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Next Generation Solutions for Clean Air and Sustainable Transport in Asia:

Electric Mobility

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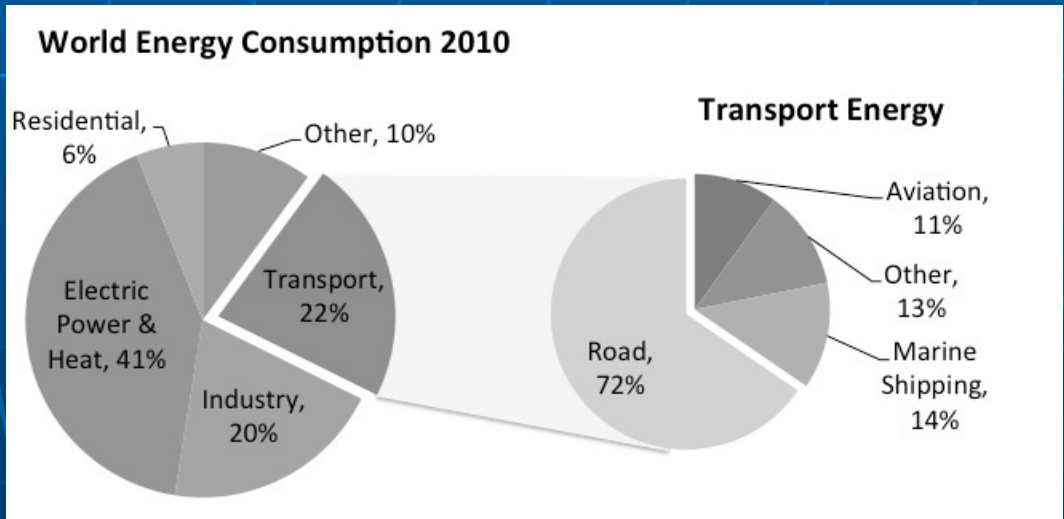
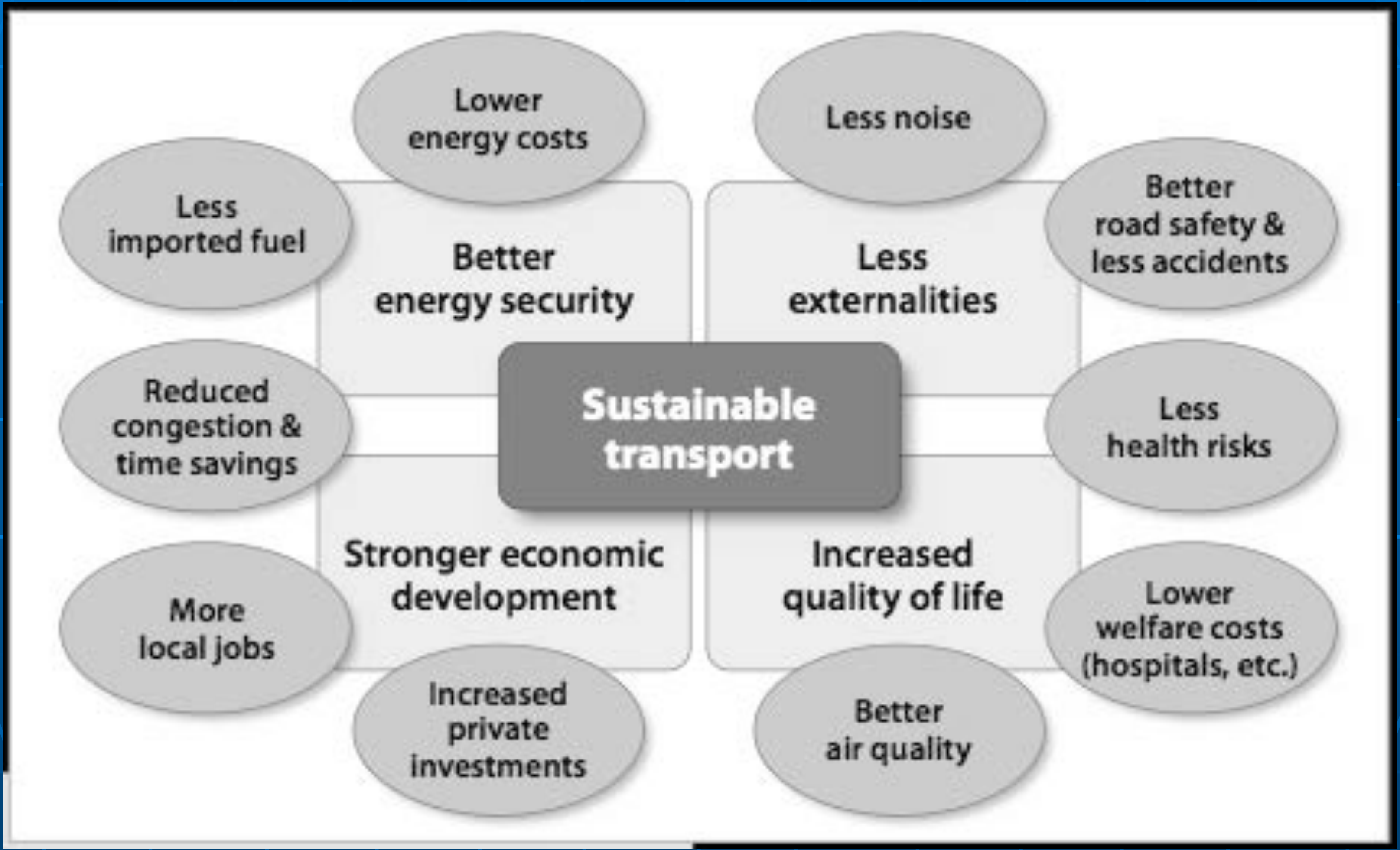
Trends, issues and challenges in urban transport in Asia

