Urban Mobility Solutions

An EV Perspective

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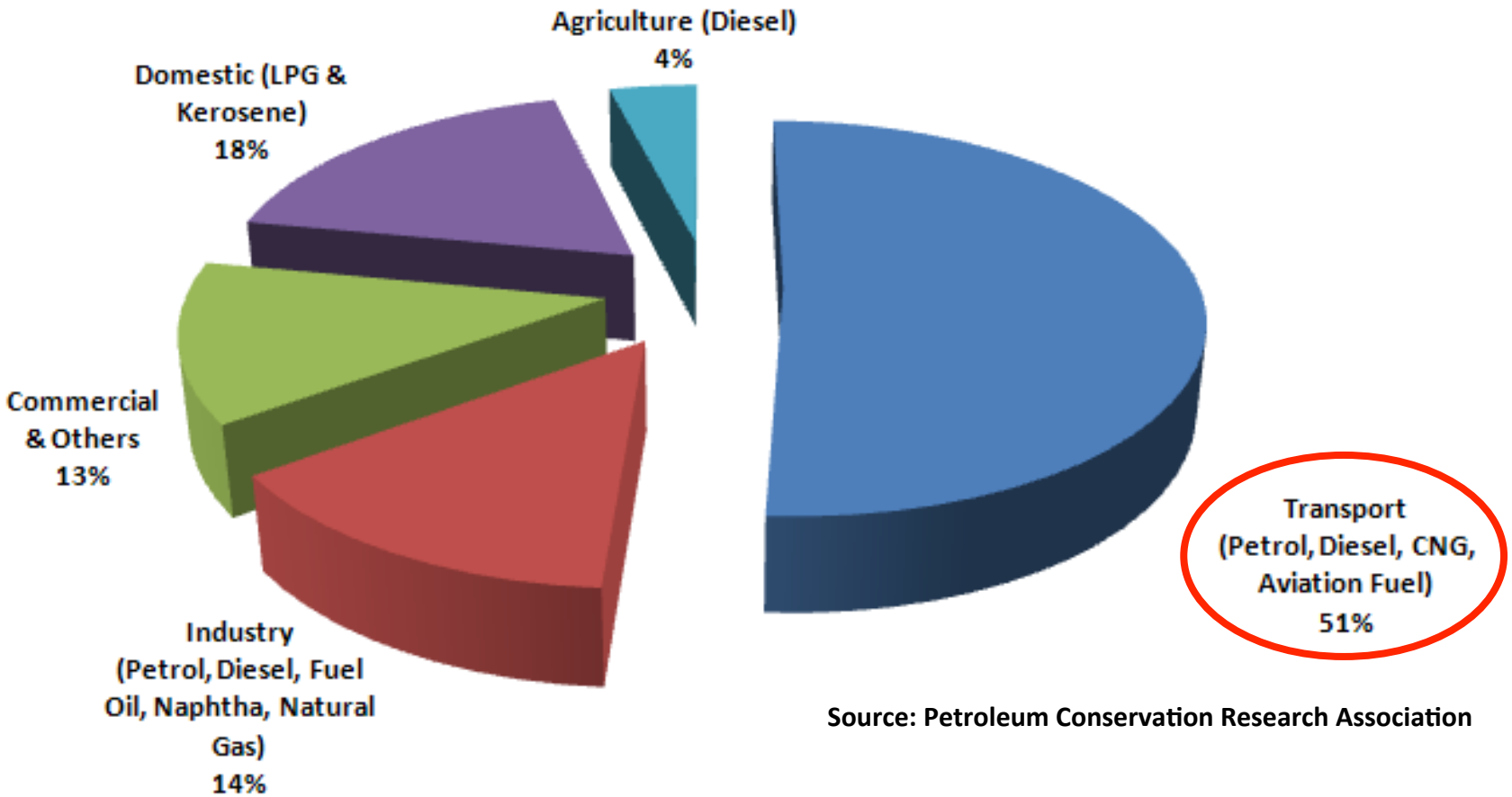
Overview

- Mobility Context today
- Reimagining the paradigm

India's Greatest Polluter

Transportation comprises 51% of pollution in India, and in urban areas, 75-80%!



Source: Petroleum Conservation Research Association

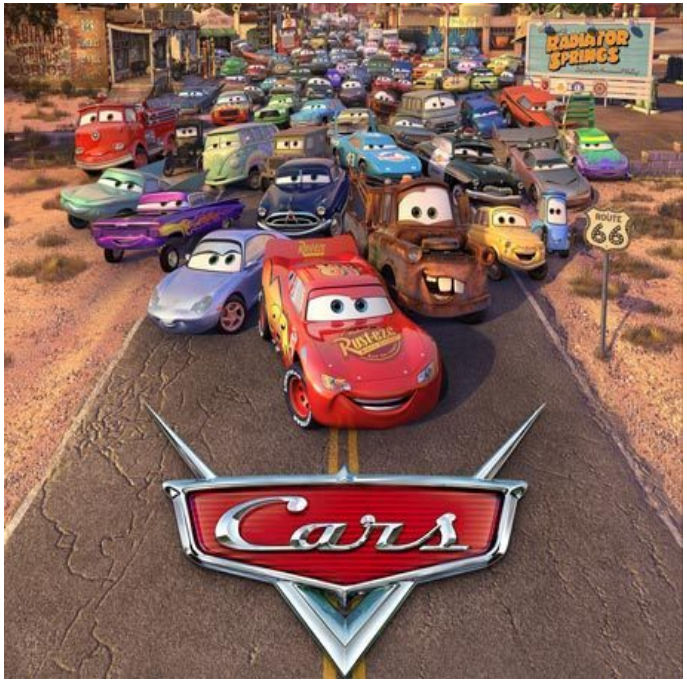
Some truths about cars...

