Rethinking Propulsion.

Sustainable E-Mobility and Energy Infrastructures

Guenther F. Brauner

Alternative Propulsion Systems and Energy Carriers

Austrian, European and global R&D- and demonstration projects, research institutions and funding programs

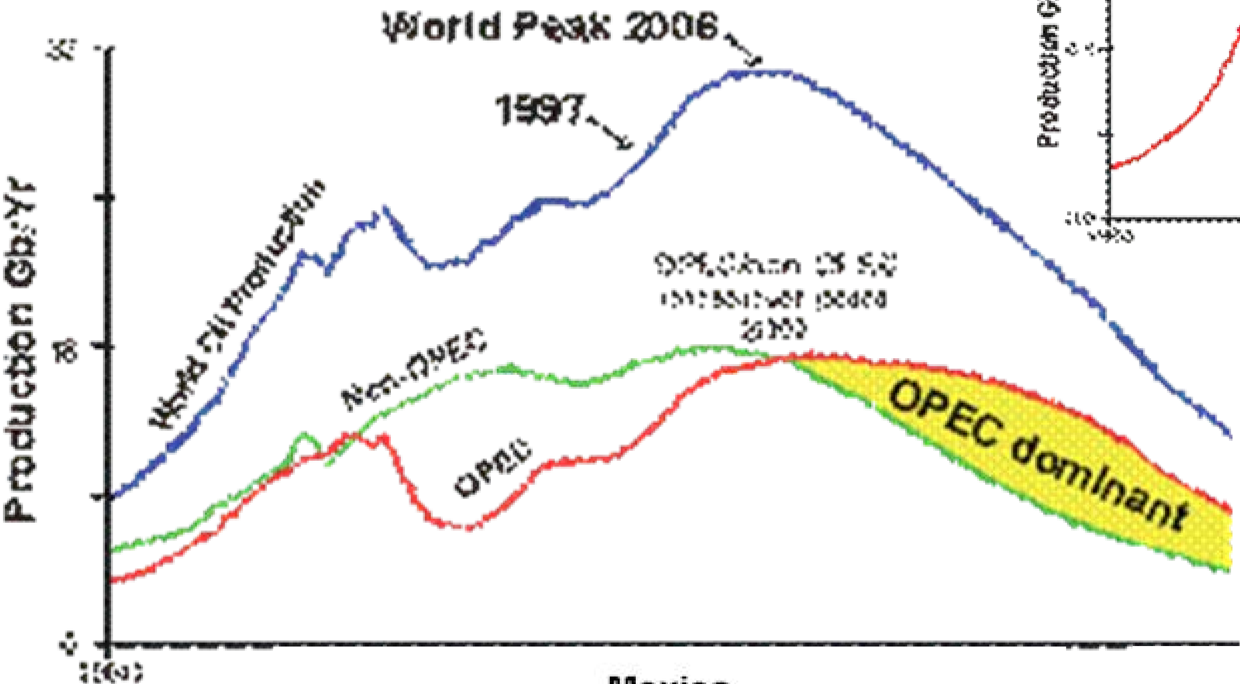
Vienna, 16.10.2009