- **Rapid urbanization and growing demand for transport;**
- **Limited transport infrastructure and growing land use for private motorized transport;**
- **Increased urban air pollution from transport;**
- **High energy use and growing CO_2 emissions;**

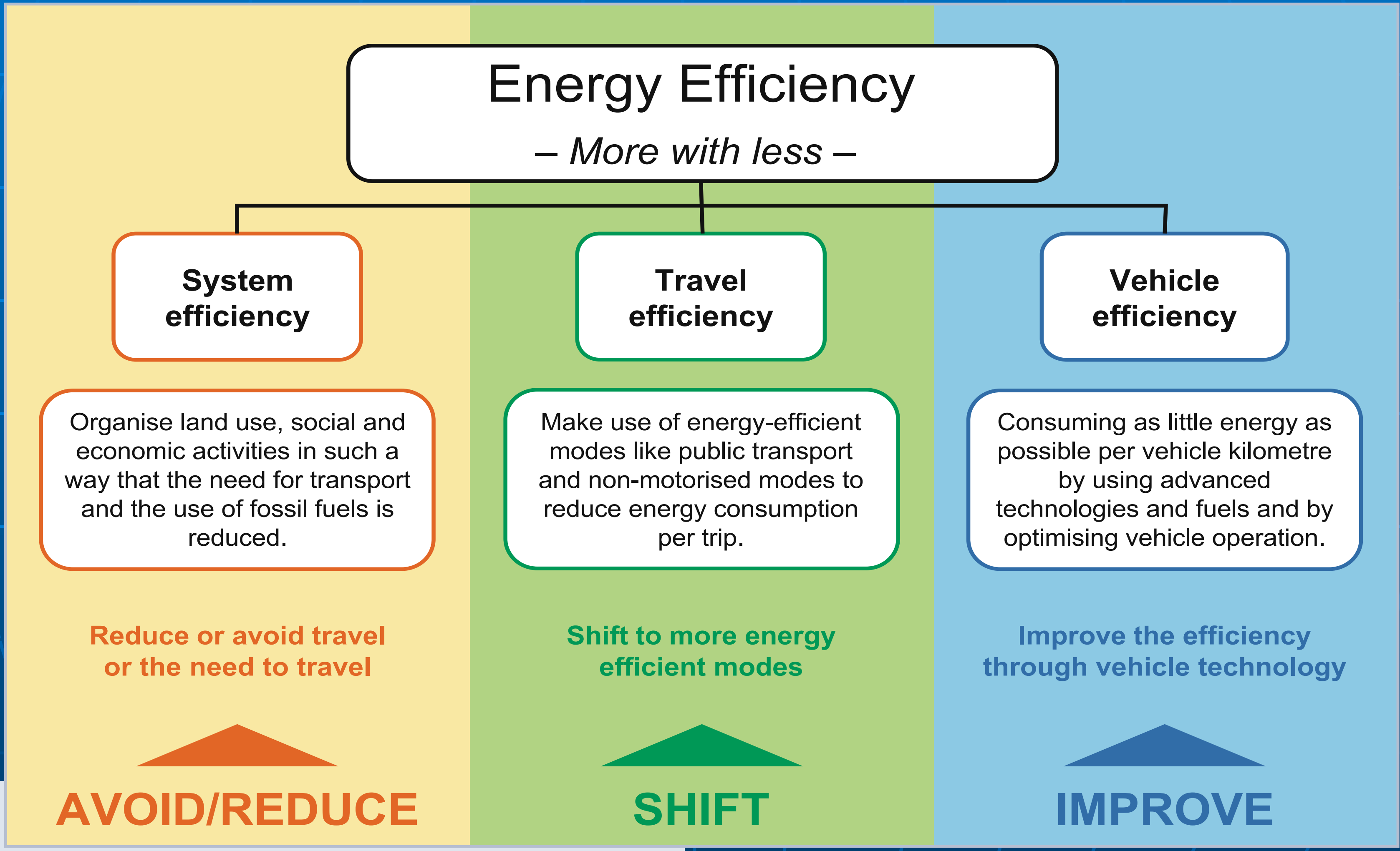


Multi-criteria qualitative definition of sustainable transport

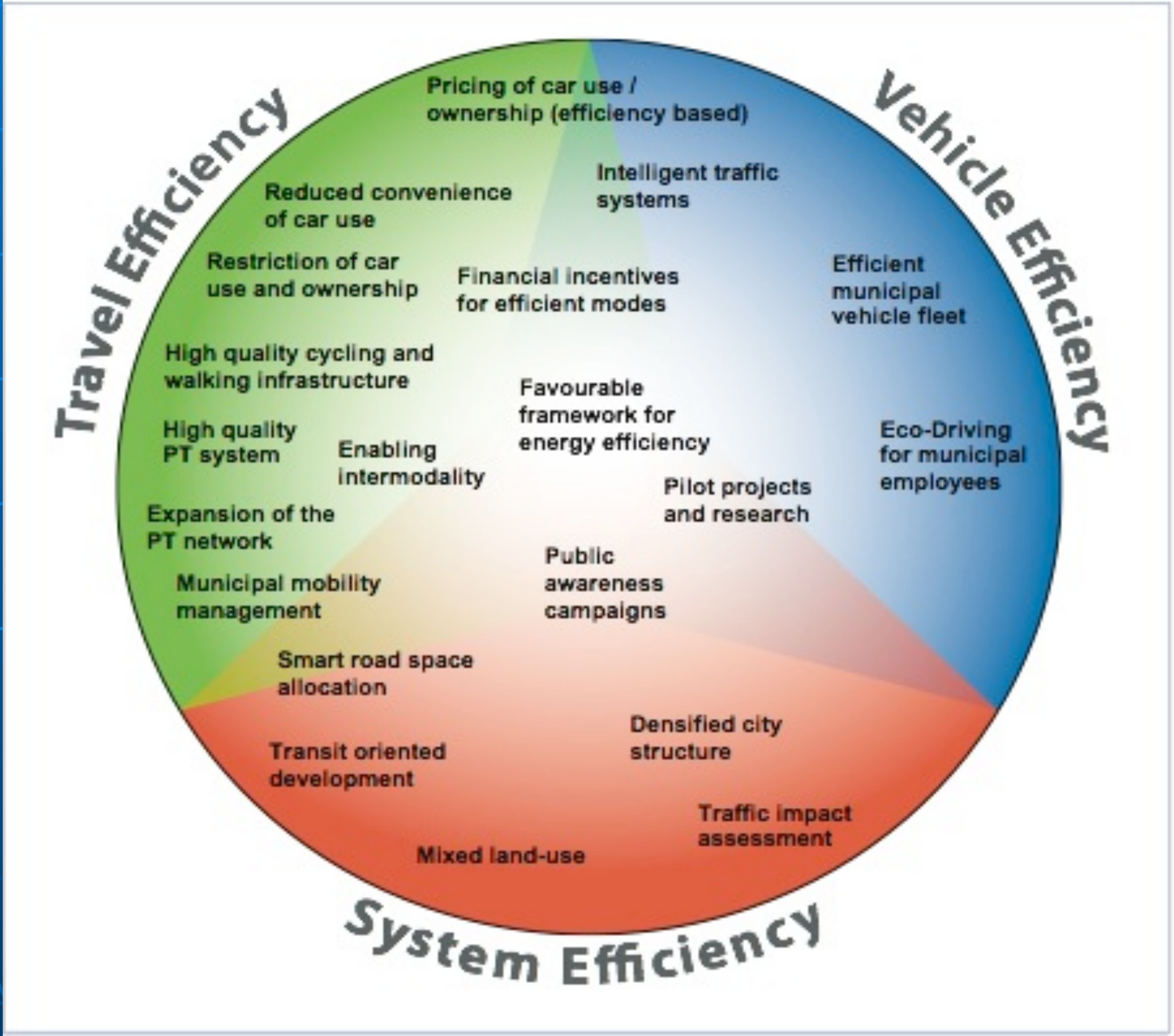


Source: Susanne Böhler-Baedeker, Hanna Hüging: Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities, Module 5h: Urban Transport and Energy Efficiency, p.19

The 'Avoid-shift-improve" paradigm for cost-effective management of transport in Asia



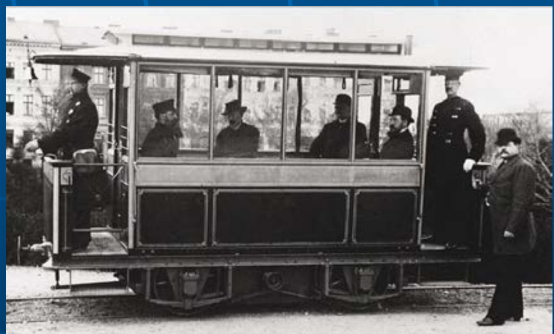
Energy and transport efficiencu navigator for cities and local authorities



Source: Susanne Böhler-Baedeker, Hanna Hüging: Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities, Module 5h: Urban Transport and Energy Efficiency, p. 23.

