Sustainable Transportation and E-Mobility – Research and Product Development at Cairo University
Vision of the E-mobility projects in EPM

- Strategically focus teaching, projects, research, and student activities in field of e-mobility
- To acquire industry level the knowledge in the topic of EV
- To prepare students for new markets
- To be able to support the EV market in Egypt in the future
- To explore and integrating knowledge of all research groups towards a common objective
International trends

- In 2030 electric vehicles will cheaper than internal combustion cars
- With removal of customs this can happen earlier in Egypt
- The EV market will pick up in Egypt in 6-7 years
- But are we ready?
Market Segment

- Competing with Chinese ICE cars (BYD-Geely), KIA picanto and smaller European cars (Renu Logan)
- Target is small families, graduates and middle class
- Travel in cities and between major cities in delta region and Suez Canal
- Specs
  - 250 km drive per charge
  - Top speed 120 km per hour
  - Re-charging in 2 hours
Market Segment

• This market segment is less congested by car manufacturers. It very much suits Egypt mega cities and small travel distances

• Few manufacturers started to realize this, VW signed a partnership deal with Toshiba to develop small EVs

• A market study needs to be run as well as transportation research to understand demand on EVs and also define the specifications well
Timeline of EV at EPM

- **2013**: Graduation project – integrating e-bike
- **2014**: Student project with STEP – remote controlled toy car – Dr Ahmed Huzayyin
- **2015**: Graduation project – integrating e-bike powered by solar and 15% local
- **2016**: Urban Car prototype 1 m x 0.8 m
- **2017**: Student project Urban Car Ministry of Environment
- **2018**: National roadmap
- **2019**: Student project with STEP – remote controlled toy car – Dr Ahmed Huzayyin
- **2014**: Graduation project e-bike 20% local
- **2015**: Student project Urban Car Ministry of Environment
- **2016**: National roadmap
- **2017**: Urban Car Diagnostic System and reverse engineering
- **2018**: Racing student competition car
- **2019**: Urban Car road tested 4 m x 2.8 m

Course on EV
More than 50 students worked for 2 years under supervision of Prof Mohab and Dr Huzayyin.
6 Departments and 3 faculties
25% local can reach 40% local
Weight → 500 kg
Pay-load → 300 kg (2 people + luggage)
Top speed → 120 km/hr
Optimum speed → 60 km/hr
Per-charge +PV drives → 250 km (@ 60 km/hr)
Per-charge drives → 200 km (@ 60 km/hr)
Charging time home → 6 hours
Fasting charging special → 30 minutes
Cost less than → 200,000 EGP

Design features – Maximize Local Components – current model
Weight
350 kg (carbon fiber – high tensile composites)

Pay-load
450 kg (4 people + luggage)
160 km/hr (15kw motors – instead of 10kw)

Optimum speed
110 km/hr

Top speed
160 km/hr (15kw motors – instead of 10kw)

Per-charge +PV drives
450 km (@ 85 km/hr) – Li-Polyemrs ion batteries, lighter and higher capacity – already purchased and currently in customs for clearance

Per-charge drives
450 km (@ 85 km/hr)

Charging time home
2 hours

Fasting charging special
15 minutes up to 80%

Cost less than
600,000-500,000 EGP
Design features

Tested for 120 km drive

Drives 100 km with 15 EGP electricity charge (compared to 60 EGP on gasoline)

Mechanical parts are based on Fiat 128

Head lights and dashboard are based on Mitsubishi Lancer
Impact on students

Practice renewable energy systems design
Power electronics and signals
Motors and motor drives
Each year graduates are hired once the graduate
Develop partnership with private sector which can lead the manufacturing and Cairo University provides Research and Technical Assistance

Develop a national roadmap

Next steps
An EV car can become the Egypt Apollo project and Egypt Beatles VW or Tata

It can be used to develop various parallel industries in the project

It can be an R&D vehicle and the catalyst to develop local industry and solution

Capture rapid knowledge transfer to Egyptian market

It should aim to have the highest market share in Egyptian market
Assessment of Components – Key Components

- Mechanical (Body – Chassis) – Electrical (Battery and Charging System – Motor) – Control (Electric Drive – Controls – Signals)
Assessment of Components – Key Components

- Mechanical (Body – Chassis) – Electrical (Battery and Charging System – Motor) – Control (Electric Drive – Controls – Signals)

