Hybrid Vehicles and Electric Mobility Potential Utilization

Implications for the Transportation Policies

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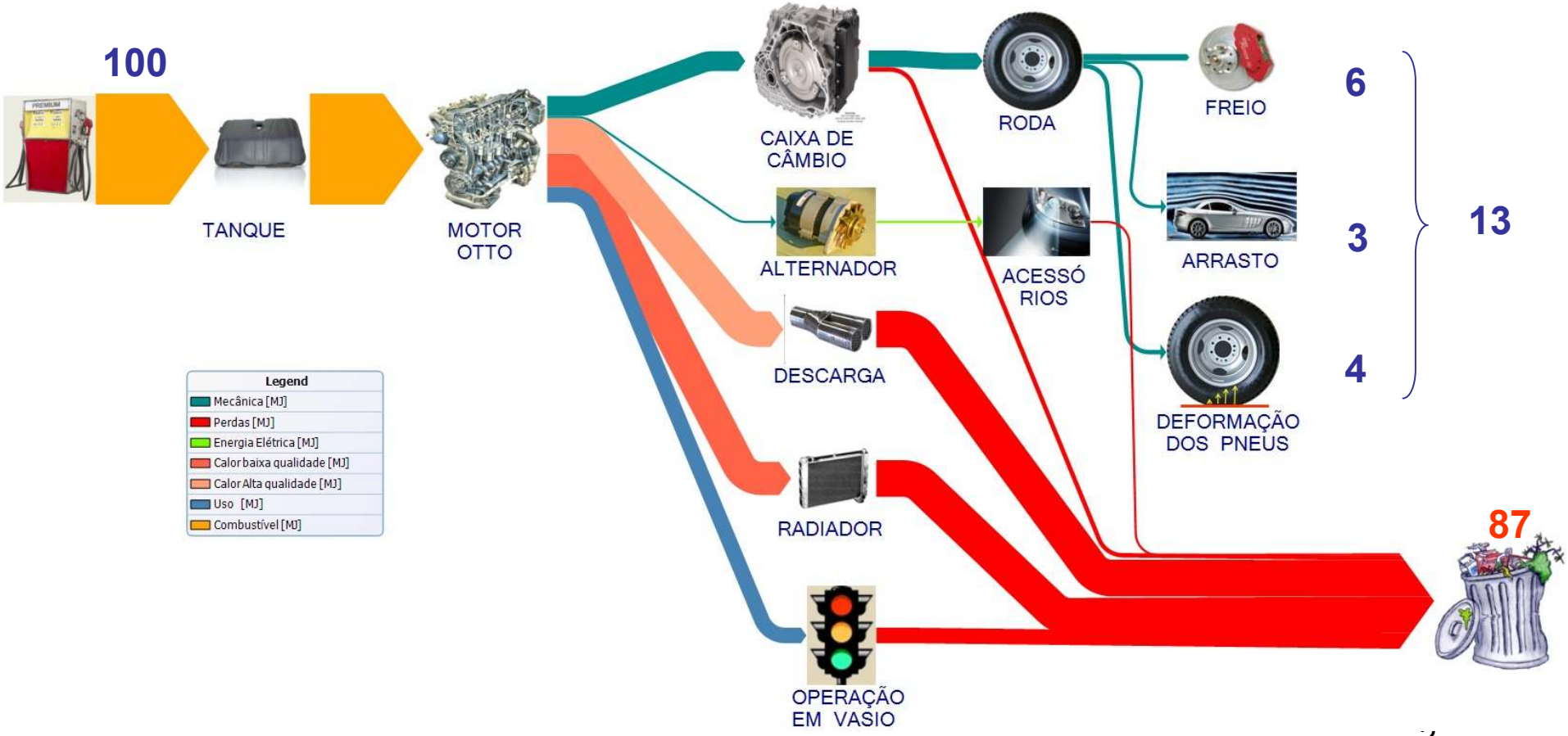
Energy Flow in a Car

