Sustainable Transport and Mobility for Cities Workshop - eThekwini Municipality

Hiten Parmar
Director: uYilo eMobility Programme
hiten.parmar@nmmu.ac.za
www.uYilo.org.za
Presentation Overview

• SA Market: History, current and future of Electric Vehicle’s (EV)

• EV Technology: Vehicle types, charging equipment

• Efficient public transport options with zero emissions

• Charging infrastructure options for electric city transport
The early rise and fall of the electric car in South Africa is proceeded by four periods of interest:

(i) the collaboration of Department of Mineral and Energy Affairs and CSIR in the early 70s

DMEA together with the CSIR, researched and demonstrated the use of EVs as an alternative to imported oil. More than 150 research papers resulted from the research and produced a few vehicles converted to electric propulsion.


Various vehicles were piloted and demonstrated – this time with technologies equaling to the performance of conventional cars. Some of the vehicles were deployed in conventional operations, e.g. the electric game viewer in the Kruger National Park, a utility vehicle as part of the eThekwini fleet and two VW shuttle buses – one on Robben Island and the other in Kyalami Business Park.
Historical Background of EVs in South Africa

(iii) the Joule Project (2004 – 2012)

Optimal Energy development of the Joule – A local all electric family car. Timing was not perfect and investors saw this as a risk. The Technology Innovation Agency transferred the Optimal Energy assets to an initiative established as the uYilo eMobility Technology Innovation Programme.
Historical Background of EVs in South Africa

(iv) Post COP 17 (2011 – present)

South Africa started gearing-up after COP 17 for the introduction of EV technology across multiple organizations and government departments:

• The **Department of Trade and Industry** (dti) EV Industry Roadmap for South Africa was launched in May 2013

• The **Department of Environmental Affairs** (DEA) was the first government department to launch its green fleet in 2013

• Electric Vehicle Infrastructure Alliance (EVIA), an initiative in 2014 by uYilo, SANEDI, GridCars, BMW and Nissan was developed to be a guide to the development of EV infrastructure hardware and software standards as well as the roll-out and positioning of recharging stations in South Africa. EVIA renamed as the **Electric Vehicle Industry Association** at the official launch in 2016.

• Local market introductions of **100% Electric Vehicle** offerings began with **Nissan** (Leaf in 2013), and **BMW** (i3 in 2015), and recently **Mercedes Benz** South Africa (2016) are listed as the first OEM to initiate local production of eMobility platforms with the establishment of the manufacture of the C-Class with the latest plug-in-hybrid technology for both local and export markets.

• In 2015 Nissan SA and BMW SA signed a **Memorandum of Understanding** stipulating their **collaborative** efforts in the national implementation of Electric Vehicle **charging infrastructure**.

• dti green transport study report (2016) identified national projects and initiatives as 18 electric vehicle based, 12 gas vehicles and 5 liquid biofuels.
South African Regulatory Framework on EVs

**Department: Trade and Industry**
**REPUBLIC OF SOUTH AFRICA**

The IPAP 2015/2016 – 2018/2019 lists a number of intervention programmes to foster industrial development in a South African green economy. The electric vehicle (EV) project is one of them. The aim of the project is to stimulate the uptake of EVs into the SA transport sector, triggering a range of spin-off opportunities for new businesses supporting the industry through recharging infrastructure, energy storage components (batteries) and so forth.

**Department: Transport**
**REPUBLIC OF SOUTH AFRICA**

The Environmental Coordination Directorate in the Integrated Transport Plan is currently developing a Green Transport Strategy for the transport sector. The strategy aims to emphasise green transportation policy statements, whilst minimising the adverse impact of transport activities on the environment and addressing current and future transport demands based on sustainable development principles.

**Department: Energy**
**REPUBLIC OF SOUTH AFRICA**

The Department’s Energy Policy is based on the following key objectives: attaining universal access to energy, accessible, affordable and reliable energy, especially for the poor; diversifying primary energy sources and reducing dependency on coal; good governance, which must also facilitate and encourage private sector investments in the energy sector; environmentally responsible energy provision.

**Department: Environmental Affairs**
**REPUBLIC OF SOUTH AFRICA**

The Department of Environmental Affairs launched the Green Cars (ZERO Emission Electric Vehicles) programme in February 2013. The initiative seeks to ensure that South Africa contributes to the reduction of environmentally harmful gases by promoting the use of cleaner sources of fuel by the automotive industry. South African Governments through the Department of Environmental have also established the Green Fund to support the transition to a low-carbon development path.