90% of rides <60 kms

Mostly 1-2 person occupancy

Unrestricted freedom of Movement

Segmented by Size & Specs not by usage



Personal Asset Quality

Every car designed to do everything

Lifetime Opex > 2X Capex

Car-as-a-Product

Public "v/s" Private Transportation

- Seen as largely non-overlapping segments

Private Transportation

- Freedom of movement -> In 'space' and 'time'
- Aspirational, product based
- Largely hydrocarbon fuelled (today)

Public Transportation

- Circumscribed freedom of movement
- Utilitarian and system based
- Mix of electric and Hydrocarbon fuels

Public/Private Dichotomy Consequences

Engenders inefficiencies at the ***system*** level in transportation :

- Capital inefficiencies
- Energy inefficiencies
- Space inefficiencies

Key Question:

Is there a better approach to reconciling public and private transportation that addresses some of these inefficiencies?

Conjecture

A new paradigm of transportation is possible by-

- Rethinking vehicle design & manufacturing
  - To address capital inefficiencies
- Rethinking the ecosystem
  - To address energy inefficiencies
- Rethinking ownership
  - To address space inefficiencies

VEHICLE DESIGN & MANUFACTURING

Segment by Usage Instead of Specs

- Enables size and spec optimizations
- Urban commutes need vehicles that are:
  - Small
  - Energy efficient
  - Manoeuvrable
  - Connected

Getting the 'fuel mix' right

	Electric Vehicles	Fuel Cell	Hybrid EV	LPG/CNG	Petrol	Diesel
Air Pollution	Zero	Zero	Medium	Medium	High	High
Noise Pollution	Low	Low	Medium	Medium	Medium	High
Infrastructure Availability	Good	Poor	Excellent	Poor	Excellent	Excellent
Safety	Good	Medium	Good	Poor (Local Conversion)	Good	Good
Life Cycle Cost	Low	Very High	High	Low	Medium	Medium
Vehicle Degradation	Low	Medium	High	Medium	High	High
Economic Resource Sustainability	Excellent	Excellent	Medium	Poor	Poor	Poor
Uses	Urban	Inter City	Inter City	Inter City	Inter City	Inter City

The EV Design Paradigm

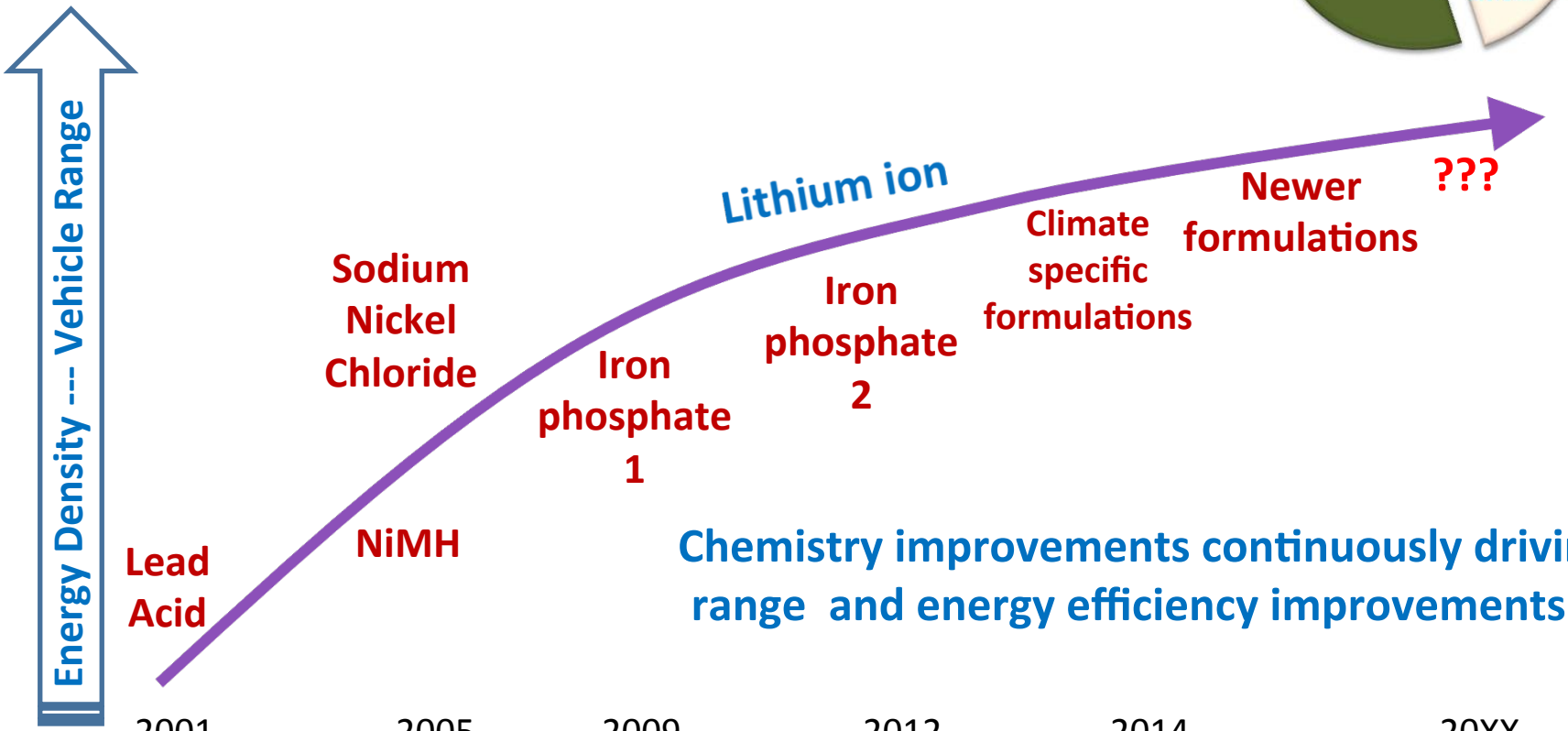
Design focussed on urban commuting

- *Small*
- *Lightweight*
- *Energy efficient*
- *Easy-to-drive, highly manoeuvrable*
- *Connected*