EUA/DOE



Eletric Vehicles

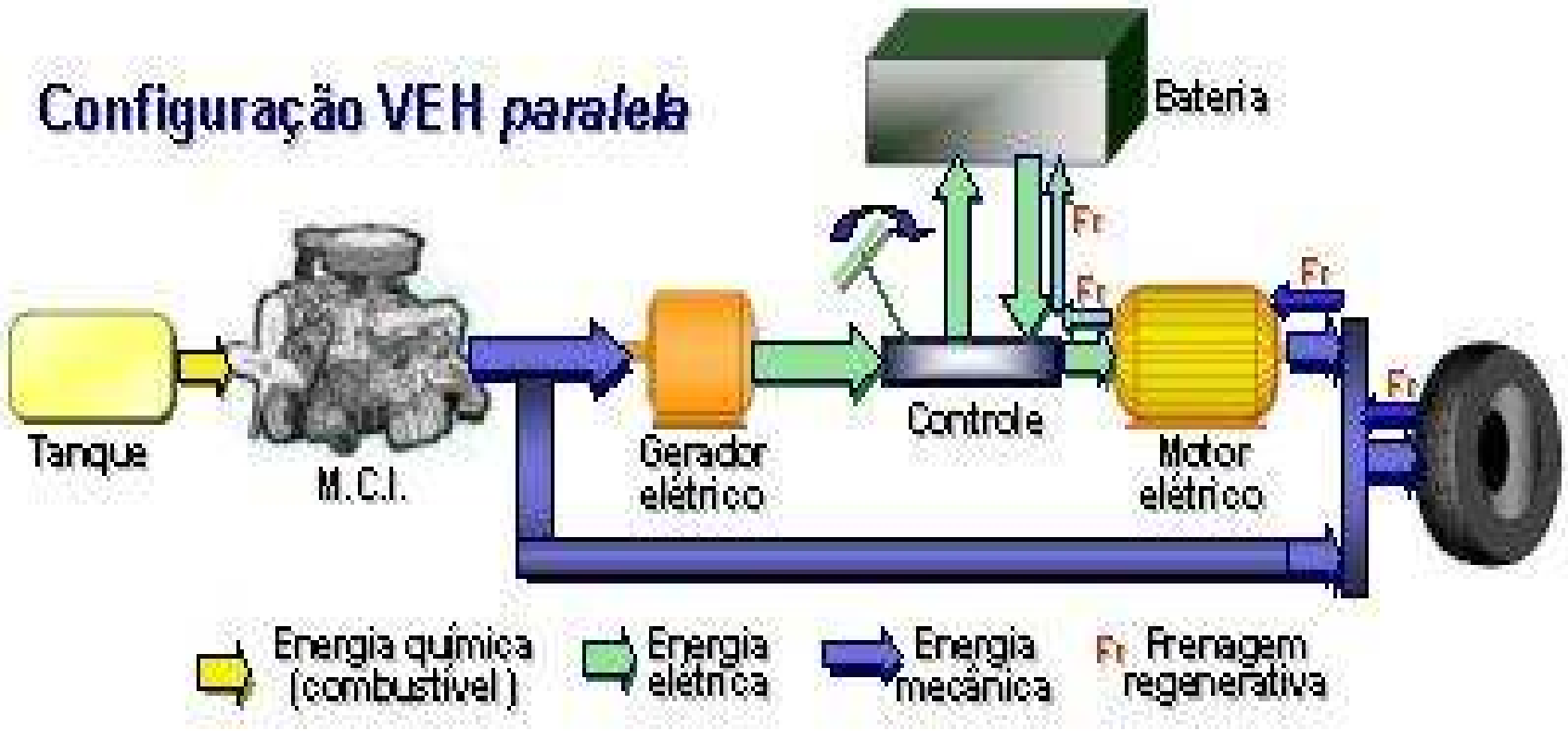
- Wheels are driven by an electric motor: high efficiency
- Regenerative breaking: more advantageous in congested traffic

Hybrids

- Electricity generated on board
- Generator is driven by a ICM or turbine or is a fuel cell
- Battery operates as a flywheel

