Energy efficient urban rail transport at Hot-spot Tokyo

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http://www.angelfire.com/wi/wunder/jpleb2.html
This lecture

Greenhouse gases reduction

Tokyo as example for a world metropolis -> Expo 2010

History of public transport in Tokyo

New railway technology reduces energy consumption
Dramatic increase in CO$_2$ concentration [ppm] -> Greenhouse effect

- Plants grow faster
- Insects and Virus are increasing
- Climate phenomena -> larger energy
- Water draughts

EPI IEA: ... only 20 years left
- EU wants to maintain 450 ppm in 2020

Peace Nobel prize recipients
- M. el-Baradei
- Al Gore
- B. Obama

We must
We can

2005 2006 2009

-> Plants grow faster
-> Insects and Virus are increasing
-> Climate phenomena -> larger energy
-> Water draughts -> Eco-system damage
Reduction in greenhouse gas Emissions…..

…. but not yet in the transport sector in Europe

To avoid restrictions, rail transport must become more attractive – fast, easy,…
Every Decade Megacities grow and new are arising
2010 75% of people live in cities, 2050 84% expected
Why do people want to live in cities?

“Better cities = Better life” – theme of Expo 2010 in Shanghai

● Good transport network means good social network

● Less travel time to work,
● Easy access to transport, hospital, shopping, culture...

● Job condition, income,
● Housing cost, access
● Number of square meter for living
● Number of city events

-> Quality of life improves when living in cities
Hot-Spots are areas of vital Activity and Energy

Physics tells us:
Driving force leads to gradient.

When migrating particles gather, a singular hot spot is formed.

Particle – car, train or pedestrian
Energy – activeness of pedestrians
Temperature – progress of passenger flow
Force – attraction or motivation to go somewhere.

Ludwig Boltzmann
(1844 - 1906 Wien)

-> Simulation of traffic flow uses particle physics

W.Wunderlich et.al., http://bulletin.soe.u-tokai.ac.jp/english_vol34/5-10.pdf
Purpose of using train

- 40% Work
- Entertainment
- Shopping

School -> 97% of all journeys are less than 100 km

Events  Culture  Art  Hiking  Sports

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Concerns about “too convenient” traffic: Urban sprawl, that means landscape consumption due to urbanization
Map of real estate prices in Tokyo area

Data:
Yomiuri Shinbun
2008-03-25

> 1000 Tsd Y / sqm
1000-700
500-300
300-200
200-70
< 70

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W.Wunderlich et.al., http://bulletin.soe.u-tokai.ac.jp/english_vol34/5-10.pdf
Why is public transport in Tokyo a success?

Network started, when rail was the only transport
-> continuous optimization started Olympia 1964

Station-based culture: shops, pubs, real-estate

Narrow and slow roads, very high parking costs

Easy and convenient, IC-tickets (Pasmo, Suica)

1964 ~ 1985

> 2000
Capacity of a commuter train

15 coaches per train
240 passengers per coach
240 x 15 = 3600 passengers per train
Mass transport

Akihabara
14:12h
14:17h
14:22h
14:27h
14:32h
....

Each time about 400 people are boarding

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Human-being’s needs related to public transport system

- less than 1.5 h commuting time = 50km due to fast trains
- less than 10 min frequency -> maintained in Tokyo at <30km
- less than 15 min walk to the nearest station
Criteria for evaluation of public transport

Travel time versus distance

Train capacity versus population

Sufficient capacity, but economic concerns

Distance [km]

Population

For details see this paper:

W.Wunderlich et.al., http://bulletin.soe.u-tokai.ac.jp/english_vol34/5-10.pdf