Light-weighting

- *Space-Frame chassis*
- *Thermoformed plastic body panels*
- *High safety levels*

Improved Battery Technologies



Chemistry improvements continuously driving range and energy efficiency improvements....

2001

2005

2009

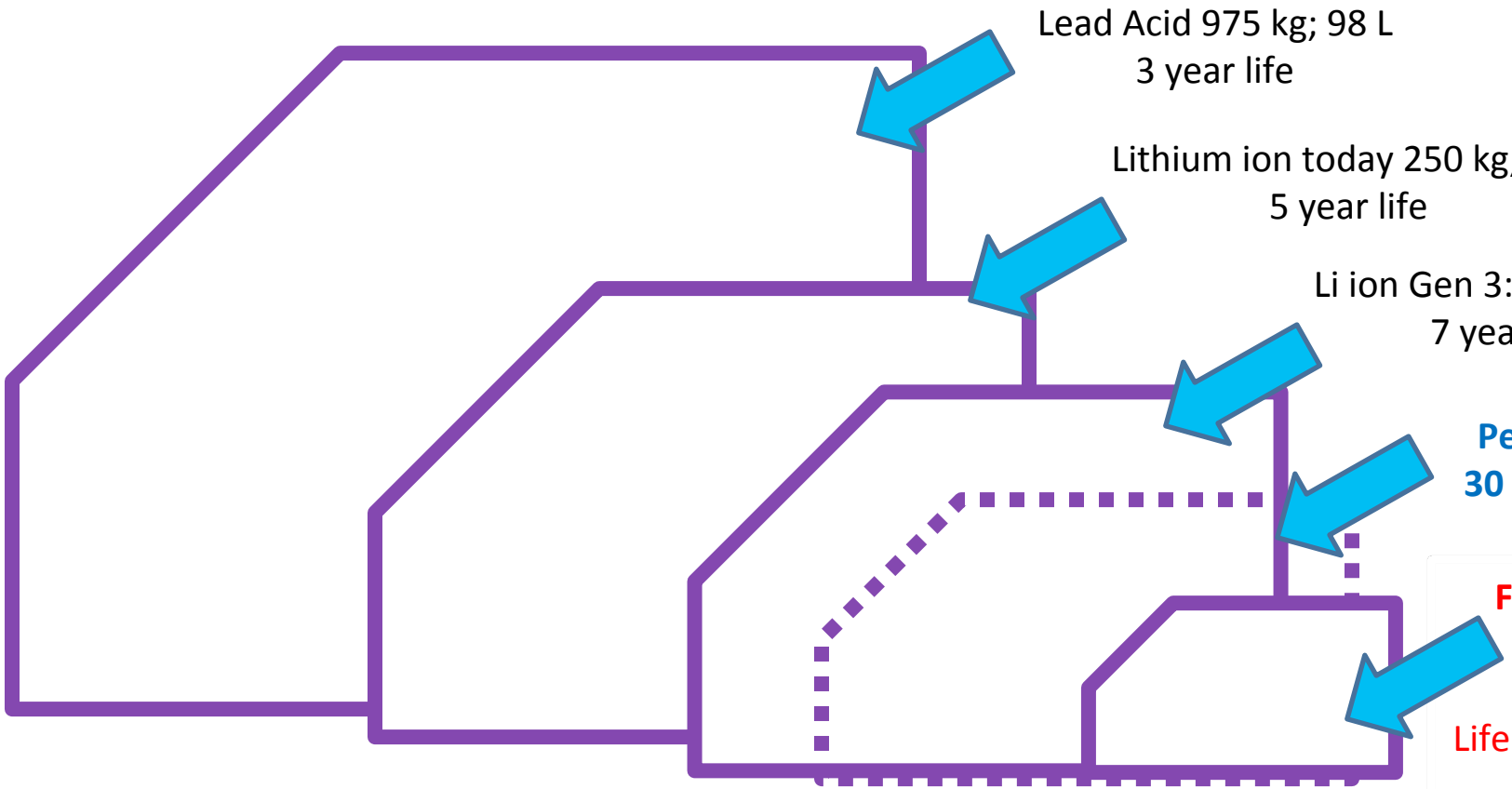
2012

2014

20XX

The Shrinking Tank

Battery size for 300 km range



Future Battery
2020
Min 20 years
Life , at a fraction
of size / cost;
rapid recharge

