



# Future Fuels & Mobility

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# THE CHALLENGES FOR FUTURE MOBILITY



## ACCESS TO ENERGY/FUELS

- Which energy sources will meet the growing demand for mobility?



## TOTAL COST OF OWNERSHIP

- Which fuel/vehicle combination will allow mobility to remain affordable?



## WORLD POPULATION GROWTH & URBANISATION

- How will mobility & infrastructure concepts change mobility in Mega cities?



## MANAGE TRANSPORTATION OF GOODS

- Major Growth of Goods Logistic – How will this influence Mobility?



## REDUCTION OF GHG & LOCAL & NOISE EMISSIONS

- Fuel/vehicle options for lowest amount of GHG and local emissions



## NEW TECHNOLOGY OPTIONS

- Vehicle Autonomous Drive, Continuous Connectivity, Safety Features (Night Vision, active braking, distance control, advanced stability control...)



## NEW MOBILITY POLICY

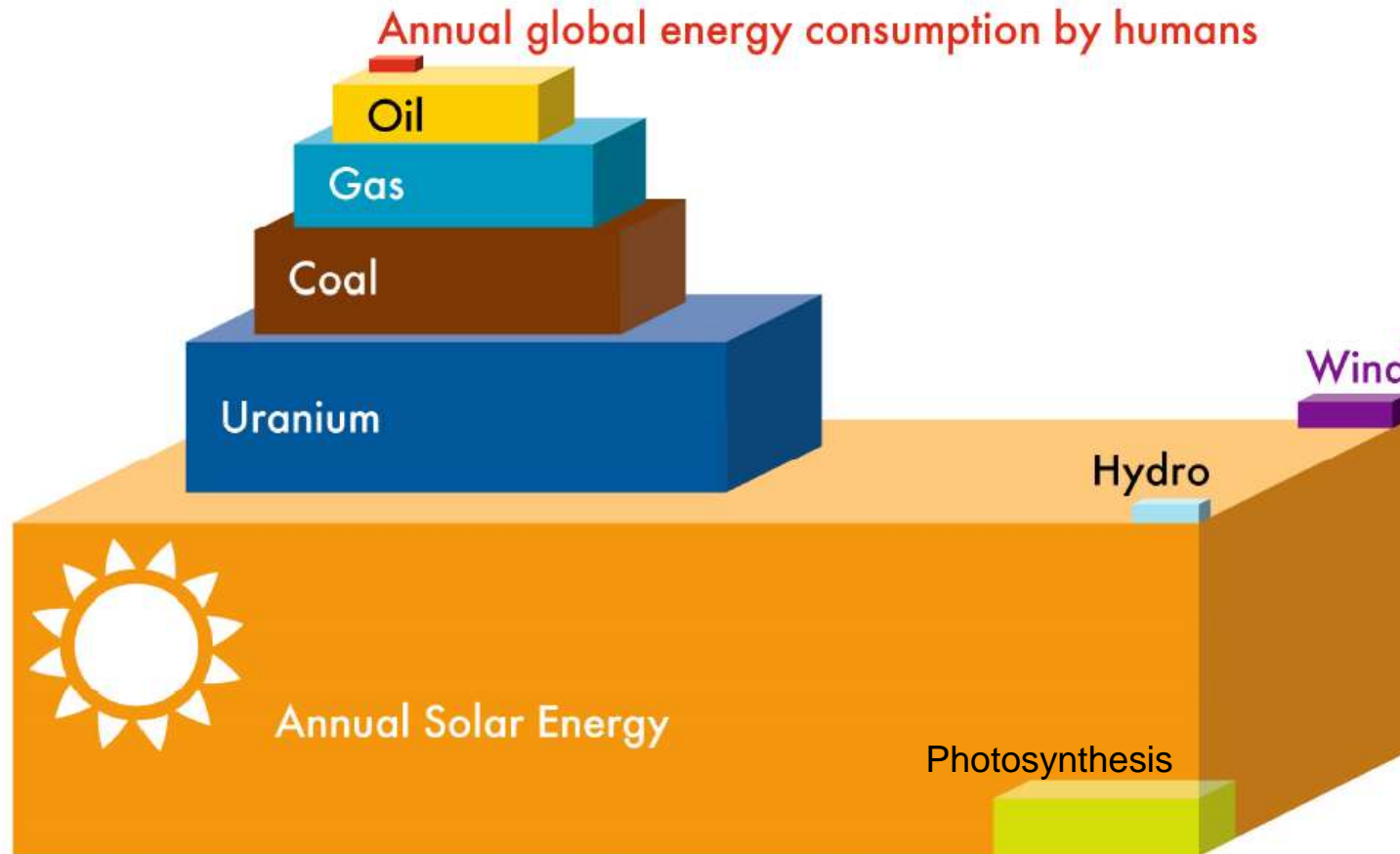
- Taxes/Incentives to manage Mobility & Local Entry Restrictions (Cities)



