The Future of Mobility: the role of technology and Integrated Mobility Plans

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Outline

1. MEGA Trends & Changing Mobility Landscape
2. The New Definition of Urban Mobility
3. The Maturity of Urban Mobility Technologies
4. The New Mobility Ecosystem and Business Models
5. Roadmap for Egypt
Mega Trends
Urbanization and The Changing Mobility Landscape

The world is Becoming Increasingly Urban

Urban and rural population, 2010-2050 [m people; %]

2010 | 2030 | 2050
---|---|---
6,896 | 8,321 | 9,306
52% | 60% | 67%
48% | 40% | 33%

CAGR 2010-50
+1.4% p. a.

Urban Mobility Demand Explodes

Urban mobility demand, 2010-2050 [trillions pkm p.a.; %]

2010 | 2030 | 2050
---|---|---
25.8 | 43.2 | 67.1

CAGR 2010-50
-0.2% p.a.

Source UN reports
The Changing Mobility Landscape

Delay hours due to congestions p.a.

Urban mobility investment need p.a.
Cairo

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2030</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cairo’s population</td>
<td>18.5 mln</td>
<td>25.5 mln</td>
<td>40%</td>
</tr>
<tr>
<td>GRDP Per Capita</td>
<td>10,724 EGP</td>
<td>27,286 EGP</td>
<td>145%</td>
</tr>
<tr>
<td>Total Number of Trip Demand</td>
<td>21.2 mln</td>
<td>28.5 mln</td>
<td>34%</td>
</tr>
<tr>
<td>(Trips / Day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Speed (Km/Hr)</td>
<td>9.6</td>
<td>4.3</td>
<td>-45%</td>
</tr>
</tbody>
</table>

Total Cost of Congestion is Expected to reach 50 Bill. EGP/ Year by 2030
Cities, and Not Countries, Will Drive Wealth Creation In the Future

Cities like Seoul account for 50% of the South Korea’s GDP; Budapest (Hungary) and Brussels (Belgium) each for roughly 45%.

What are the Micro Implications?
- High Economic Power
- Hub and Spoke Business Model
- Transit oriented development
- New Mobility Solutions

City as a Customer
MEGA TREND 2: Connectivity

More People have Access

To More Information

At Lower Cost

1 Trillion Devices is Expected to Connect by 2025

15 Connected Devices for Every Household by 2025

5 billion internet users by 2025

DISRUPTIVE TECHNOLOGIES TO WATCH

Mobile Internet
$4 trillion–$11 trillion

Automation of knowledge work
$5 trillion–$7 trillion

Internet of Things
$3 trillion–$6 trillion

15B CONNECTED DEVICES IN 2015
Knowledge Gaps

**Traditional Approach**

- Increased demand met by building more capital-intensive infrastructure
- Vehicle-oriented
- Focus on reacting to congestion
- Emphasis on “knowing and seeing”

**Smart Approach**

- Increased demand met by making infrastructure more efficient, not larger
- People-oriented
- Customer-centric
- Focus on positive business and operational outcomes
- Emphasis on “predicting and anticipating in order to avoid”
Pathways for Cities

Newly motorizing cities without much traffic-immune mass transit

- Rapidly rising car ownership
- Low transport investment

Traffic-saturated cities

- Some cities act early to change mindsets and policies on cars
  - Avoid car subsidies and restrain growth of car ownership and/or use
  - Improve public transport institutions, investment, capacity and quality
  - TOD

Automobile dependent cities

- Some increase their efforts to welcome cars

Continued rapid motorization

Low Transport Investment

Chronic traffic saturation

spectrum between the extremes (depending on priority for cars versus alternatives)

NEW TRANSIT CITIES

Continued rapid motorization

Low Transport Investment
Urban Mobility Redefined
Multimodal is the new Paradigm! Door to Door
Urban Mobility Redefined

User Centered

Integrated & Intelligent

Automation & Safety

Pricing and payments

Image Source: Deloitte, Transport on the digital age
City as a Customer

Seamless "Multi-modal mobility" without ownership

- ("mobility aggregators"), integration with public transport
- Service access over mobile and stationary channels, integration of various interfaces/value added services