<table>
<thead>
<tr>
<th>Component</th>
<th>Presence of local suppliers</th>
<th>Potential for local manufacturing</th>
<th>Know how</th>
<th>Manufacturing capacity</th>
<th>Competitiveness</th>
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<td>Body</td>
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<tr>
<td>Controls &amp; signals</td>
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# Assessment of Components – Body

- **Body** (various options are metal, fiber glass, or carbon fibers/graphite)
- Best option for cost is metal and best for performance is carbon fibers

<table>
<thead>
<tr>
<th>Component</th>
<th>Source Locally Now</th>
<th>Manufacture short term</th>
<th>Manufacture medium term</th>
<th>Manufacture long term</th>
<th>Always import</th>
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<td>Main body</td>
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<td>Movable parts</td>
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<td>Paint</td>
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</table>
Assessment of Components – Body

• Porche is using carbon fibers for some of its cars
Assessment of Components – Chassis

- Source from local ICE manufacturers
- Would require building on capacity of local steel industry

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<tr>
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<td>Tires</td>
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<td>Wheel frame</td>
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Assessment of Components – Batteries

• Comparison of various technologies manufacturing capacity
• Strategic importance in renewable energy at large

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<tr>
<th></th>
<th>Source Locally Now</th>
<th>Manufacture short term</th>
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<th>Manufacture long term</th>
<th>Suitability to EVs</th>
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<tbody>
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<td>Lead Acid</td>
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<td>Li-polymer-ion</td>
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<td>Cadmium based</td>
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• Begin with imported batteries for power and local Lead Acid batteries for auxiliary systems
• Gradually build local capacity for Li-ion batteries
• Replacing batteries rather than charging concept
Assessment of Components – Charging system

- Transistors and microcontrollers are difficult to manufacture outside China competitively - We can import the transistors and chips

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<td>Microcontroller</td>
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<td>PCB</td>
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<tr>
<td>Capacitors</td>
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<td>Inductors</td>
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<td>Programing</td>
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- Design the boards and circuitry, eventually we can manufacture the high quality inductors in parallel with developing motor industry
Assessment of Components – Electric drive

- Electronic chips and components are most competitive when manufactured in China

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<tr>
<td>Power transistor</td>
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<td>Components</td>
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Assessment of Components – Motors

• Strategic product in water and industrial sector (95% of integral motors are imported) – coreless or core motors can be developed

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<td>Casing</td>
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<td>Silicon steel</td>
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<td>Magnet</td>
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<td>Cables</td>
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<td>Shaft</td>
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• Continue to import magnets (China is extremely competitive)
Assessment of Components – Controls and signals

• Electronic chips and components are most competitive when manufactured in China

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<tr>
<td>Throttle</td>
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<td>Components</td>
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• This most smart car in the market – including thorough monitoring, fault diagnosis, battery health monitoring, and autonomous driving, optimum speed recommendations, interconnection with charging stations through 3G
Spill over effects

- Advancing motor industry (replacing about 250 Million USD of investment and support market growth associated with national projects; new cities for pumps and home appliances, national rural sanitation 10 years project as well as industrial development and potentially exporting)

- Leveraging local car industry capacity in body

- Leveraging and building local capacity in carbon fibers (kemaweyat al bena2 al7adeeth has a good infrastructure)

- Developing know how in battery charging systems and batteries which are crucial for renewable energy systems
Spill over effects

• Developing know how in embedded systems and intelligent (smart) machines as well as IOT – eventually automatous cars
• Drives know how can help developing inverters for solar energy and low power applications in industrial applications
• Develop advanced carbon fibers can have applications in fuel efficient lighter cars
• Developing the value chain of SMEs in the topic, plastic industry, electronics industry (battery charging, LED lighting)
• This could be our landing on the moon, when all these industries develop in such a high performance applications they can compete in other markets
Stakeholders

• Joint venture of lead national entity and international car manufacturers

• this should be supported by a consortium national suppliers in the value chain

• Local industries in the consortium will include, battery manufacturers (chloride), glass (Dr Greish), inverters (ABB or Schnieder), Cables (elswediy), Motors (Daoud, Elaraby, Fresh), Steel (Beshay, Kandeel, Ezz), Aluminum (SMEs), etc.
Policies and supporting services

• There should be an immediate review of licensing processes and standards and specification
• Service centers planning should be developed
• Charging stations and policies should be developed
• Zero customs on import inputs which are not available locally for a grace period till local industry develops
• Public private finance for R&D → private firms get to test their technology