## CHANGING CONSUMER VALUES & SOCIAL ACCEPTANCE

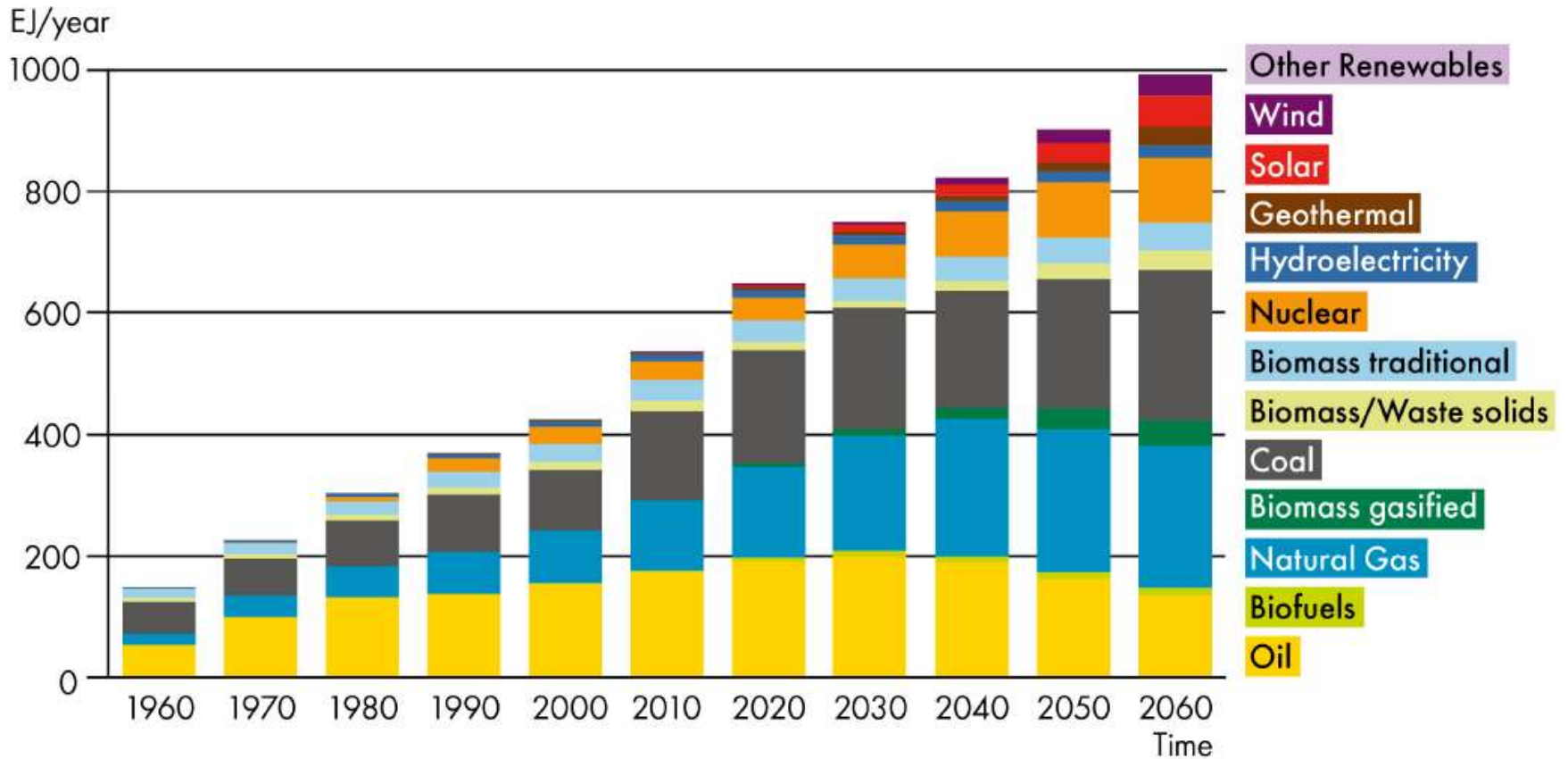
- New consumer values – „Mobility on Demand“. Which factors drive social acceptance & the resulting uptake of new fuel/powertrain solutions?