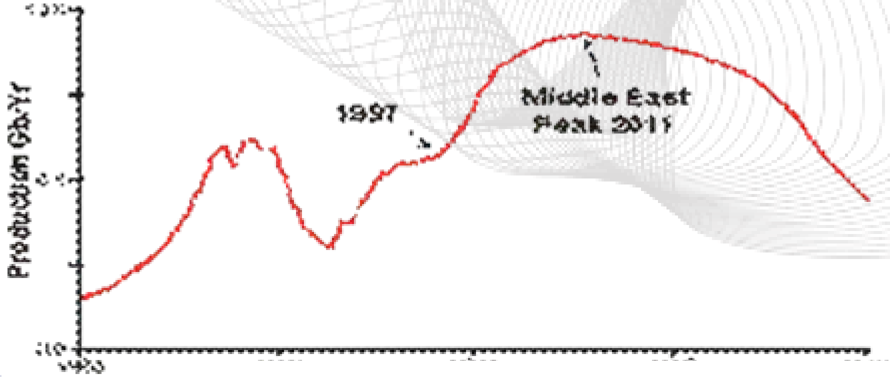
in cooperation with

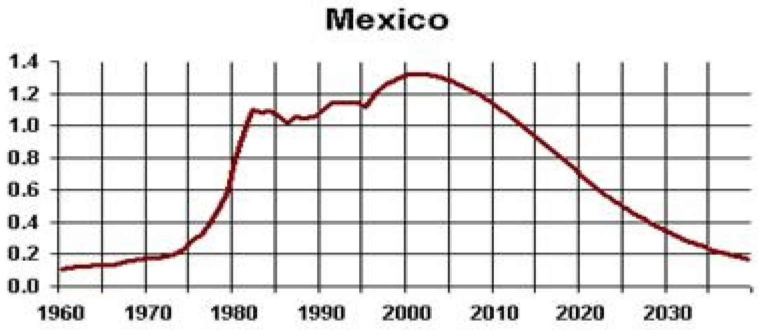
Sustainable E-Mobility

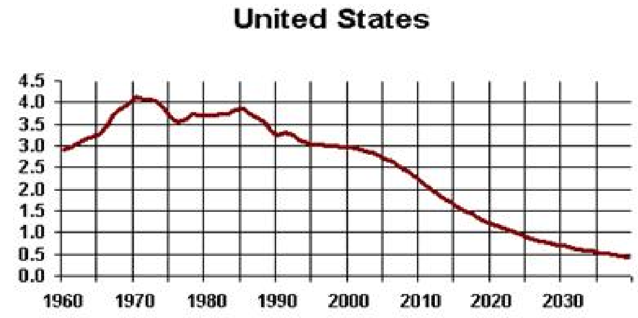
- Energy Carriers
- Efficiency of Energy Chain Use
- Infrastructure Development
- Energy Storage Systems
- Development Path in short and long term

World Peak Oil 2008 ?

