Urban Mobility Solutions

An EV Perspective
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Overview

• Mobility Context today
• Reimagining the paradigm
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
- Personal Asset Quality
- Lifetime Opex > 2X Capex
- Segmented by Size & Specs not by usage
- Every car designed to do everything
- 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
Segment by Usage Instead of Specs

- Enables size and spec optimizations
- Urban commutes need vehicles that are:
  - Small
  - Energy efficient
  - Manoeuvrable
  - Connected
<table>
<thead>
<tr>
<th></th>
<th>Electric Vehicles</th>
<th>Fuel Cell</th>
<th>Hybrid EV</th>
<th>LPG/CNG</th>
<th>Petrol</th>
<th>Diesel</th>
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<tbody>
<tr>
<td>Air Pollution</td>
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<td>Zero</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
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<tr>
<td>Noise Pollution</td>
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<tr>
<td>Infrastructure</td>
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<td>Poor</td>
<td>Excellent</td>
<td>Poor</td>
<td>Excellent</td>
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<tr>
<td>Availability</td>
<td></td>
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<tr>
<td>Safety</td>
<td>Good</td>
<td>Medium</td>
<td>Good</td>
<td>Poor (Local Conversion)</td>
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<td>Low</td>
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<td>Vehicle Degradation</td>
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<td>Medium</td>
<td>Poor</td>
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<tr>
<td>Sustainability</td>
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<td>Uses</td>
<td>Urban</td>
<td>Inter City</td>
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Getting the ‘fuel mix’ right
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....
The Shrinking Tank

Battery size for 300 km range

Lead Acid 975 kg; 98 L
3 year life

Lithium ion today 250 kg; 55L
5 year life

Li ion Gen 3: 210 kg; 40L
7 year life

Petrol tank
30 kg; 33 ltrs

Future Battery
2020
Min 20 years
Life, at a fraction
of size / cost;
rapid recharge
Localized, ‘Green’, Low-volume Manufacturing

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

- Solar charging
- Solar water heating
- Rain water harvesting
- Natural ventilation & lighting
ECOSYSTEM DESIGN
The EV Ecosystem

Storage

Renewables

Energy

V2G

EV

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

Source: MIT Electric Vehicle Team
"Capital Inefficiencies in Energy Generation"

- 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.

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

**On-demand Rental**

**Public Transport**

**Energy & Information**

**‘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?
Earth’s Favorite Electric Mobility Solutions Company
Driven by Consumer Insights, Ideas & Technology

Thank You

http://www.petrolfreeworld.com
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
## ICE v/s EV’s

<table>
<thead>
<tr>
<th>ICE</th>
<th>(MREVA) EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segmented by tech specs</td>
<td>Segmented by usage model</td>
</tr>
<tr>
<td>Overengineered: every car can do everything</td>
<td>Engineered 'just right' for usage</td>
</tr>
<tr>
<td>Needs mainstream markets, high volumes</td>
<td>Niches and fringes OK</td>
</tr>
<tr>
<td>Automated manufacturing</td>
<td>Not necessary at lower volumes</td>
</tr>
<tr>
<td>Car-As-A-Product</td>
<td>Apt for &quot;Commuting-As-A-Service&quot;</td>
</tr>
</tbody>
</table>
Life Cycle Emissions

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

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