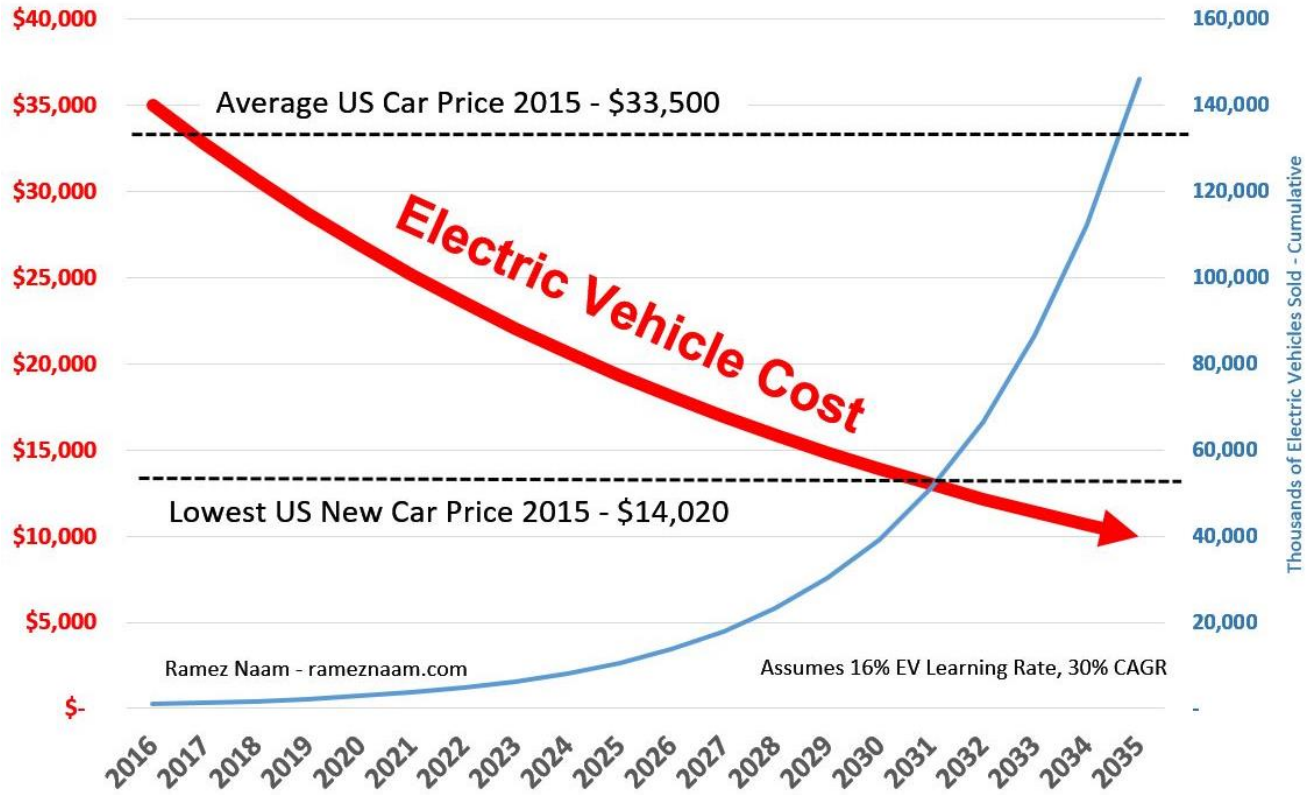
Sustainable Transportation and E-Mobility – Research and Product Development at Cairo University

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

Student project with STEP – remote controlled toy car – Dr Ahmed Huzayyin

2014

Graduation project – integrating e-bike

2015

Graduation project – integrating e-bike powered by solar and 15% local

Student project Urban Car Ministry of Environment

2016

Graduation project e-bike 20% local

Graduation project e-golf car

Course on EV

2017

Graduation project e-bike 30% local

Urban Car prototype 1 m x 0.8 m

National roadmap

2018

Urban Car road tested 4 m x 2.8 m

2019

Racing student competition car

Urban Car Diagnostic System and reverse engineering

More than 50 students worked for 2 years under supervision of Prof Mohab and Dr Huzayyin

6 Departments and 3 faculties

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25% local
can reach
40% local