Electric mobility is as old as auto-mobility:

	Historic Timeline on Emergence of Electric Vehicles
1834 - 1839	First inventors: Robert Anderson (Scotland) and Thomas Davenport (US)
1859	Gaston Planté (France) invents reachargeable lead-acid battery
1891	William Morrison (Iowa, US) builds first successful electric automobile in United States
1897	First electric taxi fleet in New York City
1900	United States produced 4,200 motor vehicles (with 30 per cent electric cars)
1908	Ford Model T introduced mass-produced gasoline-powered Model T with profound effect on national vehicle market



1881 – Electric tram – Berlin Lichterfelde

Types of electric mobility

- **Hybrid electric vehicles (HEVs)**

  - combined combustion engine and electric motor in one and same car

  - "Micro-Hybrid", "Mild Hybrid" or "Full Hybrid" Vehicles

  - Fuel efficiency up to 25 % better than pure combustion engine (e.g. Toyota Prius)

- **Plug-in hybrid electric vehicles (PHEVs)**

  - Externally recharged battery and electric motor, combined with combustion engine for long-distance driving (e.g BMW i3 plus, GM Volt / Opel Ampera)

- **Battery electric vehicles (BEVs)**

  - only externally recharged battery and electric motor (e.g. e-bicycles, e-scooters, e-tricycles, e-vehicles for passenger and goods transport, e-buses)

- **Fuel cell electric vehicles (FCEVs)**

  - battery and electric motor powered by on-board fuel cell

Potential benefits of e-mobility in Asia

- **Potential national economic benefits:**

  - reduction of oil import dependency,

  - increased economic resilience

- **Contribution to environmental protection**

  - Lower urban air pollution;

  - Lower urban noise pollution;

- **Social aspects: New mobility options**

  - e-bicycles / e-scooter = new individual transport options where public transport is overcrowded or note available;