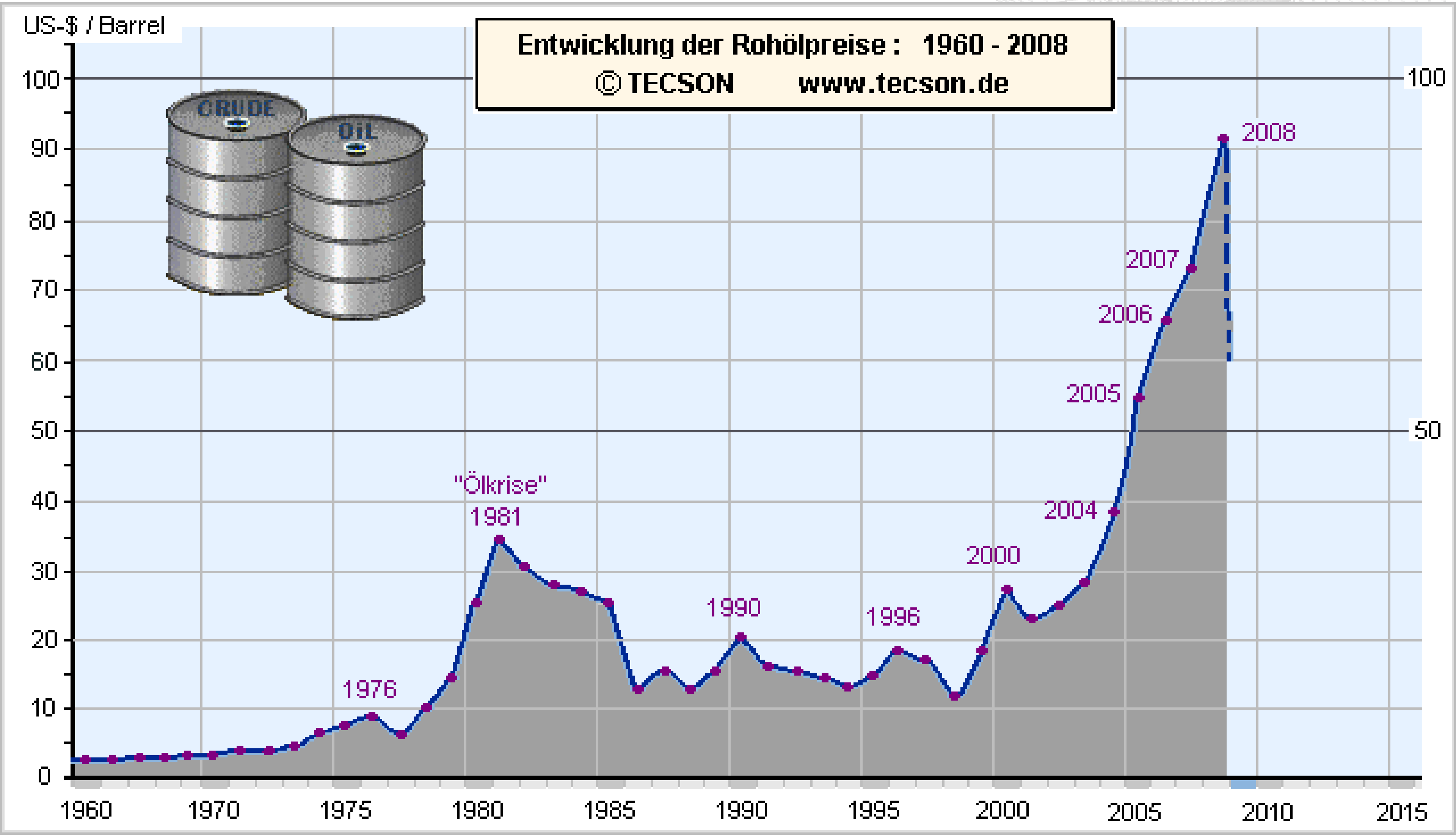








Crude Oil Price since 1960



Energy Carriers for Sustainable E-Mobility

Sustainable Energy to Electricity

- Hydropower
- Wind Energy
- Photo Voltaic
- Biomass

Conventional fossil Energy to Electricity

- Natural Gas (combined cycle power station)
- Coal (steam power station)

Energy Efficiency of Mobility

Type	Energy Demand kWh/100km	Passen-gers	mean use of capacity %	Energy per passenger kWh/100km	Energy per passenger Liter*/100km
Airplane A320-200	3.500	150	70	33	3,7
ICE 200 km/h	3.700	700	30	**18**	**2,0**
Regional Train	1.800	500	20	**18**	**2,0**
Underground	1.900	600	21	**15**	**1,7**
Bus	360	40	20	45	5,0
car fossil	55	4	30	46	5,2
Hybrid Car	40	4	30	33	3,8
E-Vehicle	18	4	30	**15**	**1,7**

*) 1 Liter gasoline equivalent = 8,9 kWh

Future of public and individual traffic

- The public traffic can scarcely be down sized according to fluctuating demand.
- Many empty transportations necessary for attractive timetable.
- E-Mobility brings energy efficiency of public train to individual car traffic.

Prognosis:

- The small e-vehicle will press the public traffic in the suburban areas with low population density.

