Communities. 2008.


Green Building and Architecture
What is a “Green Building”?

Green building is the practice of increasing the efficiency of buildings and their use of energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal — taking into account every aspect of the complete building life cycle.
Difference between Energy Efficient and Green

- An Energy Efficient building will only conserve energy as compared to other buildings.

- “Green” or “Sustainable” buildings are characterized by:
  - Efficient management of energy and water resources
  - Management of material resources and waste
  - Restoration and protection of environmental quality
  - Enhancement and protection of health and indoor environmental quality
  - Reinforcement of natural systems
  - Analysis of the life cycle costs and benefits of materials and methods
  - Integration of the design decision-making process
What is a “Green Building”?

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  - Integration of the design decision-making process
What is a Green Building?

- Effective use of existing landscapes
- Use of energy efficient and Eco-friendly equipment
- Use of recycled and Environmental friendly Building materials
- Quality indoor air quality for human safety and comfort
- Efficient use of water
- Use of Non-Toxic & recycled materials
- Use of renewable energy
- Effective controls and building management system
The Global CO2 Emissions by Sector

1- Buildings (Electricity + Heat + Construction) = 47.5%
2- Transportation = 25%
3- Land-Use Change & Forestry = 22%
4- Other = 5.5%

Source: World Resources Institute, 2008
What is a “Green Building”?

- Green makes business sense
  - Increased flexibility to allow for longer building and TI useful life and reuse of materials
  - Improved building performance
  - Increased revenue (higher rents/sales price, improved productivity, fewer/shorter vacancies)
  - Lower cost (utilities, costs of conversion)
- Going “Green” is the “right thing”
  - Reduce carbon consumption,
  - Energy independence,
  - Encourage community,
  - Preserve natural systems
Environmental and Economic Impacts of Buildings

Compiled from: Worldwatch Paper #124
Aim of the Green Building

- The aim of the green building design is to
  - minimize demand on non-renewable resources;
  - maximize utilization efficiency; and
  - maximize reuse, recycling, and use of renewable resources.

- A green building is evolved through a design process that requires all the concerned professionals –
  - the architect;
  - the landscape designer; and
  - the air conditioning, electrical, plumbing, and energy consultants –

  to work as a team that carefully considers all aspects of the building and associated systems.
Goals of Green Building

- Green building brings together a vast array of practices and techniques to reduce and ultimately eliminate the impacts of buildings on the environment and human health. It often emphasizes taking advantage of renewable resources, e.g., using sunlight through passive solar, active solar, and photovoltaic techniques and using plants and trees through green roofs, rain gardens, and for reduction of rainwater run-off. Many other techniques, such as using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water, are used as well.
What is a “Green Building”? 

- “Metrics” for such “green” benefits are articulated and certified by LEED, BuiltGreen or other organizations.
- Green standards measure different environmental qualities of buildings.
- Each has a different emphasis and purpose.
Fundamental Principles

- Structure Design Efficiency
- Energy Efficiency
- Water Efficiency
- Materials Efficiency
- Indoor Environmental Quality Enhancement
- Operations and Maintenance Optimization
- Waste and Toxics Reduction
Reduce the impacts of natural resource consumption.

Benefits of Green Buildings

- Economic
- Environmental
- Health and Safety
- Community

Minimize strain on local infrastructures and improve quality of life

Enhance occupant comfort and health

How to Make Green Homes

Green Building with Heartland Builders, LLC.
www.heartlandbuilders.com

Exposure to the sun: Consider your home's orientation to the sun to harness energy or to shield it from heat and UV light.

Other Considerations: Low VOC paints, "green" flooring, energy efficient lighting. Conduct a "blower door" test on your home to determine performance.

Insulation: Air sealing a home, using blown insulation and minimizing thermal bridging lowers utility bills. Consider SIPS or ICF's.

Recycled Deck Materials: Utilize sustainable resources and reduce maintenance costs.

Recycled Framing Materials: Such as finger jointed studs and an I-Joist floor system. Help reduce new lumber use.

Native Landscaping: Requires less maintenance and irrigation.

Rain Gardens: Help reduce storm water run off.

Conserv Water: With dual-flush toilets, water saving faucets and rain sensors for lawn sprinkling.

High Efficiency Mechanical Systems: Reduce your energy bills. Consider a geothermal heating system. Always seal your duct work.

Energy Efficient Appliances: Reduce utility costs.

Insulated Foundation Walls: Improve the comfort of your home and reduces utility costs. Consider ICF's.

Insulated Basement Floors: Help eliminate dampness and reduces utility costs.
How to Make Your Building Green

- Rainwater harvesting systems on the roof can collect water to be used to flush toilets.
- Solar panels can heat bath water.
- Wind turbines on the roof can be used to generate electricity.
- Non-toxic paints should be used on the walls. These use water rather than petroleum-based solvents and do not emit smog-producing pollutants.
- Dual-flush toilets help conserve water with controlled water outlet options.
- Use compact fluorescent lightbulbs (CFLs), which use 20% less energy than incandescent bulbs.
- Use graywater from baths, sinks, kitchens, and washing machines to flush lavatories.
- Use composting to reduce waste and help your garden at the same time. Most food scraps and biodegradable materials produce nutrient-rich fertiliser.
- A rain garden can help reduce stormwater runoff.
- Native landscaping requires less irrigation and maintenance.
- High-efficiency, insulated glass windows reduce energy use.
- Motion detectors can be used to switch off lights if there is no one in the room.
- Energy-efficient appliances reduce power use.