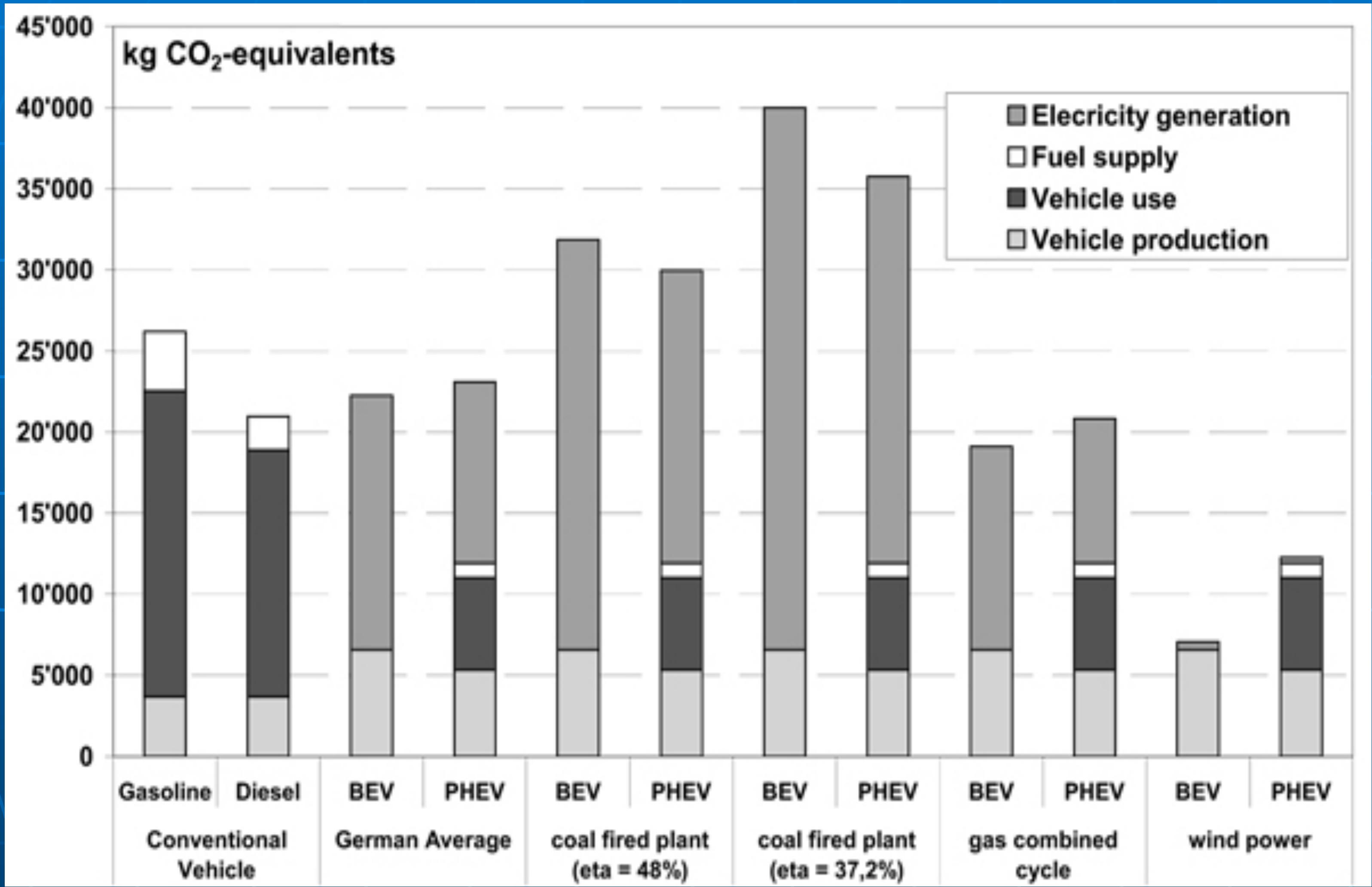
  - typically low maintenance required

  - mobility options for various social groups (e.g. persons with disabilities)

- **Contribution of electric vehicles to CO_2 emission reduction goals**

  - requires comprehensive analysis of "tank-to-wheel", as well as "well-to-tank" emissions

Life cycle greenhouse gas emissions of a compact car with different drive trains (120,000 km ; 70% urban driving)



Source: Helms,H., Pehnt, M.; Lambrecht, U.; Liebich, A.(2010): Electric vehicle and plug-in hybrid energy efficiency and life cycle emissions, in: Proceedings of 18th International Symposium Transport and Air Pollution, Ifeu – Institut für Energie- und Umweltforschung, Heidelberg, Germany, p. 113

Barriers and challenges to e-mobility in Asia

- **Consumer preferences and expectations;**

  - high costs of EVs in Asia (even after Government subsidies / consumer incentives;

  - perceived inconvenience of limited driving range / (frequent) need for re-charging, and lack of necessary re-changing infrastructure;