Design features – Maximize Local Components – current model

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

SEVCUT
Solar Electric Vehicle
Cairo University Team

Design features – Maximum performance

Weight → 350 kg (carbon fiber – high tensile composites

Pay-load → 450 kg (4 people + luggage

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

Optimum speed → 110 km/hr

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

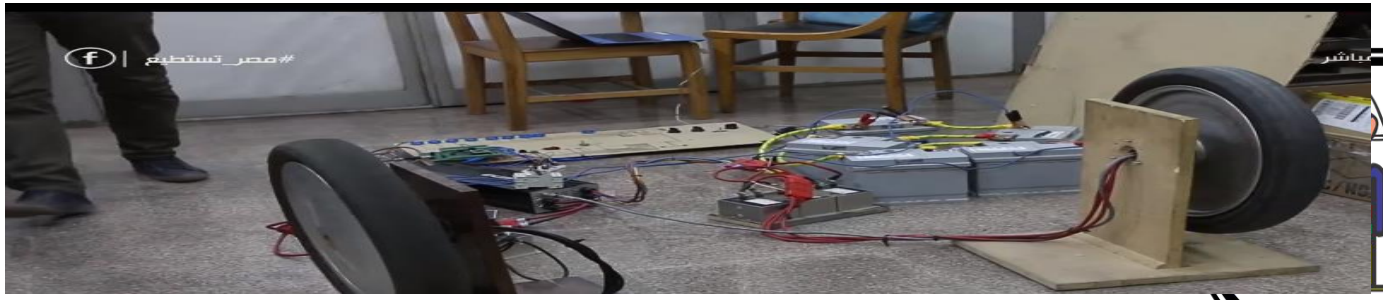
Design features

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

Next steps

Develop partnership with private sector which can lead the manufacturing and Cairo University provides Research and Technical Assistance

Develop a national roadmap

National Roadmap

Competitiveness analysis to define local manufacturing scope

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

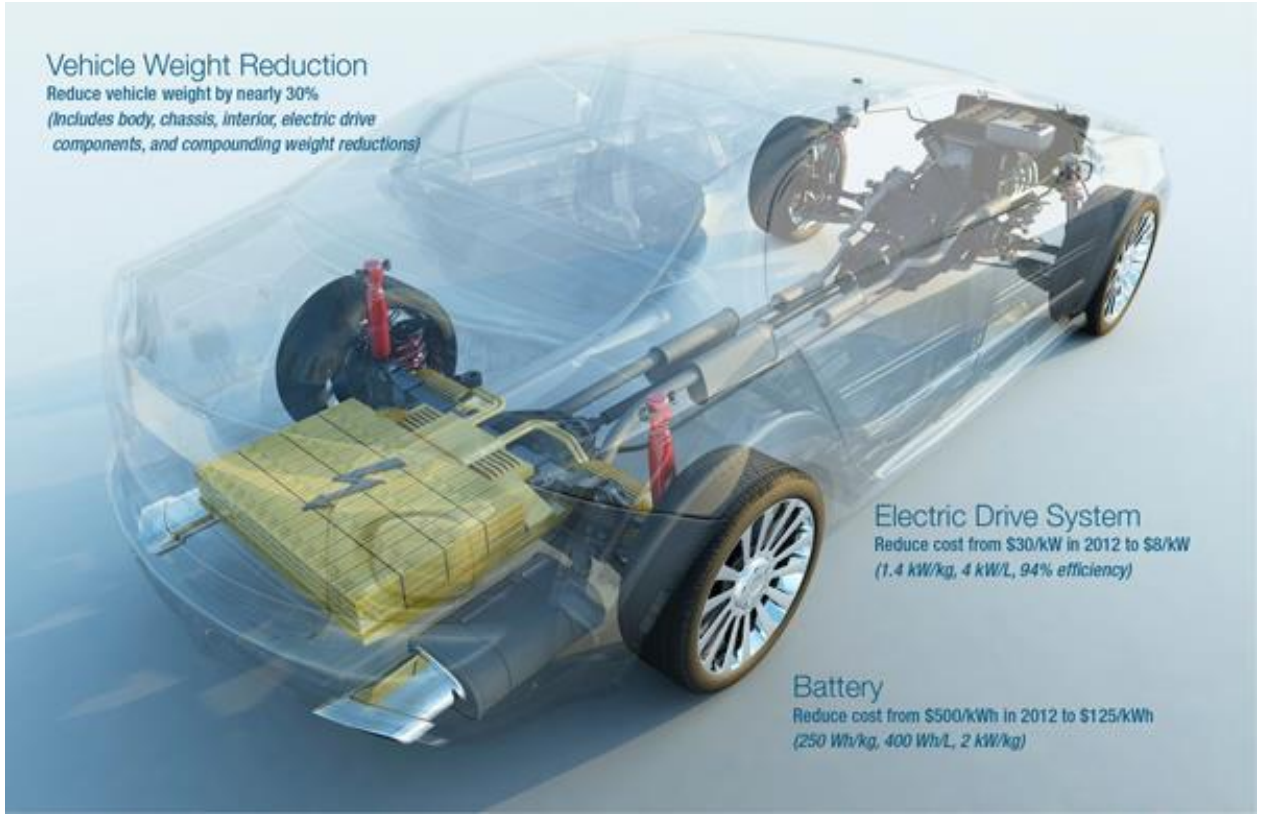
It can be an R&D vehicle and the catalyst to develop local industry and solution

