Electrification and Modernisation of Transport

Capacity Development Seminar

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Automotive & Transportation Business

16th and 17th October 2017
## OVERVIEW

1. A Recap
   - About KPIT
   - The sustainable transport problem that we seek to address
   - Sustainable transport solution
   - Challenges during implementation

2. Since then

3. R&D for other alternate fuel technologies

4. Work in some more transportation technologies
A recap
A Global Technology Company – providing transformational products, solutions and services by combining Engineering and IT

USD 500 Mn Revenues

12,000+ Employees worldwide

Employees from 25 nations

34 offices in 16 countries

~3% of Revenue invested in R&D

54 Patents filed

96 Papers published

11 Innovation awards in past 4 years

Automotive and Transportation

Manufacturing

Energy and Utilities

Development centers in US, Germany, India, China, and Brazil

Global offices

Manufacturing

Energy and Utilities
Providing best in class solutions to the Industry

Leading Brands
Leveraging Technology
Innovations from KPIT

Playing meaningful role with Associations and Consortiums
The sustainable transport problem that we seek to address
Key challenges in public transport buses in India

Bus ridership declined **62% to 17%** in 2 decades

1994 vs 2006

- 94 to 62%
- 06 to 60%
- 06 to 07%

**0.4%** of total Public Transport Buses on road cause **~ 9%** of the total vehicular pollution

~**$1 Billion** worth Crude Oil is used by existing (**35,000**) diesel buses

65% population under the **age of 35**, middle class to double by 2025 to **547 million**

To overcome these challenges and attract citizens to bus transport, we need...

Public Transport at an affordable price!
KPIT’s solutions for sustainable transport

Clean
- Alternate Fuel Technologies
  - EV for bus
  - HEV for bus
  - PHEV for cars

Connected
- Intelligent transport system
- Vehicle Tracking System
- Command Center

Comfortable
- Mobile Apps for Journey planning
- Public Information Systems
- Wi-Fi Infotainment System for Buses

Safe
- Advanced Safety Systems e.g. Monitoring of Harsh Braking, Sudden Acceleration etc.
- Advanced Driver Assistance Systems (ADAS) e.g. FCW, LDW
KPIT’s electrification technology for buses - REVOLO

A unique solution to convert ‘Existing buses to electric’ & ‘create new smart electric buses’

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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<tbody>
<tr>
<td>Indigenously developed and manufactured in India</td>
<td></td>
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<tr>
<td>Cost effective</td>
<td></td>
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<tr>
<td>Designed specifically for Indian conditions</td>
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<tr>
<td>Suitable for a wide range of buses</td>
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<tr>
<td>Configuration as per customer requirements</td>
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<tr>
<td>Supports air conditioning</td>
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Electric buses with KPIT’s technology at the Indian parliament

Mr. Narendra Modi, PM of India, flagged off KPIT’s Electric bus at the Parliament in 2015

- Joint project by KPIT & CIRT supported by Ministry of Road Transport and Highways
- Two retrofitted electric buses were deployed at the Indian parliament
- Buses have covered 15,000 kms, providing valuable data and user feedback
Feature rich smart electric bus technology

ITS | Mobile App | AC | WiFi Infotainment
Adv. Safety System

Clean
Zero Emissions
No Fossil Fuel

Connected
ITS
Journey Planning

Comfortable
Ease of Driving
Smooth & Comfortable

Safe
Surveillance Cameras
Bus tracking from CCC*

*CCC – Central Command Centre
KPIT’s ITS solution in India

- Automatic Vehicle Location (AVL)
- Vehicle Health Monitoring & Diagnostics
- Emergency Voice Calling
- Alerts
- Surveillance Camera Network System
- Passenger Information System (PIS)