# ENERGY RESOURCES ARE ABUNDANT



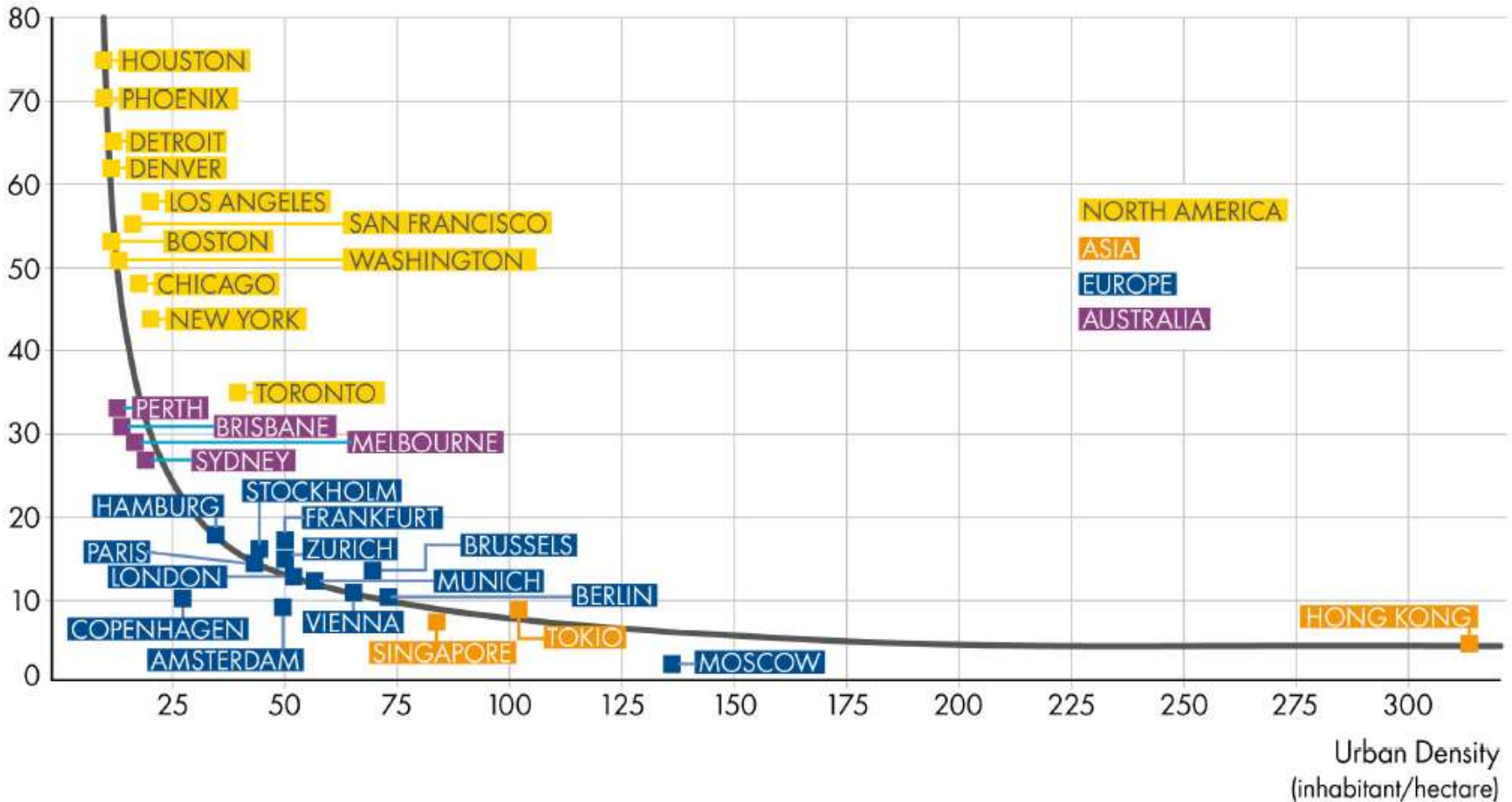
Source: National Petroleum Council, 2007 after Craig, Cunningham and Saigo