HEV: Series Configuration

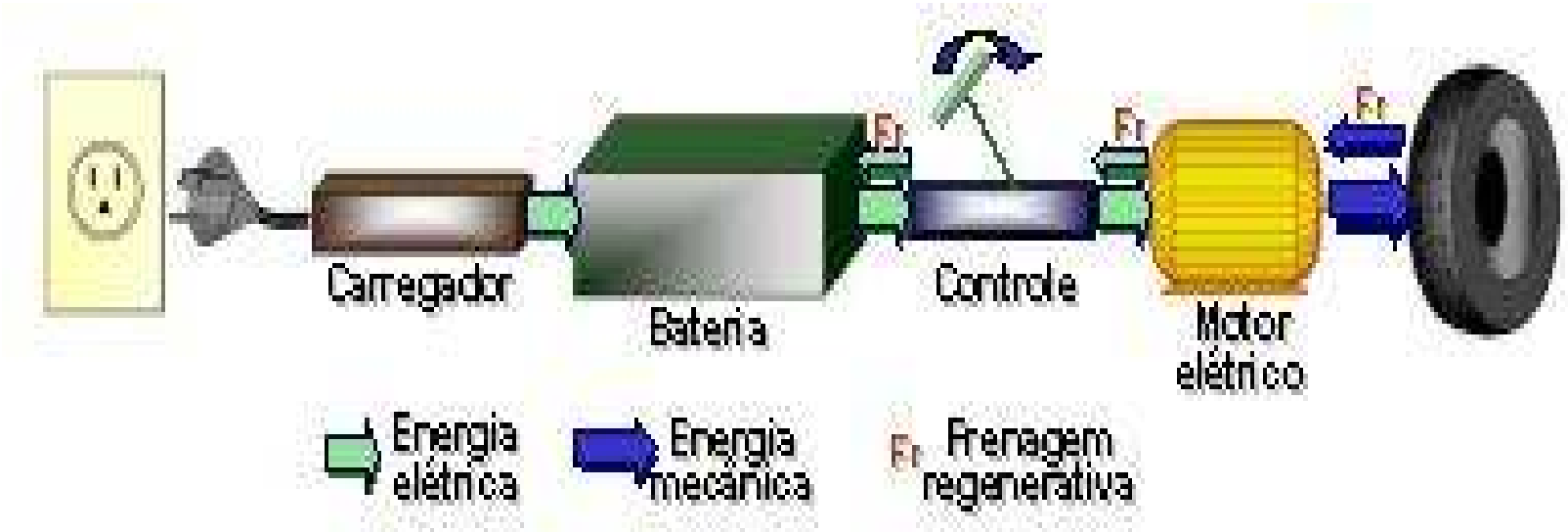
HEV: Parallel Configuration



PHEV - Plug-in Hybrid Electric Vehicle

BEV with extended autonomy

BEV - Battery Electric Vehicle



HEV - Operational Features

- ICM: maximum efficiency rotation speed
- When starting: only the battery provides energy
- ICM: operates only when required
- 30% less fuel per km
- 90% less particulate material
- 65% less NOx
- 85% less CO
- 90% less hidrocarbonetos
- 3 db less

VEB - Aspectos Operacionais

- Maior eficiência energética do que o VEH
- Menor custo por km
- Elevado custo inicial (bateria + SGB)
- Menor autonomia do que o VEH
- Tempo de carregamento da bateria
- Requer pontos de carregamento
- Aplicação favorável: veículos de duas rodas e veículos pesados - baterias de chumbo

EV - Evolution Tendencies

- Lower battery cost and weight
- Scale economies
- PHEV substitute HEV
- Wider application of BEV
- Utilization of capacitors instead of batteries for fixed route
- BEV: predominantly urban, small personal use vehicles, vehicles sharing.
- Large EV: locomotives, ships, out of the road trucks

EV –Demand Drivers

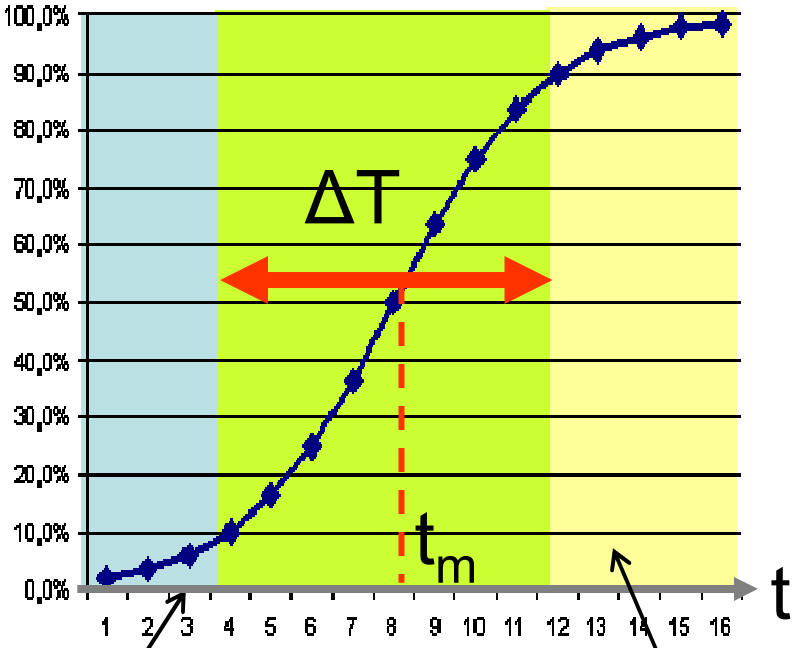
- **Upfront Price**
  Technological development
  Production scale
  Taxes and incentives
- **Autonomy Range**
  Battery caharge capacity and recharge time
  Recharge points availability
- **Utilization Cost**
  Fuel x electricity prices
  Emissions reduction valorization
  Vehicles performance