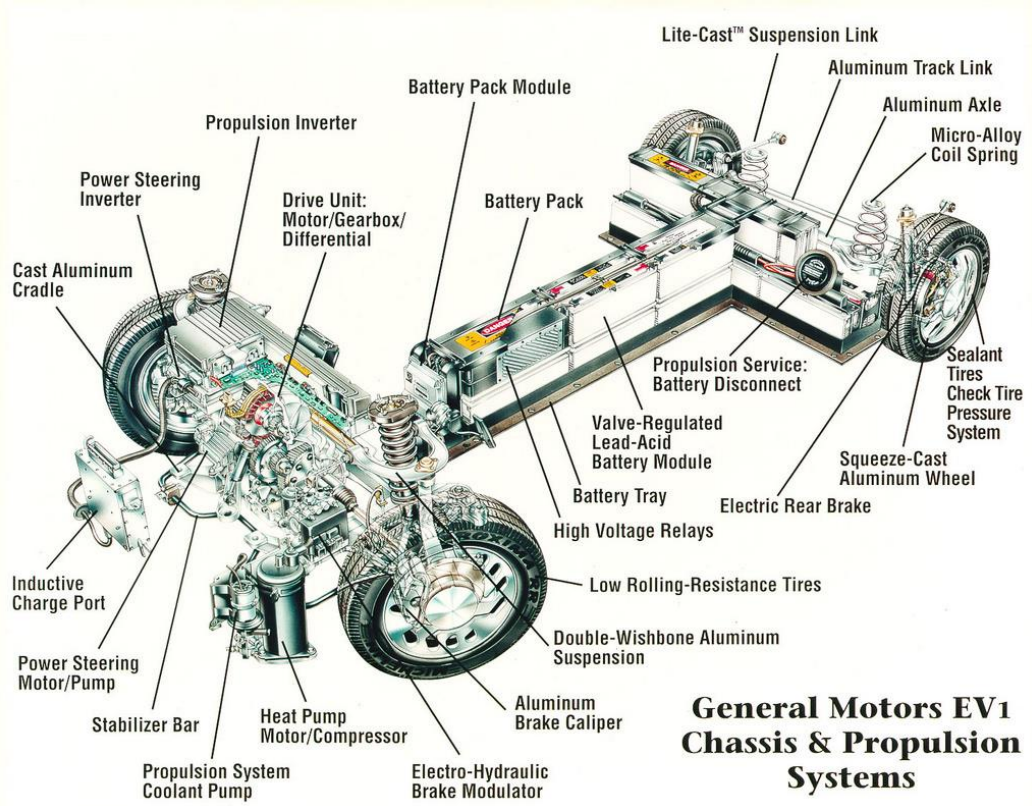
Capture rapid knowledge transfer to Egyptian market

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)

	Presence of local suppliers	Potential for local manufacturing	Know how	Manufacturing capacity	Competitiveness
Body					
Chassis					
Battery					
Charging system					
Motor					
Electric Drive					
Controls & signals					

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

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Always import
Doors		●			
Wind shield	●				
Dash board	●				
Main body		●			
Movable parts					●
Paint	●				

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

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Always import
Main chassis		●			
Axes		●			
Brakes					●
Power steering					●
Suspension					●
Tires	●				
Wheel frame			●		

Assessment of Components – Batteries

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

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Suitability to EVs
Lead Acid	●				●
Li-ion			●		●
Li-polymer-ion			●		●
Cadmium based				●	●

- 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

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Always import
Transistors					●
Microcontroller					●
PCB	●				
Capacitors					●
Inductors			●		
Programing	●				

- 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

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Always import
Power transistor					
Components					
PCB					
Programing					

Assessment of Components – Motors

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

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Always import
Casing	●				
Silicon steel			●		
Magnet					●
Cables	●				
Shaft	●				

- Continue to import magnets (China is extremely competitive)