# TOTAL PRIMARY ENERGY DEMAND FORECAST FROM SHELL ENERGY SCENARIOS

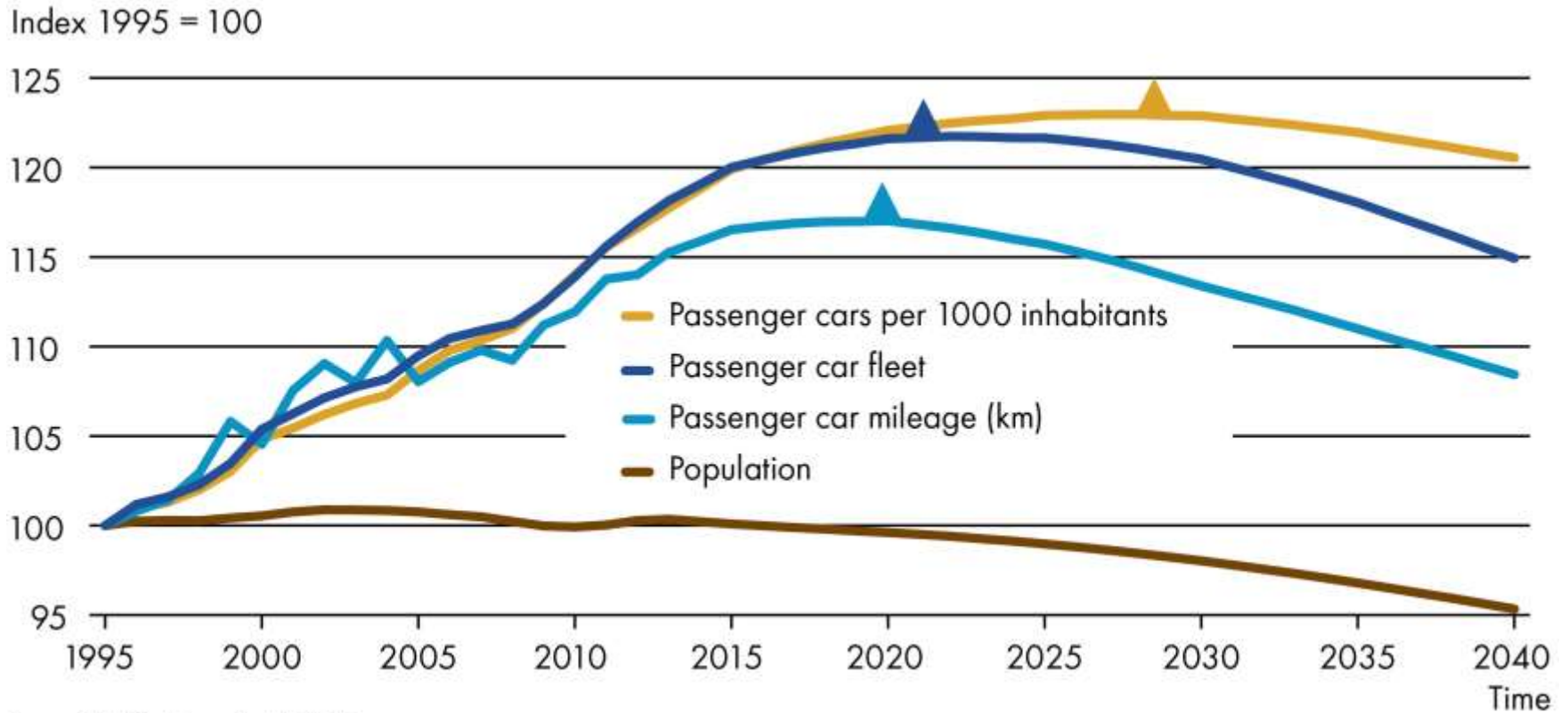


# OVERVIEW OF THE IMPACT OF URBAN DENSITY ON TRANSPORT

Transport-related Energy Consumption  
(Gigajoules per capita per year)