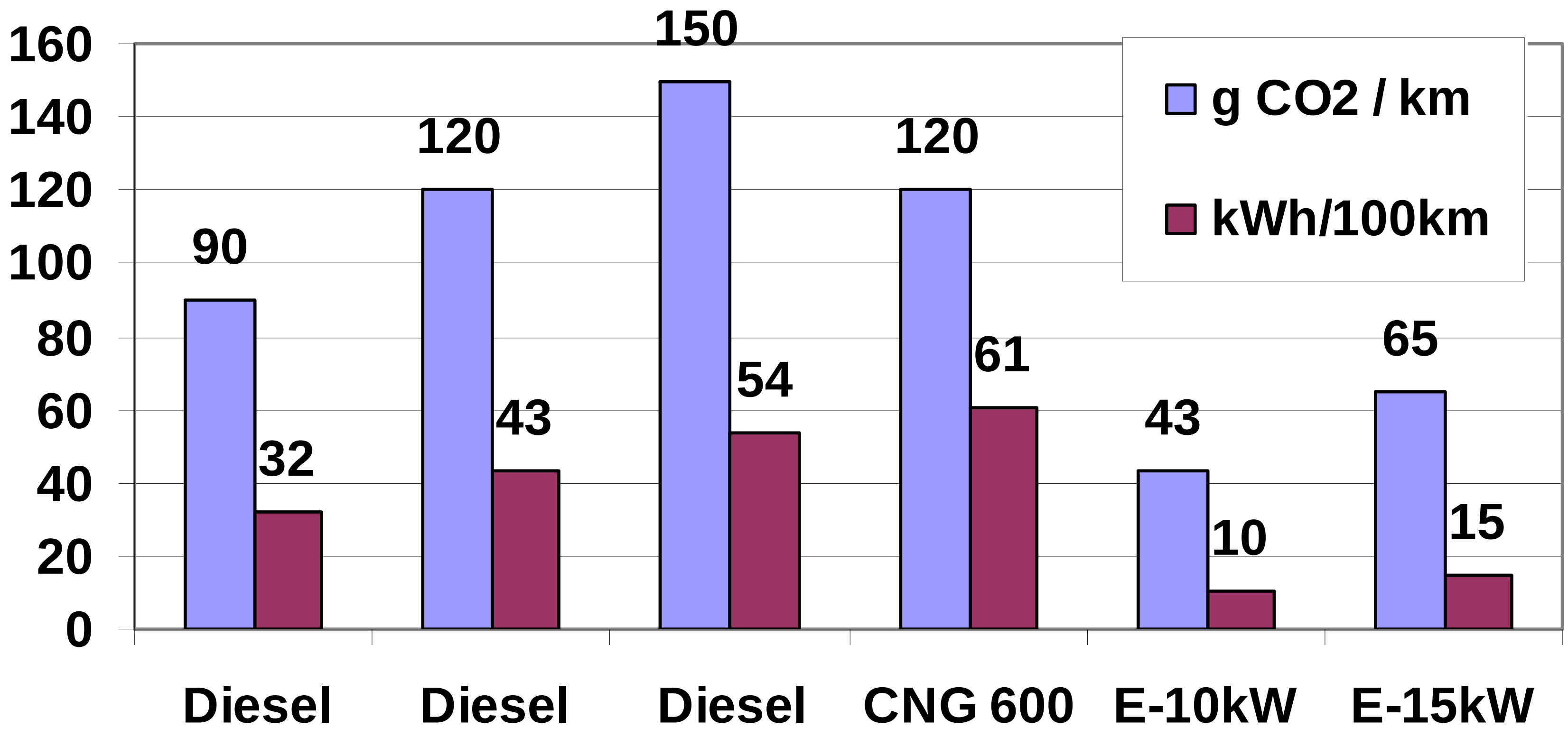
Sustainable Energy for E-Mobility: 10.000 km/a

500 E-Mobiles per 1000 Inhabitants: 15 % of Electricity Demand.

Source	Efficiency	Full load hours per year	Installed power per E-mobile	remarks
Photo Voltaic	12 – 23 %	900	2,5 kW	20 – 25 m^2 PV per E-Mobil
Wind	30 – 45 %	2.000	1,0 kW	2 MW Wind for 2.000 E-Mobiles
Hydro	90 – 95 %	4.500	0,5 kW	10 MW Hydropower for 21.000 E-M.
CC-power station	58 - 60 %	8.000	0,25 kW	350 MW-installation for 1,35 Mio. E-M.

Comparison. Diesel-car and E-vehicle (supplied with electricity from CC-power station).