New vehicle concepts

- Zero emission
- Quasi-autonomous driving
- Communication with road infrastructure/other vehicles

Low-price mobility:

- Low-priced mobility enabling further movement than walking/biking distance
- Inferior to 4-wheeler speed, size, driving distance, safety and comfort
- Low-cost energy (fuels or electricity)
The Maturity of Urban Mobility Technologies

- Adaptive signal control
- Bicycle sharing system
- Automobile sharing
- Autonomous self-driving vehicle
- V2V and V2I technologies
- Speed Map Panel
- Smart vehicles
The New Mobility Ecosystem and Business Models
Mobility Integrators—Stakeholders making it possible

The Concept of a Dynamic Transport Solution Integrating Different Modes Under a Single Entity to make Personal Transportation Easy and Simple

MIs will start exploiting the Web 2.0 and Mobile 2.0 Internet service to offer mobility-based applications (apps) on smart phones.
New Business Models

What if ...?
Consumers replace traditional car ownership models with on-demand access to the vehicles they want?
Substitution Effects of Shared Mobility

- Between **9 to 13 vehicles removed**, including postponed purchase
- **27 - 43% VMT/VKT** reduction per year, considering vehicles sold and purchases postponed
- Net CO2 reduction of ~**27%**
- **34% - 41%** reduction of GHG emissions per year for one household
Electric Vehicles Market Overview, Technology Roadmap and Infrastructure Trends
## Today’s powertrain portfolio

<table>
<thead>
<tr>
<th>powertrain type</th>
<th>Internal combustion engine</th>
<th>Electric propulsion</th>
<th>Energy generation/source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICE</td>
<td>Internal Combustion Engine</td>
<td>Driving with conventional combustion engine only</td>
<td>Primary ICE, Secondary Plug-in</td>
</tr>
<tr>
<td>HEV</td>
<td>Hybrid Electric Vehicle</td>
<td>Driving with combustion engine and/or e-motor</td>
<td>Primary ICE, Secondary Plug-in, Primary Fuel Cell</td>
</tr>
<tr>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicle</td>
<td>Driving with combustion engine and/or e-motor, plug-in to recharge battery</td>
<td>Primary ICE1, Secondary E-motor, Secondary Plug-in</td>
</tr>
<tr>
<td>REEV</td>
<td>Range Extended Electric Vehicle</td>
<td>Driving with e-motor only, ICE &amp; plug in (or fuel cell) used to recharge battery</td>
<td>Primary E-motor, Secondary Plug-in, Secondary Fuel Cell</td>
</tr>
<tr>
<td>BEV</td>
<td>Battery Electric Vehicle</td>
<td>Driving with e-motor only and storing energy in battery</td>
<td>Primary E-motor, Secondary Plug-in</td>
</tr>
</tbody>
</table>

*Primary, Secondary: MASART confidential Material*
Global Demand for xEV

**Global Demand for E4Ws**

- Global Demand: 45, 61, 70 (M units)
- Penetration of total (%): 2%, 5-7%, 7-19%

**Global Demand for E2Ws**

- Global Demand: 43, 55, 76 (M units)
- Penetration of total (%): 38-40%, 37-39%, 34-36%

**Global Demand for E-Buses**

- Global Demand: 350, 474, 570 (`000 units)
- Penetration of total (%): 5%, 8%, 20%

Source: Global Engine & Transmission Forecast, Deutsche Bank - Electric Cars Plugged
## XEV AUTONOMY

<table>
<thead>
<tr>
<th>Performance</th>
<th>Autonomy</th>
<th>Infrastructure investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto - Low</td>
<td>Distance</td>
<td>already existing</td>
</tr>
<tr>
<td></td>
<td>Time to recharge</td>
<td>already existing</td>
</tr>
<tr>
<td></td>
<td>Storage weight</td>
<td>already existing</td>
</tr>
<tr>
<td>Internal Combustion Engine</td>
<td>600 km</td>
<td>5 min</td>
</tr>
<tr>
<td>Plug-in hybrids</td>
<td>600 km (20 to 60 km electric)</td>
<td>2-3 hours</td>
</tr>
<tr>
<td>Electric vehicle</td>
<td>60 to 250 km electric</td>
<td>4-8 hours</td>
</tr>
<tr>
<td>Fuel Cell Vehicle</td>
<td>600 km</td>
<td>5 min</td>
</tr>
</tbody>
</table>
## Charging infrastructure