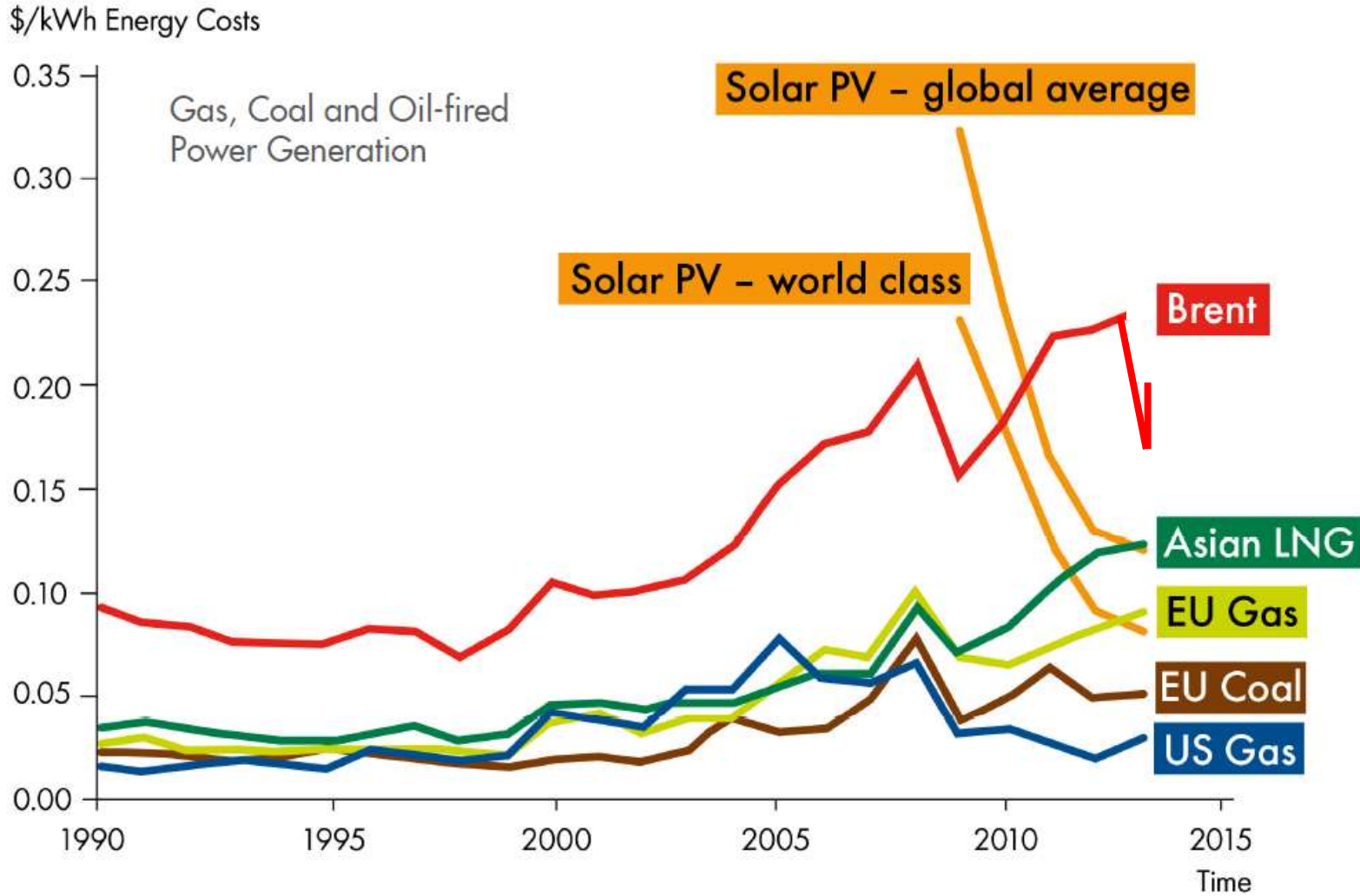


# PEAK CAR INDICES FOR GERMANY



Source: Shell Pkw-Szenarien bis 2040