7,000+ ITS deployed across 31 Transport Undertakings in India

100+ Mumbai- Pune MSRTC Buses use KPIT’s ITS Solution

Command centre set-up for 130+ buses at South Asian Games, Guwahati

Passenger Information App

KPIT’s ITS solution in India
Challenges for electric buses in India

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Actions</th>
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<tbody>
<tr>
<td><strong>Expensive</strong> – High upfront cost</td>
<td>Government support through schemes: FAME-Updated, Vision 2030 document from NITI AAYOG for 100% Electric Vehicles</td>
</tr>
<tr>
<td>Cost of <strong>Batteries</strong> (import)</td>
<td>Working on developing indigenous battery chemistries</td>
</tr>
<tr>
<td>Availability of <strong>Charging Infrastructure</strong></td>
<td>NTPC, IOCL, BPCL, BHEL, REIL are looking to set charging stations</td>
</tr>
<tr>
<td><strong>Awareness</strong> on implementation</td>
<td>Promotion of technologies, innovation and product through conferences/ seminars</td>
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</table>
Since then
KPIT’s eBus at Bandipur forest reserve – Karnataka, India

Revolo powered electric bus customized for Jungle Safari

- **8m EV**
- **16+1 seating**
- **100 km range**
- **70 kmph top speed**

- **42 days of trial**
- **76 Safaris completed**
- **2700 km covered**
- **683 tourists**

99% terrain coverage inside the tourist zone

* The remaining 1% terrain can only be covered by a 4x4 Jeep
Supply of electric buses

In a joint initiative, WBHIDCO & Coal India have procured 3 electric buses equipped with KPIT’s Electrification Technology ‘REVOLO’

The 1st bus was flagged off on August 31st 2017

These buses will be used for public transport in ‘New Town Kolkata’
Initiatives by India for electrification of transportation

**Smart Cities Mission**
15 out of 90 selected smart cities have focus on electric buses

**FAME - Updated**
Incentive up to INR 1 Crore ($ 0.15 million) for the purchase of fully electric buses

**Reliance Energy & Tata Power**
Electric vehicle charging station, Mumbai

**NITI Aayog**
India Leaps Ahead: Transformative Mobility Solutions for All

**EESL**
Awarded the tender to procure 10,000 electric sedans for various ministries

**ARAI**
Standards for charging stations (AIS 138)

**Vision 2030:** 100% electric mobility
### New smart electric bus powered by REVOLO

<table>
<thead>
<tr>
<th>9 Mtrs; Occupancy 30 to 40</th>
<th>70 kmph</th>
<th>70 - 120 kms</th>
<th>ITS</th>
<th>Gear Less Driving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best suited for city operations i.e. congestion, small roads, last mile connect</td>
<td>Average speed of buses in a city between 40 – 50 kmph</td>
<td>On route, top up, charging can increase range up to 200 kms. Avg. max. route length- 30k</td>
<td>Tracking, ETA, Vehicle Health Monitoring, Command Centre</td>
<td>Lesser stress for bus drivers</td>
</tr>
</tbody>
</table>

### Advanced Safety Systems
- Control of Over speeding & aggressive braking, Overloading warning
- Air Conditioning & auxiliaries like power steering etc.

### AC, Power Steering
- A/C

### Wifi Infotainment
- Free Movies and videos on mobile phone

### Lower Maintenance
- Lesser parts leads to lower maintenance

### UBS II & AIS 052
- Compliant with industry standards for buses
Route map: Gandhinagar (GN) to Ahmedabad (AH), Gujarat, India

**Route overview**

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Bus frequency</td>
<td>10 min</td>
</tr>
<tr>
<td>One way distance</td>
<td>30 km</td>
</tr>
<tr>
<td>Average journey speed</td>
<td>28 km/h</td>
</tr>
<tr>
<td>Number of stops in the route</td>
<td>24 stops</td>
</tr>
<tr>
<td>Bus halt at each stop</td>
<td>15 sec.</td>
</tr>
<tr>
<td>One way journey time</td>
<td>70 min</td>
</tr>
<tr>
<td>Distance covered/ day per bus</td>
<td>302.0 km</td>
</tr>
<tr>
<td>Running time/ day per bus</td>
<td>12 hr. 30 min.</td>
</tr>
<tr>
<td>Fast charging time/ day per bus</td>
<td>03 hr. 15 min.</td>
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**Buses and infrastructure required**