η(CC) = 60%, *η(grid)* = 95%, *η(charging)* = 80%. *η(total)* = 45%,



E-smart


Nissan: Nuovo

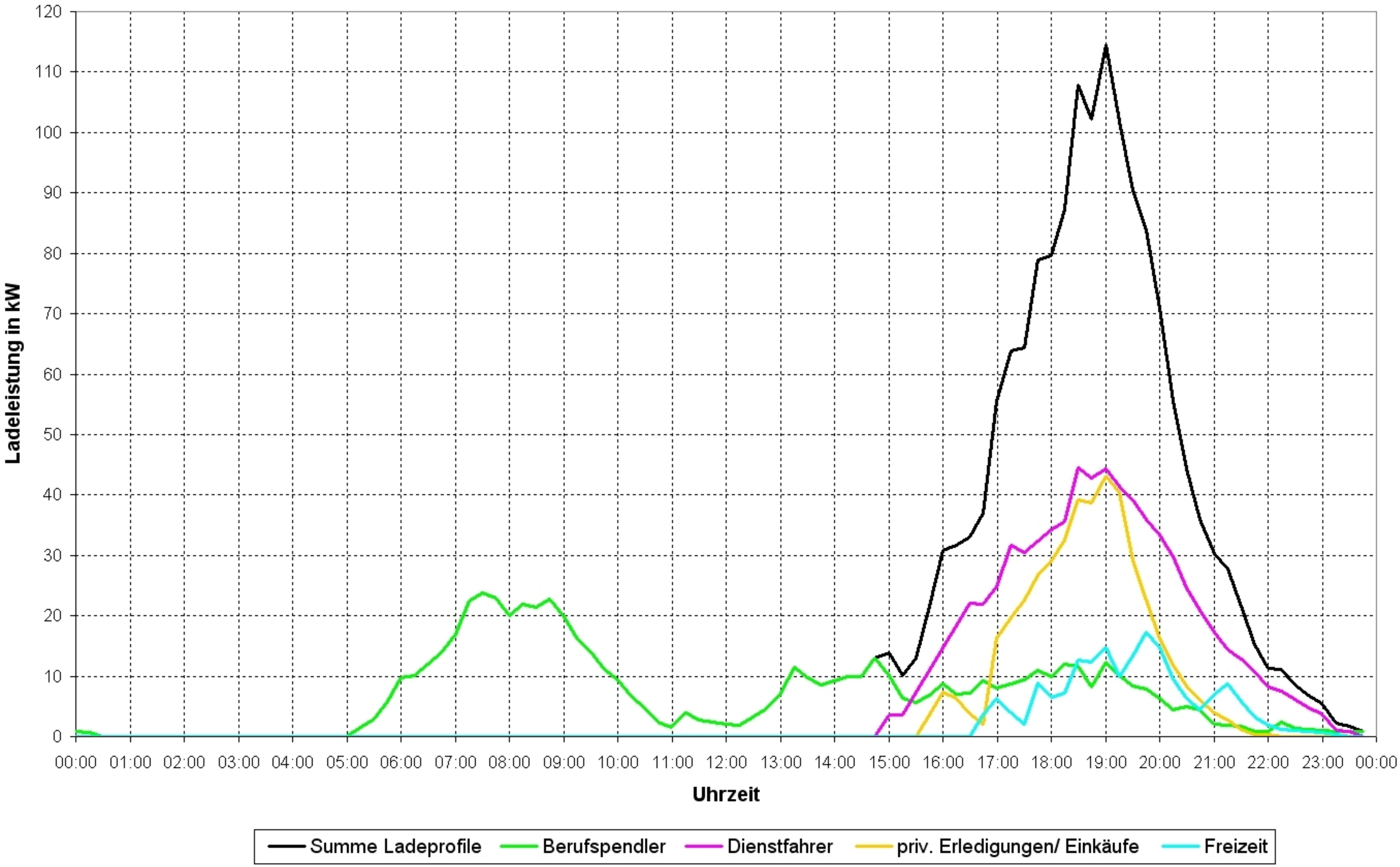

Pininfarina


Honda

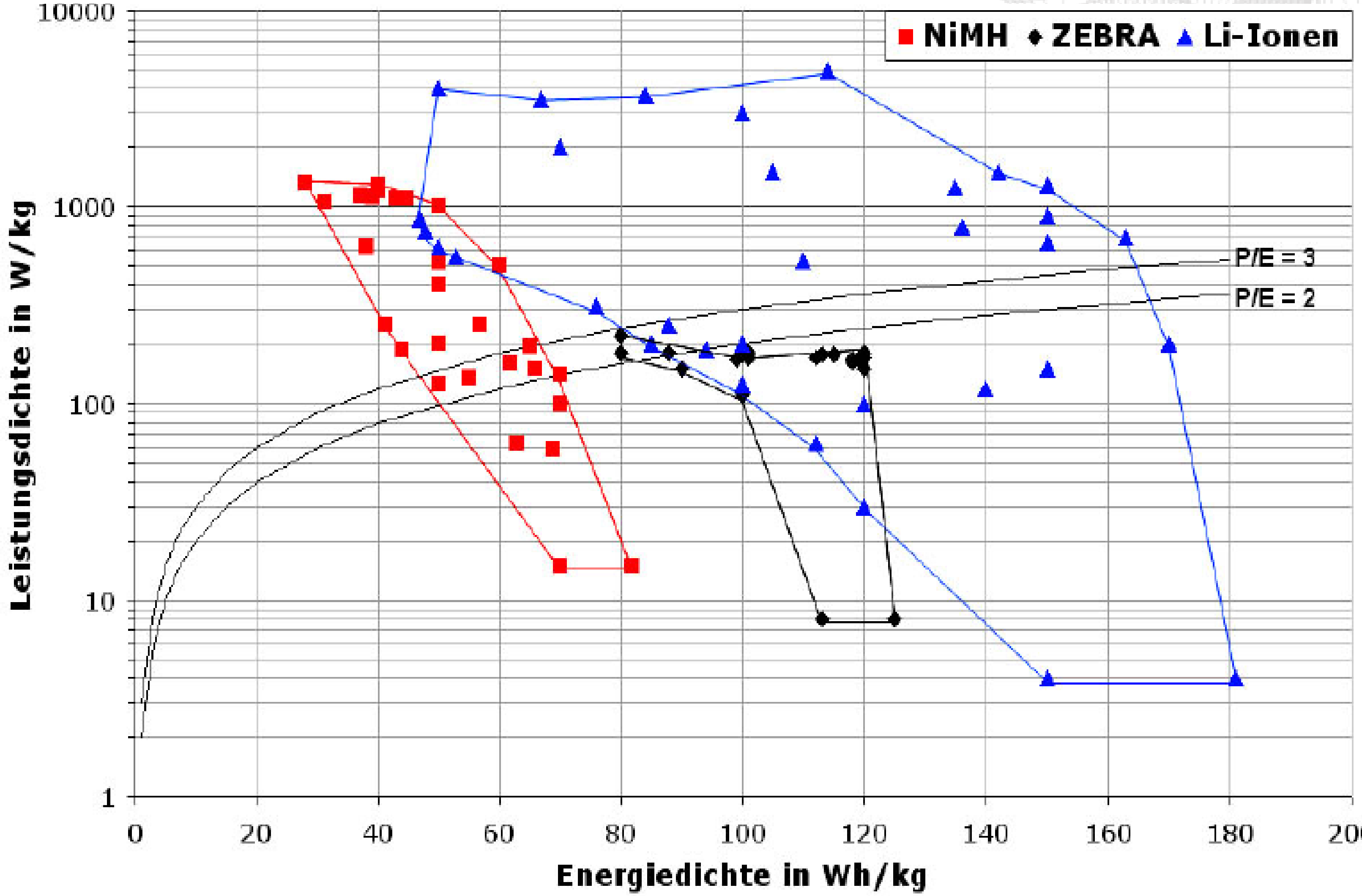
Charging Methods

- home charging with no restriction
  - Advantage: no public charging necessary
  - Disadvantage: grid overload in the evening
- Home charging with load management
  - Advantage: grid friendly, no overload
  - Disadvantage: charging mainly during night.
- Charging during parking
  - Advantage: solar charging possible, reducing of evening load
  - Disadvantage: public charging system and access electronic necessary

Charging power - driving profile
[TU Wien, Litzlbauer, Master Thesis 2009]



Energy and Power Characteristic of Batteries
[TU Wien, A. Schuster, Master Thesis 2009]



Energy Storage Systems

- Small scale storage in car batteries
  - Daily storage need only 5 to 20 kWh
- Large scale storage in pumped storage hydro plants
  - Wind and solar energy will need large scale storage capacities in pumped storage hydro plants

    e.g. Kaprun 75.000 MWh (3 mio. E-mobiles)

Kaprun: Limberg II pumped storage

Storage 2 x 80 Mio. m^3
represents: 75.000 MWh

Pump Turbines
2x240MW

energy of storage volume equivalent to 3,1 Mio. E-Car Batteries
each 24 kWh

Thank you for your attention !!!!!

Contact

Prof. Dr. Guenther BRAUNER

Vienna University of Technology

Institute for Energy Systems

Address:	Gusshausstrasse 25/373
	A-1040 Wien
	Austria
Tel:	+43-1-58801-37310
Fax:	+43-1-58801-37399
web:	www.ea.tuwien.ac.at
Email:	brauner@ea.tuwien.ac.at