Localized, 'Green', Low-volume Manufacturing

Solar charging

Solar water heating

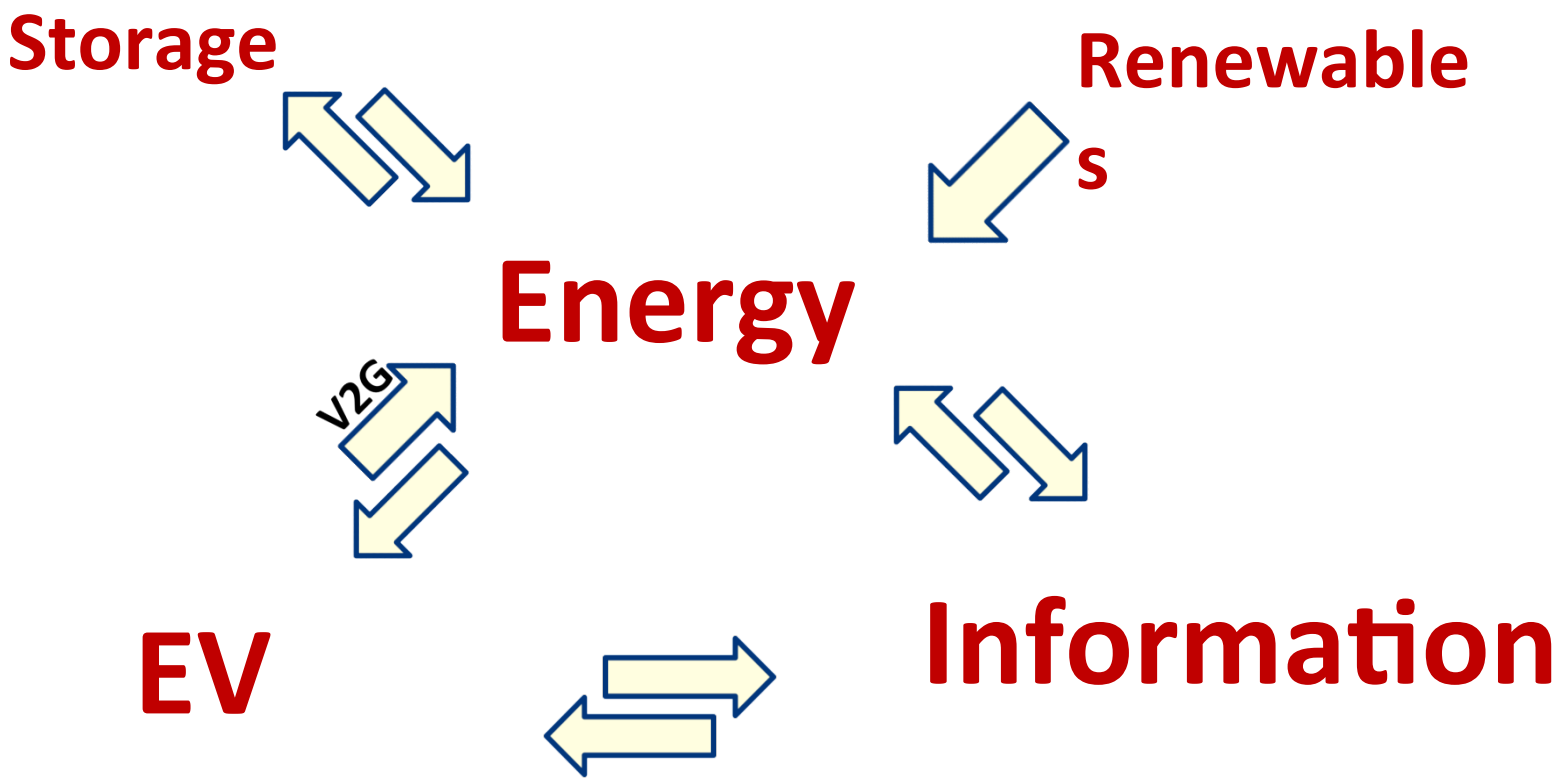
Rain water harvesting

Natural ventilation & lighting

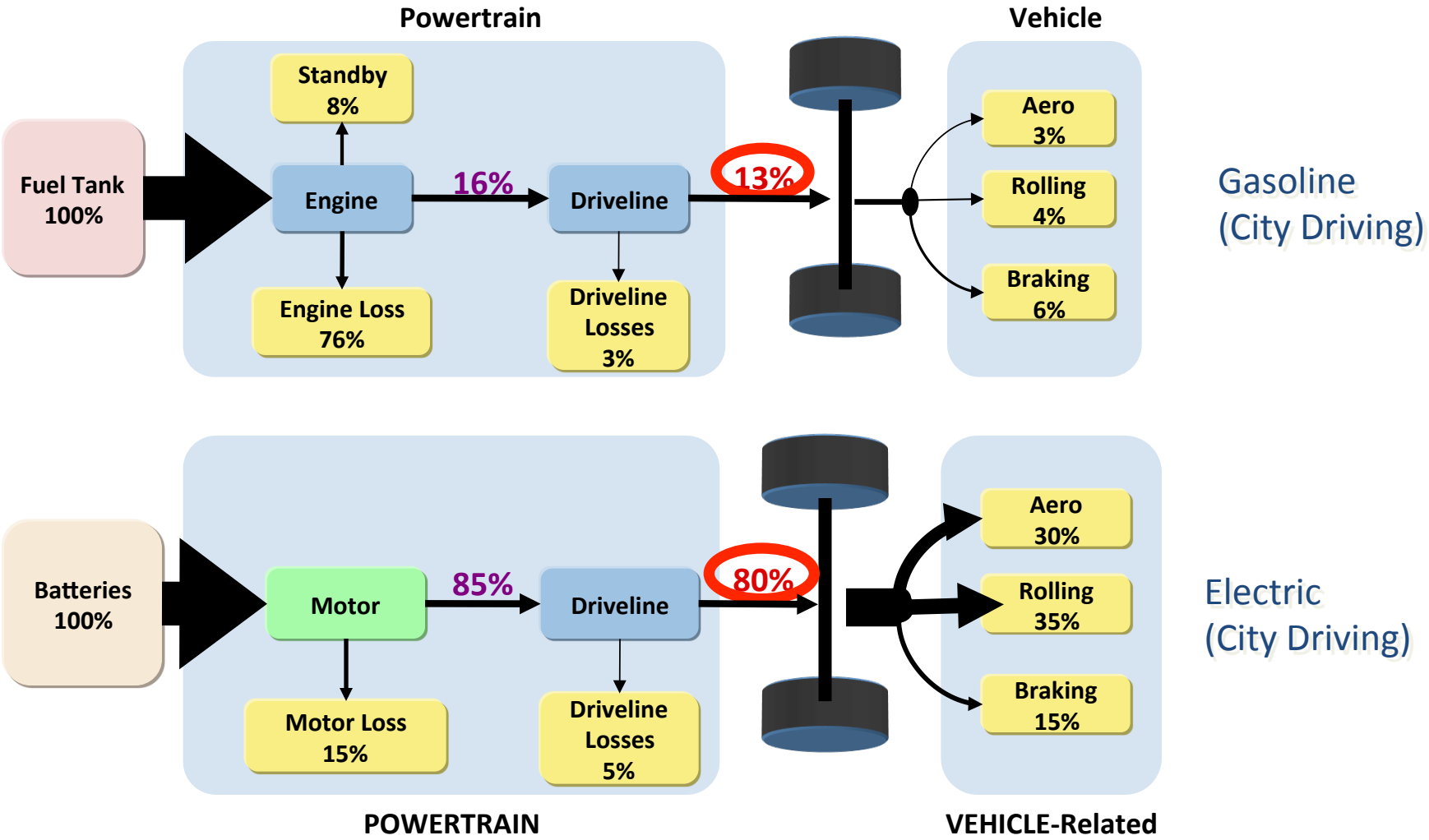
- New plant with annual capacity of 30,000 cars
- Expecting an IGBC 'Platinum' rated