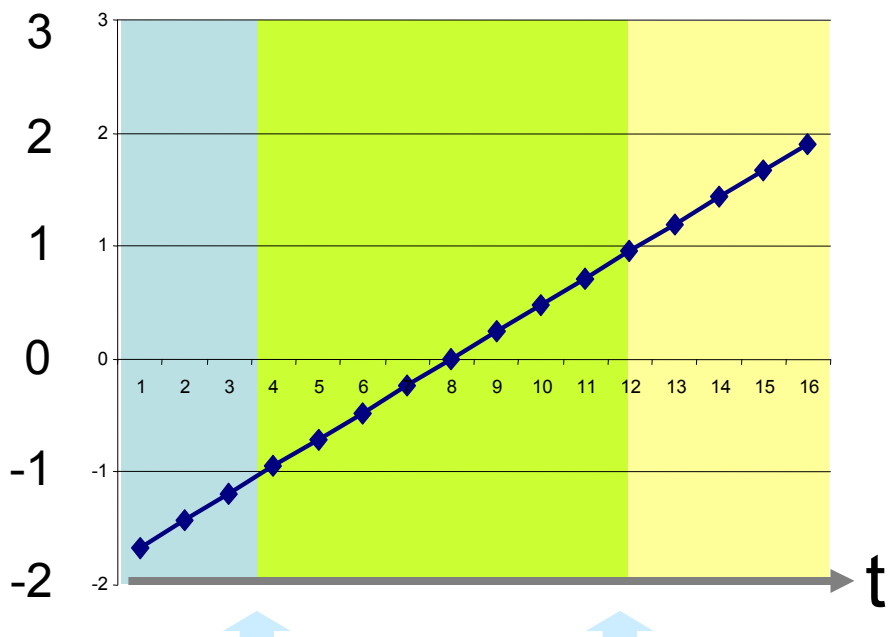
Market Penetration
logístic curve

$$F(t) = \frac{1}{1 + exp\left[-\frac{ln(81)}{\Delta t}(t - t_m)\right]}$$

Fischer-Pry

$$log_{10}\left(\frac{F(t)}{1 - F(t)}\right)$$





Taxa alta
Total peq

Satu-
ração

10%

90%

Automobiles and Light Commercial Vehicles
% Annual Sales in Brazil
ABVE

Year	HEV	PHEV	BEV
2020	13	14	3
2025	18	22	10
2030	12	34	20

EV - Utilization Policies Should Consider

- **Advantages:**
  - Reduction of the utilization fuels and of emissions
  - Greater utilization of renewable energies
  - Smart grids valorization
- **Incentives for:**
  - Utilization of EV for intensive urban uses (environmental improvement)
  - Technological and industrial development
  - Substitution of ethanol for diesel in HEV

Measures for EV Diffusion

- **Fiscal**: reduce IPI (industrial products tax) of automobiles and other light weight EV, reduce ICMS and IPVA (sales and road tax) for automobiles according to their mpg and size
- **Battery charging**: expand network, standardize connections, incentivate off peak charging, battery swapping
- Support to power utilities to help charging points expansion

VE and Transportation Policy I

- Priority for electric drive trains: high torque, high efficiencyand reduced emissons
- Eletrification of transports (freight and passengers) network supply and hybrids
- Improvement of road infrastructure
- Priority for urban, intensive use EV (taxis, busses, etc.): financial and traffic advantages
- Vehicles sharing
- Expansion of bicicle lanes

VE and Transportation Policy II

- Differentiated fiscal burden: according to efficiency and size
- Emissions control and incentive to obsolete vehicles disposal (junking)
- Energy pricing compatible to respective production and utilization costs
- Charging negative externalities in order to finance transports racionalization

Thanks for Your Attention !