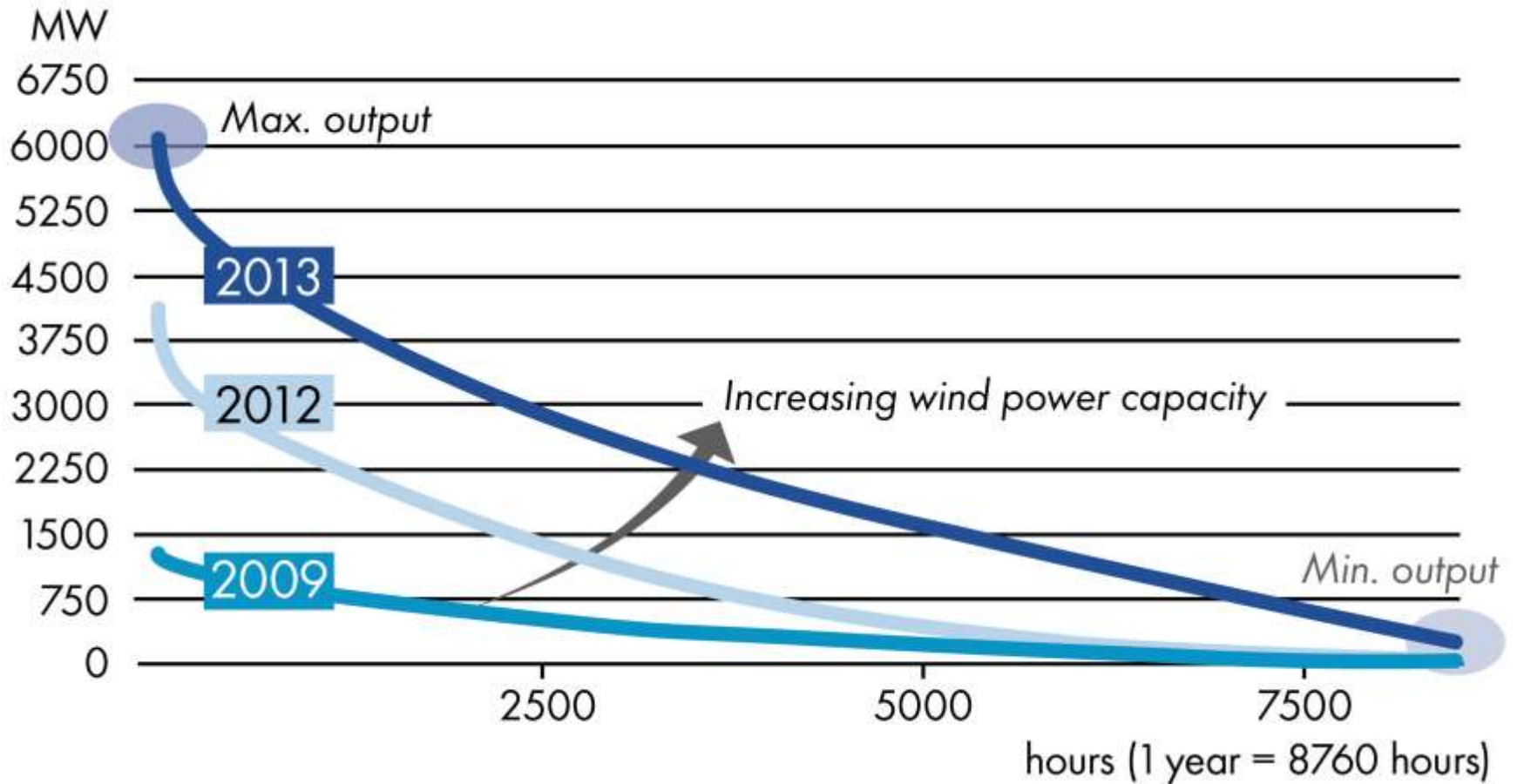
# COSTS OF SOLAR PV VS. FOSSIL FUEL COSTS