- **Expanding electric mobility: Resource constraints?**

  - ample reserves of lithium carbonate (mostly Chile, Argentina and Bolivia) and lithium rich minerals (mostly Australia and US) ;

- **Battery safety concerns**

  - In general, the driving, the maintenance and the re-charging of electric vehicles is not associated with any significant ricks;

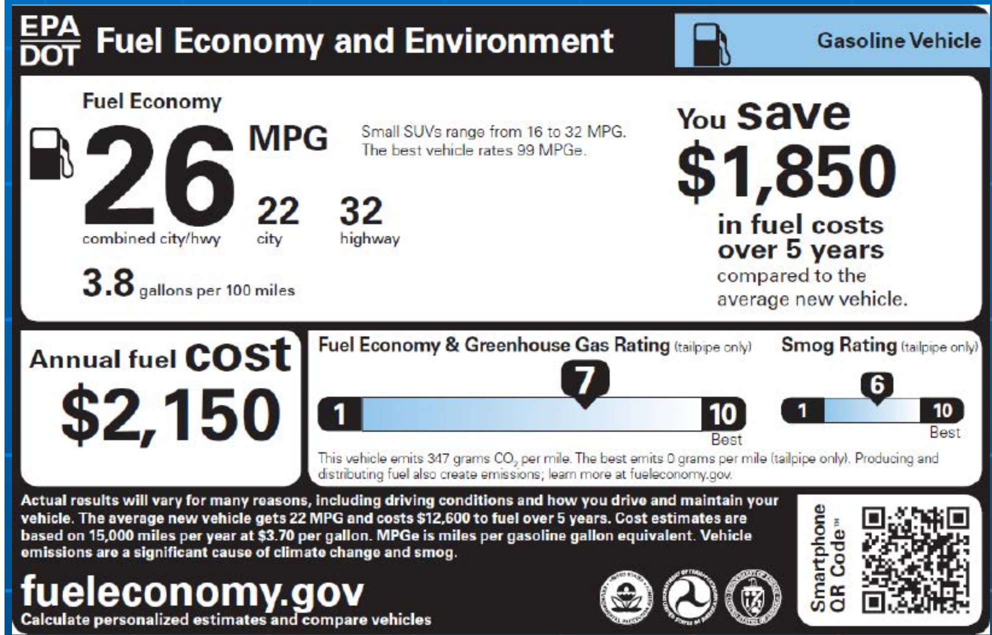
  - additional design studies and crash tests are needed to eliminate any remaining risks;

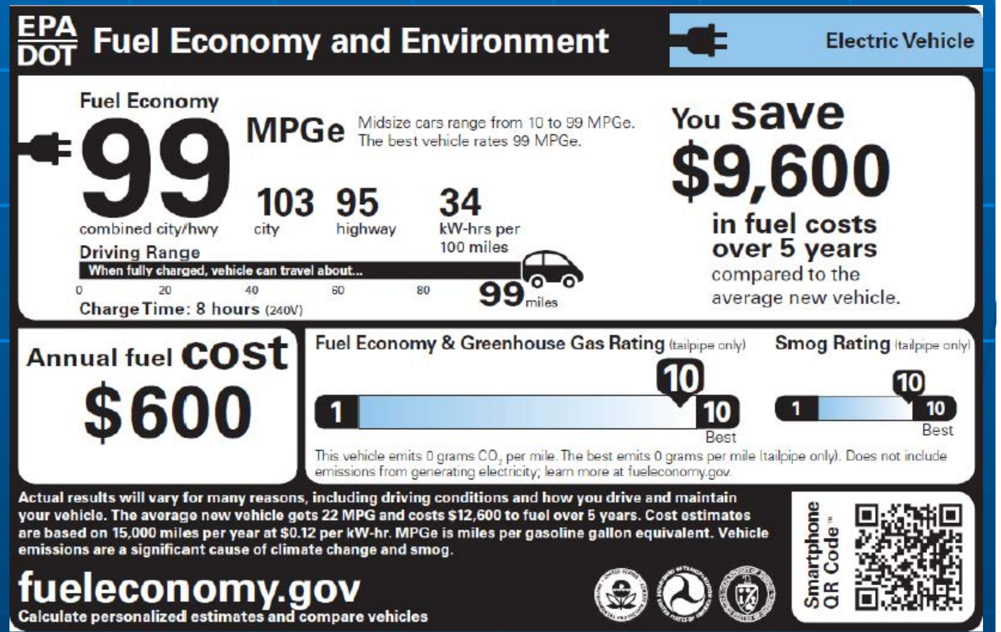
- **Waste management concerns: Future car battery recycling re-use and disposal;**

  - options for re-use of former e-vehicle batteries for larger electricity storage facilities;

  - improved regulations and implementation of battery collection and recycling systems is needed.