ECOSYSTEM DESIGN

The EV Ecosystem

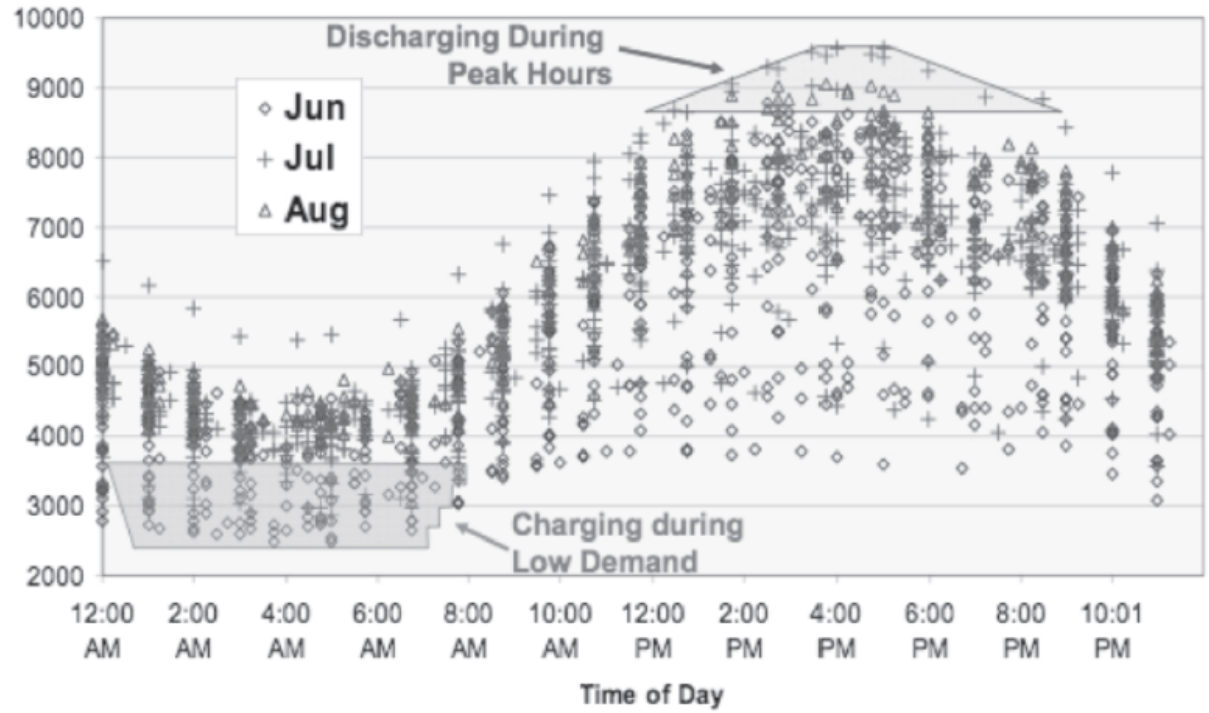


6x higher tank-to-wheel efficiency than petrol/diesel



Source: MIT Electric Vehicle Team

Capital Inefficiencies in Energy Generation



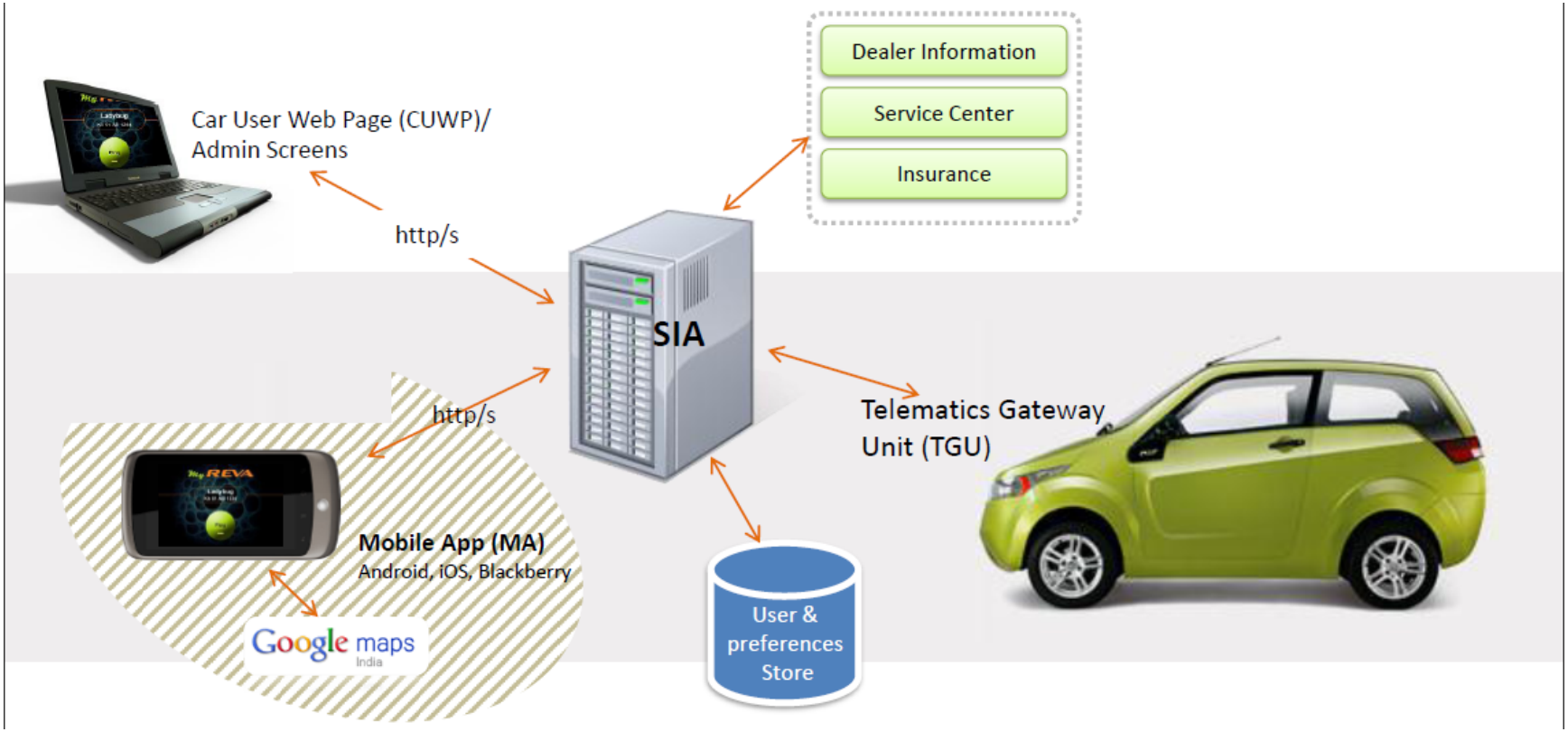
EPRI 2008

- **Off-peak power is approx. 50% of peak power.**
- **Off-peak power is sufficient to charge >1 Million 4W-BEV!!!**

Redressing this capital inefficiency with EV's

- Charge EV's during off-peak hours
  - Results in better capacity utilization of power plants
- With integration into a "Smart Grid", EV's enable following services:
  - Smart Charging (i.e. Stagger the charging of multiple vehicles so as not to overload distribution network)
  - Vehicle-To-Grid to ***supply*** energy to grid to meet peak demand -> "Peak Shaving" -> further reduction in capital investment for peak power demand.
  - Energy storage for wind and other intermittent energy storage
- Increased integration with telematics systems a key to enabling these gains

Enabling the 'Connected Car'



Note: SIA stands for "Server Infrastructure and Applications"

Role of the 'Connected Car' in Transportation

- Traffic Management
- Safety
- Demand management for shared vehicle usage schemes e.g. 'self-drive car rental by the hour'.
- Energy management for –
  - charging demand management
  - V2G services ('peak shaving')
- User centric services

Telematics based user-centric features

An application that enables monitoring, control & access to vehicles, energy & information thereof.

Access to other car systems, where user can configure and monitor the status.

User can assess the cabin environment and remotely switch on the climate control

User can check the power reserve, and range available & control V2G profiles

A map assisted utility, which helps user book a car

Solar Charging

- Only battery EV's capable of totally 0-emission transportation
- 3x3m panel can give 15,000 km / year
- With increased efficiencies, the same size panel will soon produce enough energy to **drive free for life**, or even make money by **selling back to the grid**

New Alliances

Vehicle maker need alliances in this new ecosystem:

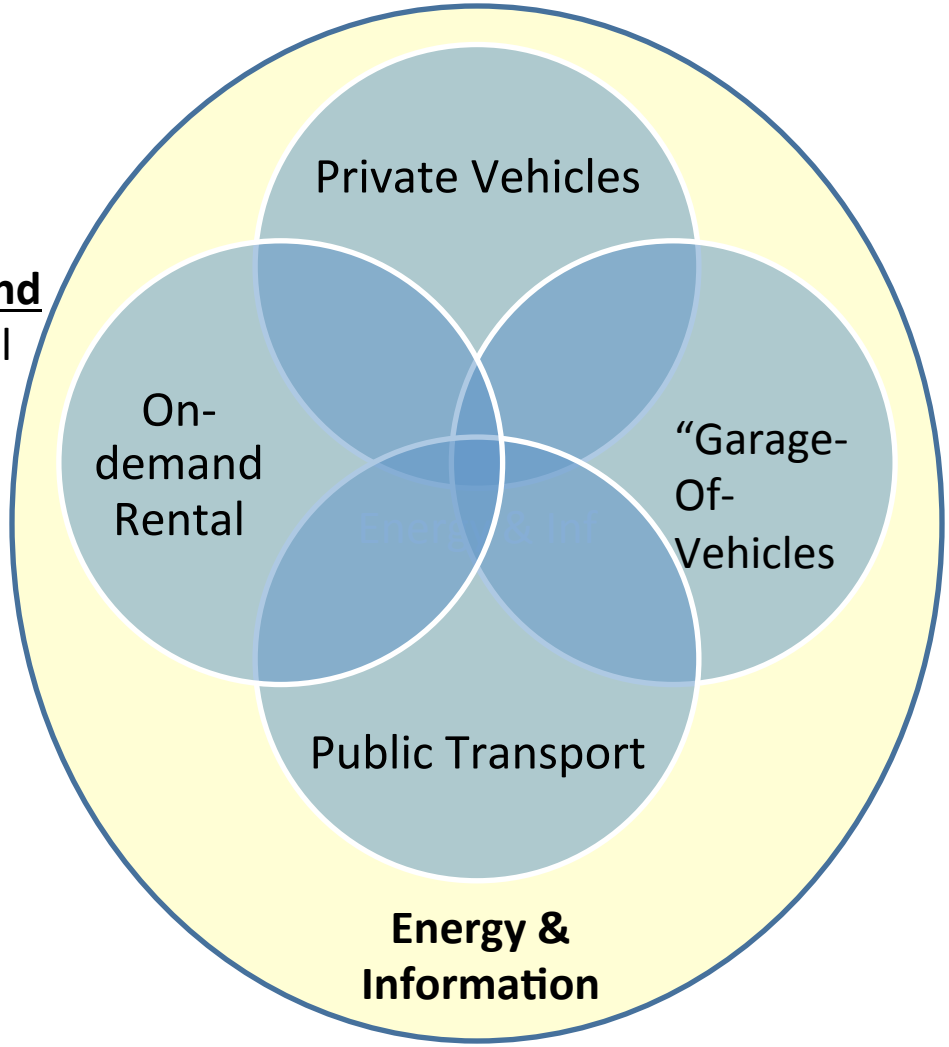
- Wireless carriers
- Energy utilities
- Energy Storage
- IT companies, data-centres
- Public transport systems...

SOLUTION DESIGN

Enabling 'Seamless Mobility'

Vehicles On-demand

- 'Zipcar' like model
- EV based
- Small-sized for urban commutes



"Garage-of-Vehicles

- Could include 2-W, 4-W, bicycles, etc.
- Not necessarily EV based but 'Right-sized' vehicles

Solution Components

- *Access* to a 'garage-of-vehicles' available on demand
- Integration with public transportation systems
- Energy Integration:
  - Grid integration via 'Smart Grid' technologies
  - Integration with renewable energies
- Information Integration:
  - A real-time vehicle, traffic and energy demand-response management information system.

Ownership -> Access

- A new paradigm can be built around ‘Access’ which does not preclude ‘ownership’
- Enables collective system efficiencies to rise
- The challenge is not in the system but in the minds of consumers
  - Can customers be incentivized to trade-off Ownership with Access?

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Thank You

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BACK-UP

The Reva Approach

- Segment the market by commuting characteristics:
  - target the intra-city commutes i.e. >90% of all commutes!
  - target the 1 or 2 person rides
- Build cars optimized for city-driving
- Deliver a low TCO solution
- Add innovative features to alleviate range anxiety
- Provide a genuine economic value proposition to a very targeted market segment
  - Not a car to just satisfy 'green guilt'
- Make EV's affordable
  - Our reason to exist