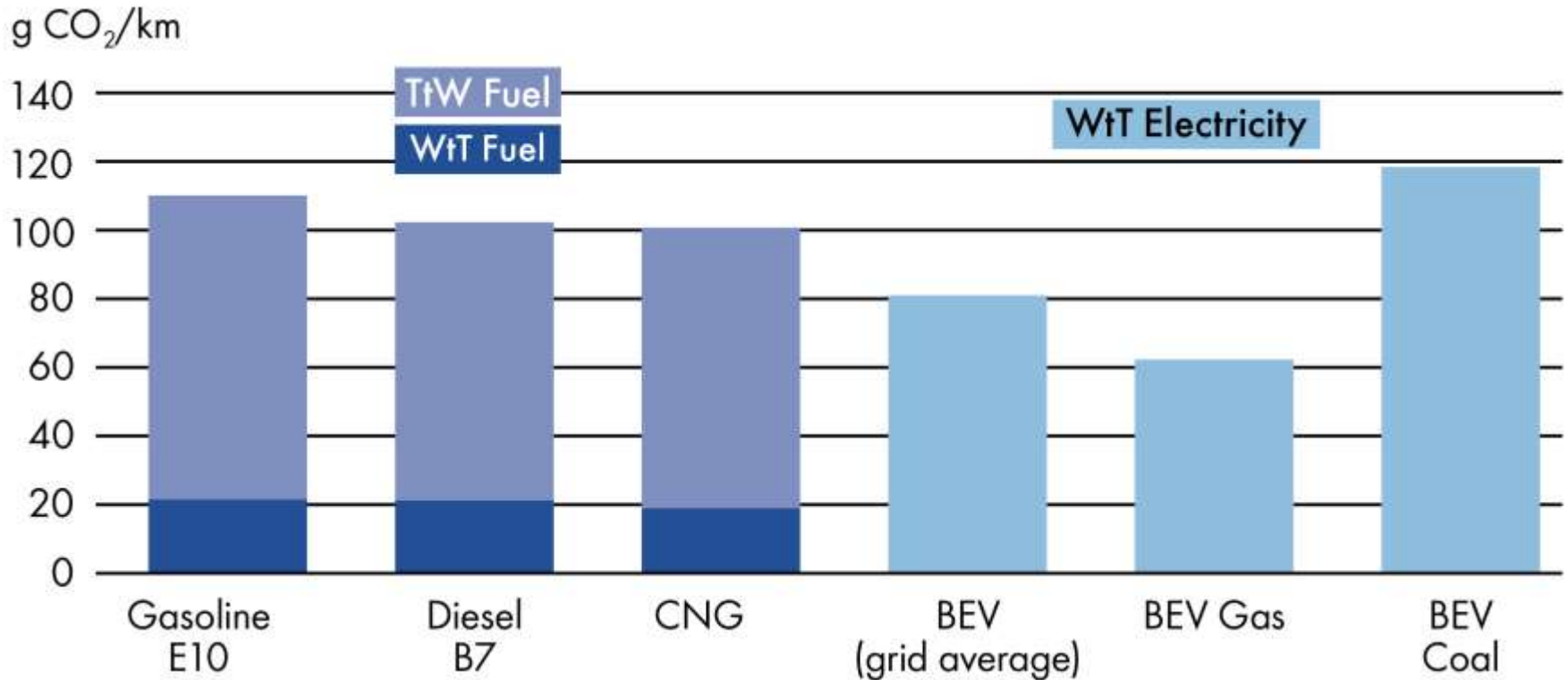
# EVOLUTION OF WIND POWER IN THE UK SINCE 2009