### Energy source

<table>
<thead>
<tr>
<th>Description</th>
<th>GASOLINE/DIESEL</th>
<th>HYDROGEN</th>
<th>BATTERY</th>
<th>Induction charging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fueling gasoline or diesel at a petrol station</td>
<td>Conventional gasoline or diesel refueling</td>
<td>Hydrogen refueling (similar to natural gas refueling)</td>
<td>“Wired” charging using a plug</td>
<td>Replacing a battery for a fully charged one at a special swapping station</td>
</tr>
<tr>
<td>Time needed</td>
<td>5 min</td>
<td>5 min</td>
<td>4-8 hrs (slow) 20-30 min (fast)</td>
<td>5 min</td>
</tr>
<tr>
<td>Suitable for which power-trains</td>
<td>ICE, HEV, PHEV, REEV (gasoline)</td>
<td>FCEV, REEV (hydrogen)</td>
<td>PHEV, BEV suitable for plug-in charging</td>
<td>Special BEVs suitable for battery swapping</td>
</tr>
<tr>
<td>Example car</td>
<td>All ICEs</td>
<td>Hyundai ix35 (FCEV)</td>
<td>Renault Zoe (BEV)</td>
<td>Special model of Renault Fluence</td>
</tr>
<tr>
<td>Current availability in Europe</td>
<td>Widely available: ~131,000 stations</td>
<td>Very limited: ~80 stations</td>
<td>Limited availability: &gt;20,000 (slow) &gt;1,000 (fast)</td>
<td>Very limited ~50 stations</td>
</tr>
</tbody>
</table>

1 Time need for full refueling or recharge. For fast-charging of battery, time to reach 80% of battery capacity is commonly used
2 Since induction charging is still in pilot stage, common duration and power level are not yet established; power levels of 22 kW have been achieved

Source: Eurovia, Fuel Cell Today, Public sources, MASARAT
Charging Infrastructure: Present Development

Pub. & Pvt. Parking Place
- Special EV parking space
- Free charging from charging outlet

Commercial Facilities
- E.g., Dept. Stores, hotels, malls
- Special parking lot for EV next to handicap provision
- Free charge (1-2 hrs) using AC outlet

Car Dealers, Public Building
- Current strategic locations for fast charging
- 15 min. charge to yield 60 miles range

Home
- Normal charging by night time discounted electricity
- Special charging plug at home

Improved range extension will see charging points extend beyond city limits to urban and sub-urban areas with emphasis on both normal and fast charging stations.
# Electric Vehicle Technology Roadmap

## Electric Vehicle Market: Technology and Product Roadmap for Electric Vehicles

<table>
<thead>
<tr>
<th>Performance</th>
<th>Driving Distance/charge</th>
<th>Charge Time</th>
<th>Battery Capacity</th>
<th>Motor Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>up to 100 kms</td>
<td>6 to 8 hrs</td>
<td>up to 16 kWh</td>
<td>up to 70 kW</td>
</tr>
<tr>
<td></td>
<td>Up to 200 kms</td>
<td>&lt; 1 hour</td>
<td>Up to 50 kWh</td>
<td>70 kW – 250 kW</td>
</tr>
<tr>
<td></td>
<td>300 + kms</td>
<td>&lt; 15 minutes</td>
<td>75 kWh +</td>
<td></td>
</tr>
</tbody>
</table>