Assessment of Components – Controls and signals

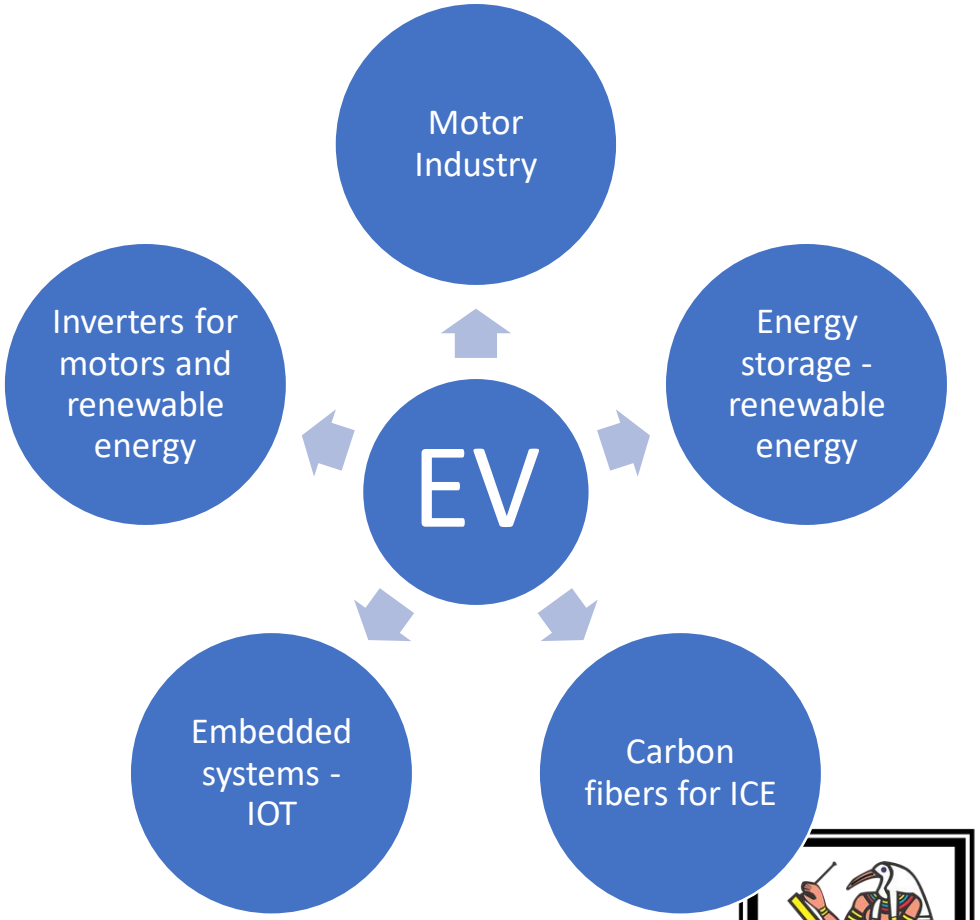
- Electronic chips and components are most competitive when manufactured in China

	Source Locally Now	Manufacture short term	Manufacture medium term	Manufacture long term	Always import
Throttle		●			
Components					●
PCB	●				
Programing	●				

- 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

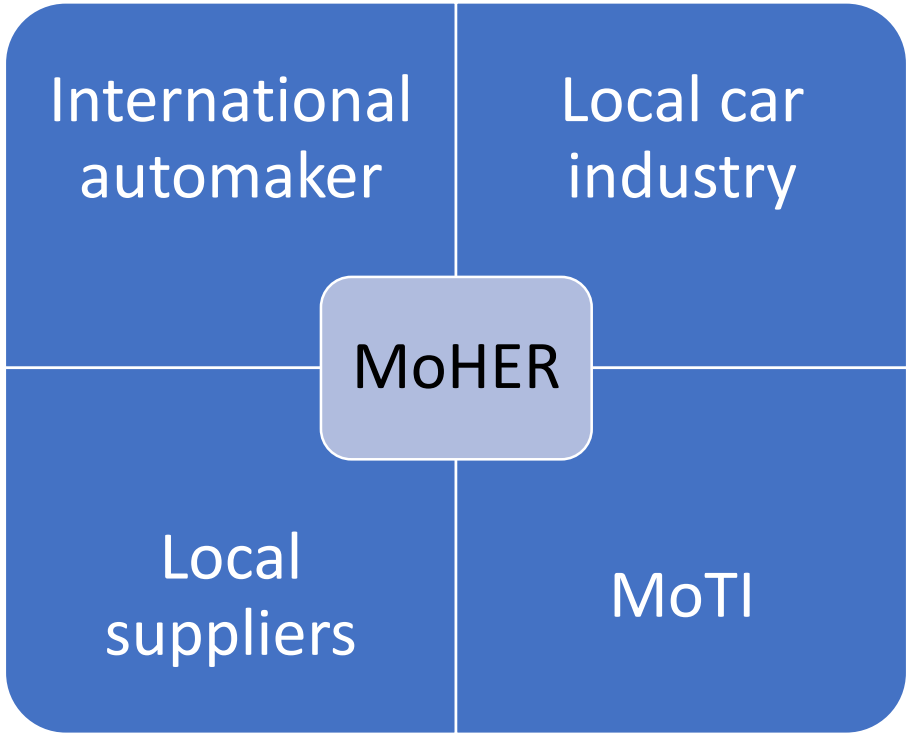


Spill over effects

- 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 (elswedy), 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