Showing Full Year Data for each Year from Maximum to Minimum Output



# WTW CO<sub>2</sub> EMISSIONS OF ELECTRIC VEHICLES

With average Grid Power & Power from Gas or Coal



**BEV WtW CO<sub>2</sub> can be really competitive only using Renewable Electricity**

# THE FUTURE ENERGY STAIR CASE



**Highest energy utilization**  
**Lowest production costs**  
**Smallest production footprint**

**Photons**  
**0\$/GJ**

TO END-USER

- Heating
- Lighting

**Electrons**  
**~ 10 \$/GJ**  
 ~ 3.5 ct/kWh

TO END-USER

- Power
- Cooking
- Heating/Cooling
- Personal mobility
- Rail

**Hydrogen**  
**~ 20 \$/GJ**  
 ~ 2.4 \$/kg

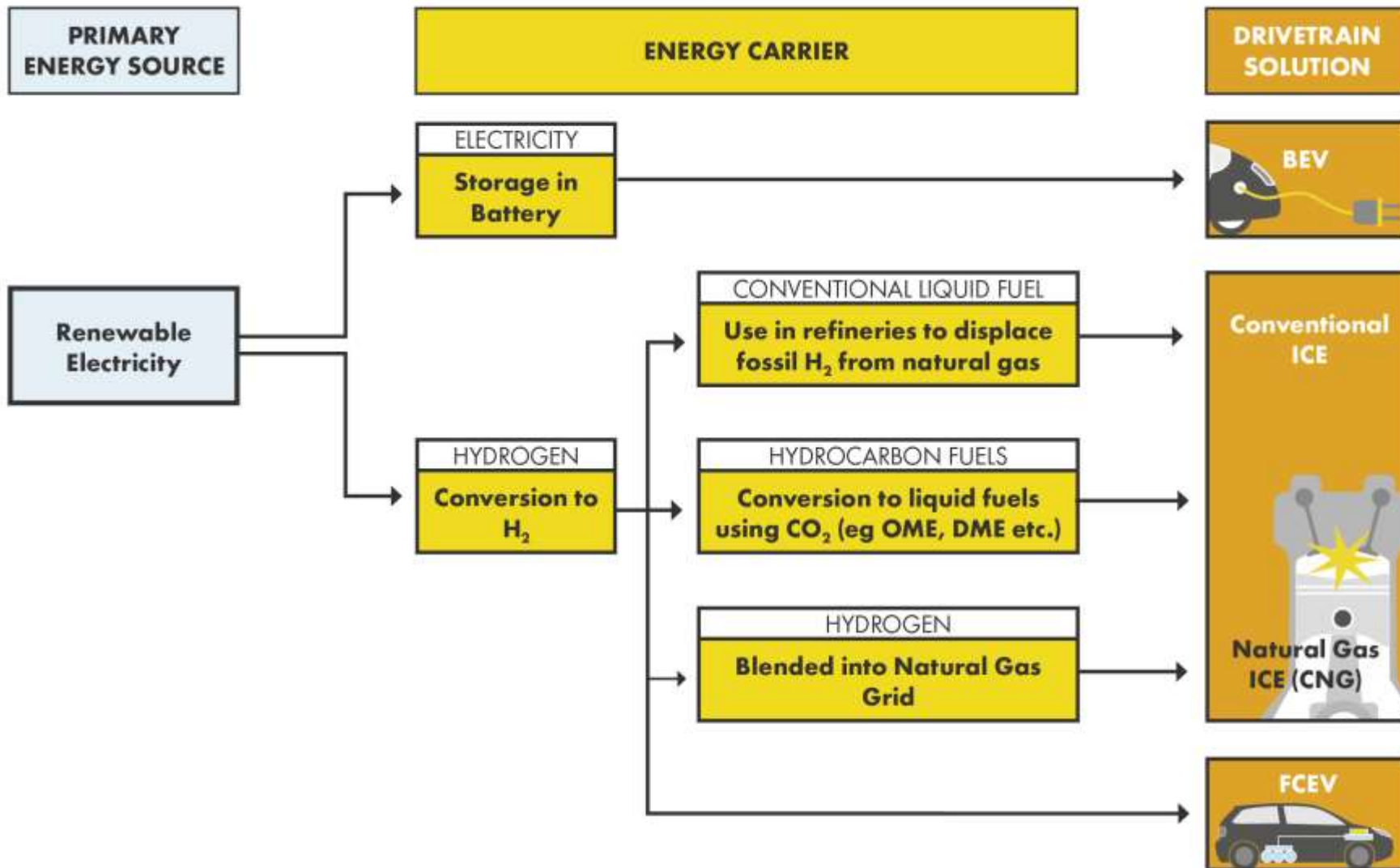
TO END-USER

- Personal mobility
- Heavy transport
- Industrial heat
- Power
- Rail
- Cooking
- Heating/Cooling

**Highest product utility**  
**Lowest handling costs**  
**Most compact use**

**Hydrocarbons**  
**~ 40 \$/GJ**  
 ~ 1.25 \$/l

# POTENTIAL ROUTES FOR USE OF ELECTRICITY FOR MOBILITY APPLICATIONS



# SPECIFIC CO<sub>2</sub> EMISSIONS PER KM FOR ICE AND HYDROGEN TECHNOLOGIES