## Infrastructure

- Slow charging - onboard
- Fast charging – mostly off board
- Battery Swapping

## Market for Extended-Range Electric Vehicles: Technology Roadmap for Plug in Hybrid Electric Vehicles

<table>
<thead>
<tr>
<th>ELECTRIC RANGE</th>
<th>BATTERY CAPACITY</th>
<th>MOTOR POWER</th>
<th>CHARGING TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 70 kms</td>
<td>7kWh – 15kWh</td>
<td>50kW – 70kW</td>
<td>2 – 6 hrs</td>
</tr>
<tr>
<td>Up to 160 kms</td>
<td>16kWh – 25kWh</td>
<td>70kW – 140kW</td>
<td>15 mins – 2 hrs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2005</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
eMobility Business Model

Key Industry Stakeholders and Key Opportunities
Traditional E-Mobility Ecosystem

Provision of infrastructure
- Charging station
- Maintenance
- Value-added services
- Billing
- Power generation
- Power distribution and storage
- Space providers

Provision of electric vehicles
- Sales and marketing
- Manufacturing
- Financing
- Value-added services
- Maintenance

Customer

Regulations and subsidies
The New Ecosystem

Integrators to create partnerships with Utilities, OEMs and Government

Key Responsibility:
Development of Charging Infrastructure

Utilities

E- integrator

OEMs

Charging Station Manufacturers

Government

System/Battery Manufacturers

Supplies infrastructure to distribute their energy

Supplies infrastructure to distribute their energy

Lower fuel dependency

Subsidies for EV purchase

Development of performing batteries

Could work to improve charging time and safety

Subsidies for EV purchase

Key Responsibility:
Promotion of EV use

Lower fuel dependency

Development of performing batteries

Integrators to create partnerships with Utilities, OEMs and Government
## New Business Models

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Business Model 1</th>
<th>Business Model 2</th>
<th>Business Model 3</th>
<th>Business Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE</td>
<td>Energy Package</td>
<td>Maintenance Package</td>
<td>Part Subsidy</td>
<td>Full Subsidy</td>
</tr>
<tr>
<td>COVER</td>
<td>Partial battery lease + Electricity</td>
<td>Energy Package+ Insurance+ Maintenance</td>
<td>Maintenance Package+ Discount</td>
<td>Maintenance Package+ 100% Discount</td>
</tr>
<tr>
<td>ENERGY</td>
<td>Monthly Bill</td>
<td>Flat: Maximum XX kms/month</td>
<td>Flat: xxx kms/year (25,000 km/year)</td>
<td>Flat: xxx kms/year (i.e. 50,000 km Year)</td>
</tr>
<tr>
<td>CONTRACT</td>
<td>NA</td>
<td>NA</td>
<td>XX Years (i.e. 4 years)</td>
<td>XX Years (i.e. 7 years)</td>
</tr>
<tr>
<td>SUBSIDY</td>
<td>NA</td>
<td>NA</td>
<td>50% car price</td>
<td>Free car</td>
</tr>
<tr>
<td>MONTHLY LEASE</td>
<td>Monthly</td>
<td>Monthly</td>
<td>Annual</td>
<td>Annual</td>
</tr>
</tbody>
</table>

### Other Possible Leasing models

<table>
<thead>
<tr>
<th>Flexible Mileage</th>
<th>Unlimited kms</th>
<th>Max number of kms</th>
<th>Pay as you go</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible Contract</td>
<td>The customer opts for the number of years and flexible mileage- customized lease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Roadmap for Egypt
Barriers to Electric Vehicles

**Market**
- Testing and certification
- Vehicle Servicing
- High capital cost and Financing
- Electricity quality
- Market for electricity storage
- Consumer perception
- Raw Materials for batteries

**Technical**
- Efficiencies of batteries
- Driving range of EVs
- Charging time
- Safety
- Environmental Impacts

**Policy**
- Taxation of vehicles and components
- Subsidies on fossil fuels
- Electricity tariff policies

**Infrastructure**
- Charging infrastructure
- Smart Grids
- Battery recycling
- Dedicated lanes for E2Ws?
Levers to support xEV adoption

- Govt. Policies
- subsidies
- Govt. Purchase
- mandates

Demand creation

Supply side interventions

- Govt. Policies & incentives
- OEM investments

Fuel Efficiency

R&D

Infrastructure

- Govt. – Industry Collaboration
- Consortia approach

- Govt. – Industry
Thank you