BORN GREEN

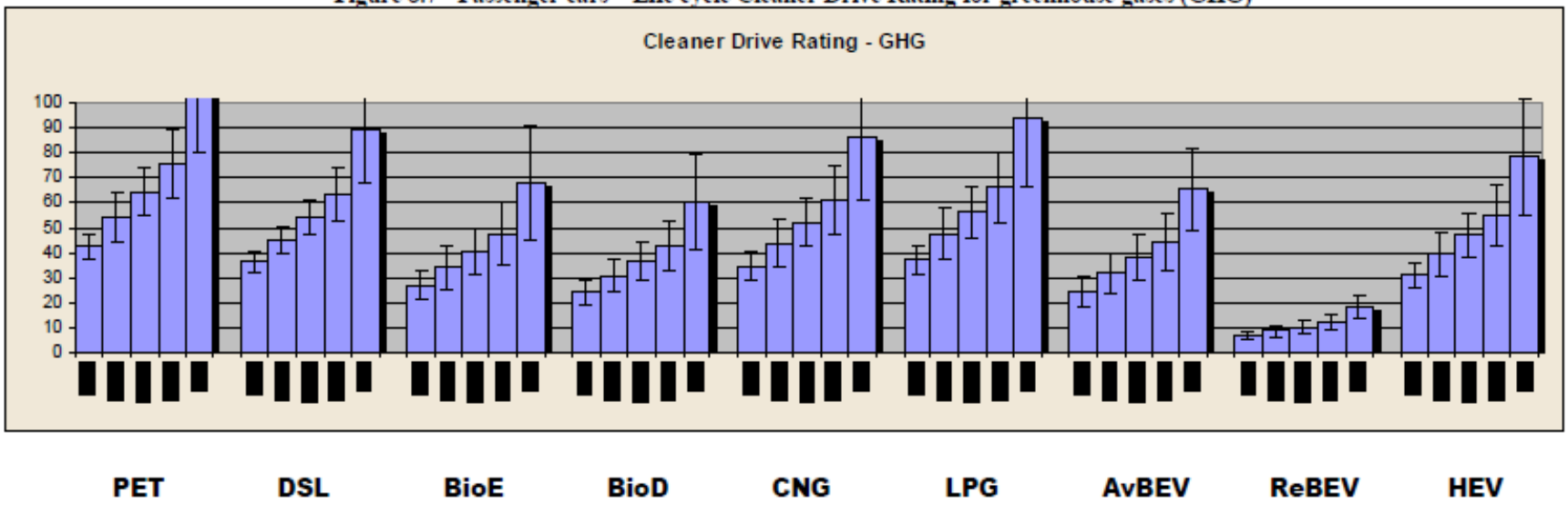
ICE v/s EV's

ICE	(MREVA) EV
Segmented by tech specs	Segmented by usage model
Overengineered: every car can do everything	Engineered 'just right' for usage
Needs mainstream markets, high volumes	Niches and fringes OK
Automated manufacturing	Not necessary at lower volumes
Car-As-A-Product	Apt for "Commuting-As-A-Service"

BORN GREEN

Life Cycle Emissions

Figure 8.7 - Passenger cars – Life cycle Cleaner Drive Rating for greenhouse gases (GHG)



Overall Life cycle drive rating for Evs are the lowest

Av-BEV (means average EV emission using a mix of energy generation)
Re-BEV (means EV emissions from renewables)

Source: Life cycle emission assessment of fuels and technologies – Dr. Ben Lane
For the London Bourgh of Camden

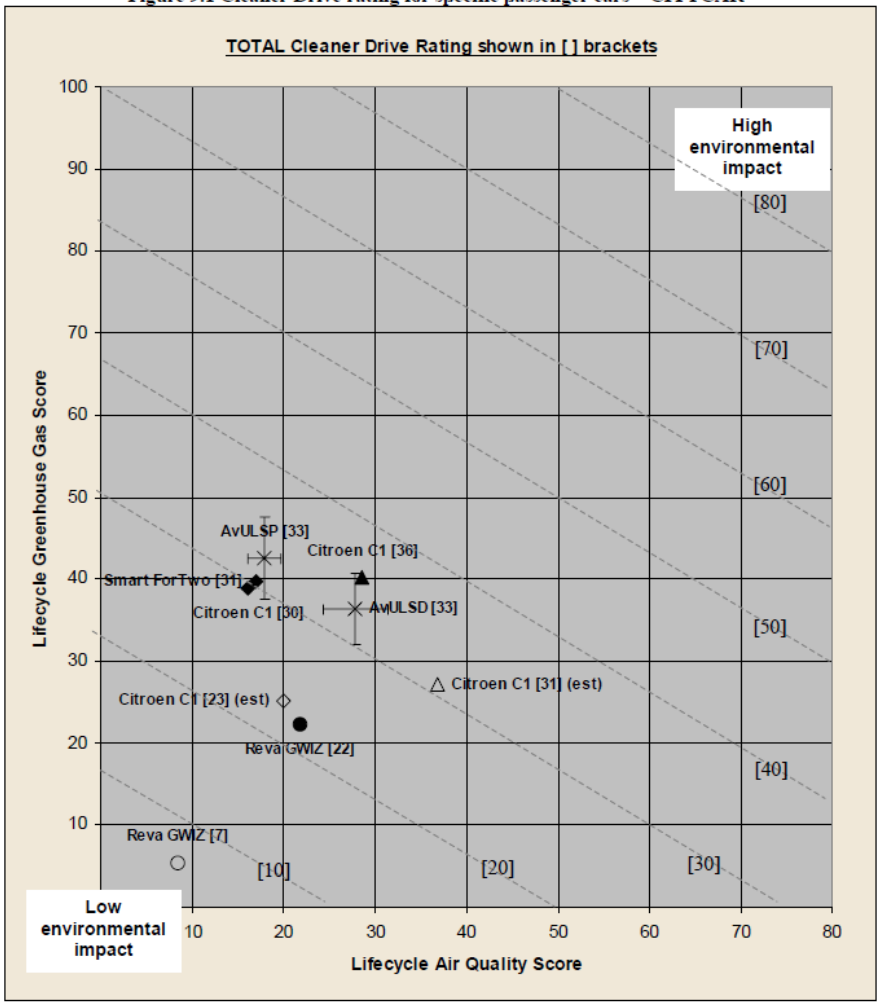
Emission comparison for small city vehicles in Europe

EV vehicles (Reva Gwiz) has the best clean rating even with a mix of energy generation

KEY TO SYMBOLS

- × Av. ULSP / ULSD
- ◆ ULSP Petrol
- ◇ E100 Bioethanol
- ▲ ULSD Diesel
- △ B100 Biodiesel
- ■ Bi-fuel LPG
- □ Bi-fuel CNG
- ● Average mix BEV
- ○ Renewable BEV

Figure 9.1 Cleaner Drive rating for specific passenger cars – CITYCAR



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