**FIGURE CONSCIOUS**

Energy savings in green buildings could range from 20 per cent to 30 per cent: water savings from 30 per cent to 50 per cent. A green building can cost between 5 and 10 per cent more to build than a regular building, but these costs can be recovered in just 2 years in power and water savings.
APPLICATION OF SUSTAINABILITY

Pre-Design
- Material Selection
- Building Program
- Project Budget
- Team Selection
- Partnering
- Project Schedule
- Laws, Codes & Standards
- Research
- Site Selection

On-Site
- Site Analysis & Assessment
- Site Development & Layout
- Watershed Management & Conservation
- Site Material & Equipment

Design
- Passive Solar Design
- Materials & Specification
- Indoor Air Quality

Construction
- Environmentally Conscious Construction
- Preservation of Features & Vegetation
- Waste Mgmt.
- IAQ Issues
- Source Control Practices

O&M
- Maintenance Plans
- Indoor Quality
- Energy Efficiency
- Resource Efficiency
- Renovation
- Housekeeping & Custodial Practices
<table>
<thead>
<tr>
<th>NAHB</th>
<th>LEED</th>
<th>Green Globes</th>
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<td>![USA Flag]</td>
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- Leadership in Energy and Environmental Design (LEED)
- Green Globes
- National Association for Home Builders (NAHB) – For Homes

<table>
<thead>
<tr>
<th>LEED 3-Star</th>
<th>BREEAM</th>
<th>GBCA</th>
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- The 3-star system run by the Ministry of Housing and Urban Affairs (MOHURD), and the Leadership in Energy and Environmental Design (LEED) program
- Building Research Establishment Environmental Assessment Method (BREEAM)
- Green Star by Green Building Council Australia (GBCA)

<table>
<thead>
<tr>
<th>LEED India</th>
<th>CASBEE</th>
<th>Estidama</th>
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- LEED India
- Comprehensive Assessment System for Built Environment Efficiency (CASBEE), Japan
- Estidama: Abu Dhabi Urban Planning Council (UPC).
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<tr>
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<th>LEED</th>
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<td>1998</td>
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<td>2004</td>
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<td>Assessment</td>
<td>USGBC</td>
<td>Trained assessors</td>
<td>Design / management team</td>
</tr>
<tr>
<td>Third Party Validation</td>
<td>GBCi</td>
<td>BRE</td>
<td>Third Party Agencies e.g. JSBC (Japan Sustainable Building Consortium)</td>
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</table>
Sustainable Architecture
ENVIRONMENTAL ARCHITECTURE

Ecological Architecture

Bioclimatic Architecture

Vernacular Architecture

Sustainable Architecture

Green Architecture

Traditional / vernacular Architecture
The history of green architecture is the history of mankind. The relationships among man, environment, and ecology were established the day the first humans (hominids) appeared on the scene. Four million years ago, the human evolutionary line had separated from that of the other primates.
Green Architecture

Environmental Architecture Systems

- Active Systems
  - Photovoltaic cells
  - Plate Solar Collector
  - Wind Turbines
  - Hydroelectric Power

- Passive Systems
  - Wind Catchers
  - Trombe Wall
  - Passive Solar energy
  - ...

Lucknow Headquarters is a Sustainable Building with Passive Systems
Active Systems

- Photovoltaic
- Wind Turbines
- Solar Water Heating
- Hydroelectric Power
Passive Systems

Wind Catchers

Trombe Wall

A Trombe wall is a surfacing wall separated from the outdoors by glass and an air space, which absorbs solar energy and releases it selectively towards the interior at night. Modern Trombe walls have vents added to the top and bottom of the interior wall, to allow heated air to flow via convection into the building interior. The vents have one-way flaps which prevent convection at night, thereby making heat flow strongly directional. This kind of design is an efficient passive thermal collector. By moving the heat away from the collection surface, it greatly reduces thermal losses at night and improves net heat gain. Generally, the vents to the interior are closed in summer months when heat gain is not wanted.
SUSTAINABLE
Mankind – Living & Interacting With Our Environment In A Way That Can Continue, So That Mankind & The Environment Remain Healthy & Happy

ARCHITECTURE
The Art & Science Of Building (Creative & Technical)
Sustainable Architecture: How Do We Achieve It?

- **Energy Efficiency**
  - Small is good
  - Passive solar design
  - Active solar design
  - High levels of insulation
  - Efficient heating of air & water
  - Thermal mass
  - Ventilation
  - Efficient lighting

- **Waste Management**
  - Through designing in modules
  - Recycling while building
  - Grey water systems
  - Low flow taps & showers

- **Building Materials**
  - Use of renewable, non toxic materials
  - Use of recyclable/recycled materials
  - Locally sourced to reduce transport

**WHY IS ENERGY EFFICIENCY AT THE TOP?**
- **Energy Efficiency**
  - Small Is Good

- **Energy Efficiency**
  - Passive Solar Design
  - Orientation
  - Roof Overhang
  - Ventilation
- Energy Efficiency
  - High Levels Of Insulation
  - Efficient Heating Of Air & Water
- **Energy Efficiency**
  - Thermal Mass
  - Efficient Lighting

- **Waste Management**
  - Low Flow Taps & Showers
• **Building Materials**
  - Use Of Renewable, Non Toxic Materials
  - Use Of Recyclable/Recycled Materials
  - Locally Sourced To Reduce Transport
References


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