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<tbody>
<tr>
<td>Buses of 120 km range</td>
<td>18</td>
</tr>
<tr>
<td>Intraday chargers</td>
<td>06 (Ahmedabad)</td>
</tr>
<tr>
<td>Overnight chargers</td>
<td>08 (Gandhinagar)</td>
</tr>
</tbody>
</table>
Intraday charging simulation for frequency of 10 minutes

TRIP START 06:00

TRIP END 21:35

TIME ➔ 07 08 09 10 11 12 13 14 15 16 17 18

01 A B A1 B A6 B B B B

A A A A A

A1 A2 A3 A4 A5 A6

02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 01

TIME ➔ B


302.0 km
Various charging methods for electric buses

**Slow & Medium Charging**
- Overnight charging for large range buses

**Trolley bus with battery storage**
- High infrastructure and overhead cables

**Pantograph Charging**
- High cost infrastructure

**Opportunity Charging**
- Preferred (quick charging, low cost and limited infrastructure requirements)

**Battery swapping**
- Preferred by grid operators; costly for bus operators
R&D for other alternate fuel technologies
Other alternate fuel technologies

Bio-hydrogen production technology

- Innovative method to produce **Bio Hydrogen** in economical way
- Abundantly available **low cost agro residue** used as raw material

### Bio-hydrogen Production

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Briquettes</th>
<th>Biogas</th>
<th>Methane</th>
<th>Hydrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 kg</td>
<td>20 kg</td>
<td>8 kg</td>
<td>4 kg</td>
<td>1 kg</td>
</tr>
</tbody>
</table>

### Sodium-ion battery chemistry

- **Fast Charging** - Can be charged to full capacity within 7.5 mins
- **Long Life** - Tested for 8C charging with cycle life of more than 8,000
- **Sodium** is 1,000 times more available in Earth’s crust than lithium

Na-Ion Cell performance chart

- **Charging**
- **Discharging**

<table>
<thead>
<tr>
<th>Rate</th>
<th># Cycles</th>
<th>Retention</th>
</tr>
</thead>
<tbody>
<tr>
<td>8C/8C</td>
<td>8754</td>
<td>77 %</td>
</tr>
</tbody>
</table>

Cycle number

Specific capacity mAh g\(^{-1}\)
Work in some more transportation technologies
Cities will need new ways to plan transportation; *Mobile Network Data* - A potential new data source to create multimodal, integrated transportation

**Various demand cases** can be generated by MND analysis...
- Origin destination analysis
- Movement around a key hub
- Congestion insights
- On road population over time

Project implemented with Smart City Pune

Around 7 billion mobile subscribers in the world = world population

Large Sample size improving the **accuracy** of the planning

Information on frequency and the number of visited locations over long term

Daily mobility network of individuals makes the data **Dynamic**
KPIT’s telematics platforms

Use cases

- Peace of Mind, Navigation
- Track, Trace, Monitor & Diagnostics
- Child Safety
- Intelligent Transport System

Building Blocks

- Bikes
- Trucks & Off-highway
- School Buses
- Passenger Buses

Cloud based Command Centre & Analytics

Diagnostics - On-board/Cloud based

Telematics Hardware
Working with all Stakeholders for Scale and impact ...

- **Ecosystem players**
  - Tie-up for research (battery technologies), IPs
  - Testing and validation (homologation)

- **Research & Regulatory Institutes**
  - Thought leadership, awareness
  - Formation of associations (EV, ITS etc)

- **Suppliers**
  - Create vendor base
  - Localization of key components

- **Customers**
  - Establish Partnerships (OEMs, Fleet operators, Bus Body builders)

**Global Outreach**
- International market

Open for partnerships and collaborations
Recognition for KPIT’s Sustainable Transportation Technologies

- Thomson Reuters Top 50 Indian Innovators’ list for Sustainable Transportation Technologies
- Promising Transport Innovation Award 2016 at the International Transport Forum (ITF) Summit, in Leipzig Germany.
- Automotive Idea of the Year - Economic Times Zig wheels
- Technology Innovation Award - Wall Street Journal
- Sustainability Innovation of the Year by a leading business school
- Promising Innovation of the year - NASSCOM
- Project Dev. Excellence By Volvo - 2014
- ‘Technology Innovation of the Year (2015) Award for REVOLO from IATIA
Thank you