Fuel Economy and Environment – Car labels in the US





Model assumptions:
Travel intensity 15,000 miles/year
City driving 55% ; Highway 45%
Gasoline average retail price per gallon:
2000-2012 US 2.45 / 2013: US$ 3.51
Electricity price $0.12 / kWh

Source: www.fueleconomy.gov

E-Mobility Applications: Urban Delivery Vans

DHL Ford e-Vans, New York

FedEx Hong Kong, China, new e-Vans

BYD T3/T5/T7 - new light trucks

7-11 Japan micro delivery vehicle

E-Mobility Applications: Urban Taxi Fleets

BYD E-6 Shenzhen, China, Taxi Fleet

Mitsubishi iMIEV – Tokyo electric Taxi

Nissan Leaf NY Taxi, Kumamoto, Japan

future electric Taxi Service in Bhutan

(Re)introducing e-mobility for public buses

Hyundai/Hankuk Fiber e-Bus, Seoul, Korea

BYD e-Bus in Bangalore (BMTC), India

Tindo Solar Bus – Adelaide - Australia

Wireless Online EV Technology – Rep. of Korea

Electric 3-wheelers: Greening passenger transport in Asia

ADB Project – e-3wheeler, Manila

e-Jeepney, Quezon City, the Philippines

Lanka EV Association – GEF SGP Project

SAFA Tempo – Kathmandu, Nepal

Quadricycles; Light EVs, Neighborhood EVs

Shifeng Mini EV, China

Jinan – Flybo EV, China

Reva NXG and NXR electric micro cars from India for export

New applications for electric mobility in China: Neighborhood Community Car-sharing

Kandi Technologies Group, Inc., Jinhua, Zhejiang Province, China

Air Pollution in Asian Cities:

E-2wheelers, e-scooters, and e-tricycles can help to address some of the issues:

Classification of Chinese Two-wheelers

Class	Types	Power (engine size)	Top speed (km/hr)	Fuel use (l / 100km)	Range (km)	Picture
Bicycle			10-15	n/a	n/a	
Electric two-wheeler	Electric bicycle	0.25-0.35 kW	20-30	1.2-1.5 kWh	30	
	Electric scooter	0.3-0.5 kW	30-40	1.5 kWh	30-40	
Motor cycle	Gasoline Moped/ Scooter	3-5 kW (50-125 cc)	50-80	2-3 l	120-200	
	Gasoline Motorcycle	4-6 kW (100-125 cc)	60-80	2-3 l	120-200	

Source: Jonathan Xavier Weinert (2007) : The rise of electric two-wheelers in China: Factors for their success and implications for the future, Dissertation at University of California, Davis, p 10-11

Conclusions and recommendations (1)

1. There is no “one size fits all” solution. Any e-mobility policy interventions need to be planned and implemented in an integrated manner taking into account other existing transport, energy, environment and urban development policies;
2. Promotion of electric mobility needs to go hand in hand with expansion of renewable energy use and improvements of energy efficiency in power generation, transmission and distribution;
3. Differentiating / discriminating import restrictions and duties on electric vehicles and parts (e.g. as “luxury goods”) should be lifted;
4. City administrations may consider temporary technical or financial support for local e-mobility pilot and demonstration projects;
5. National and local administrations may consider to standardize or facilitate registration and licensing of electric vehicles;

Conclusions and recommendations (2)

6. City administrations may consider support for public-private partnership programmes, including (e)bike-sharing and (e)car-sharing;
7. Promotion of electric mobility may be focused on promising commercially viable applications of electric mobility, e.g. taxi fleets, delivery vehicles, small e-vans for goods or passenger transport;
8. Developing countries with industrial manufacturing capacities may consider start-up support for local production or assembly of e-mobility products (notably electric two- or three wheelers and micro e-cars);
9. City administrations may consider to restrict the use of highly-polluting fuels, engines or vehicles in specific inner-city commercial or residential zones;
10. National and local administrations may consider consumer awareness and information programmes, including car labeling.

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Further information:

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