**Department: Science and Technology**
**REPUBLIC OF SOUTH AFRICA**

The Department strives to support research and development of energy storage systems, with the objective being to develop energy storage technologies that meet the requirements of electricity suppliers for on grid storage, renewable energy integration and electric vehicle applications. Since 2011, the Department has been supporting the lithium-ion battery key programme aimed at local production of the batteries at highly competitive cost based on South African raw materials and intellectual property.
EV Projects and Demonstrations in South Africa

• Policy interventions through DoT (Green Transport Strategy and The Roads Policy), dti (Green Transport Study Report)
• UNIDO’s Low Carbon Transport South Africa Project (LCT SA)
• SANEDI’s Cleaner Mobility Programme
• The CSIR Energy Centre (EV Fleet)
• uYilo E-Mobility Programme
• GIZ Transport NAMA Project
• E-Bike sharing schemes (Growthpoint, City of Tshwane pilot, University of Stellenbosch, NMMU)
• EV Charging infrastructure roll outs (LCT SA, SANEDI’s Cleaner Mobility, City of Tshwane, City of Cape Town)
• EV Public transport developments (MyCiTi e-Buses, 100% tuk-tuks by Mellow Cabs, the green cab, Futran system-concept stage)
• Blue-Rock village
• Awareness creation efforts- Solar challenge, low carbon race (WWF), Communications and PR Strategies to communicate the right message, EV Media masterclasses
• Capacity building through EVIA workshops, myth busting sessions, EV training and manuals to guide stakeholders switching to an electric drive
• Supporting of government departments in converting part of their fleet to EVs
South African landscape of public charging infrastructure

12 national cities have a total of 95 stations

- 77 standard chargers (green)
- 18 fast chargers (blue)
eMobility – Past, Present and Future...

2014 and beyond:

- Transition from early niche market to mainstream consumers
- Many new technologies can be pulled into the market
- ‘Big Ideas’ will play a pivotal role in shaping the future of eMobility

Source: Gartner Hype Cycle; Urban Foresight Limited
Global Statistics

- Electric Vehicles (EV) and charging infrastructure deployment has continued growing exponentially since 2013
- Battery costs have come down while their energy density has climbed
- Vehicle electrification has gone multi-modal with 46,000 electric buses and 235 million electric two-wheelers deployed
- Total EV spending by EVI governments equaled 16 billion USD between 2008-2014

In 2011 global plug-in electric vehicles (PEV) in were just 50,000 units

Sales increased by about 80% in 2015 to 565,668 units
• The market for EV is currently growing by 60% year-on-year and there are already more than 1 million on the roads

• Battery costs fell by 73% to $268/kWh in the seven years to 2015 and predicts they will reach $100/kWh by 2020 (US Department of Energy, Tesla)

• EVs will be cheaper than conventional internal combustion engines from 2020 and could have a fifth of the road transport market by 2030 (Carbon Tracker)

• Cost of solar PV is 85% lower than it was seven years ago

• “Electric vehicles and solar power are game-changers that the fossil fuel industry consistently underestimates. Further innovation could make our scenarios look conservative in 5 years’ time, in which case the demand misread by companies will have been amplified even more.” (Senior researcher at Carbon Tracker)
Electric Mobility (eMobility)

WHY?

• Economic stability – transition of dependency on oil and coal towards sustainable and renewable sources of energy
• Overall energy efficiency improvement across well-to-wheel within transportation
• Reduce emissions of Green-House-Gases in order to stabilize human-induced climate change

HOW?

• Diversity of electric-mobility options
• Convenient charging infrastructure
• Smart grid networks using renewable energy and efficient energy management
• Consumer awareness
Transitions to eMobility in our every day lives
Energy Efficiency within Mobility

Oil Well: 96% → Refinery: 90% → Distribution: 97% → Petrol Car: 18% (W→W)η = 15%

Coal Mine: 97% → Synfuel Plant: 40% → Distribution: 97% → Petrol Car: 18% (W→W)η = 7%

Coal Mine: 97% → Power Station: 35% → Distribution: 95% → Electric Car: 75% (W→W)η = 24%

Solar Farm → Distribution: 95% → Electric Car: 75% (W→W)η = 71%

Source: SANEDI
eMobility: Sustainable Product Life Cycle

- Vehicle manufacturers are developing sustainable and visionary concepts for mobility
- Sustainability now defines the product life cycle

Source: BMW
eMobility Infrastructure Landscape

Residential Garage:
Reduces charging time by 50% over level 1 charging solutions.

Fast-charging Stations:
Charge 80% of the battery in less than 20 minutes.

Retail Parking Lots:
User identification to ensure only authorized customers have access to charging stations.

Fleet Charging:
Energy management and remote monitoring capability in one complete solution.

Private Company Parking:
Free or pay-per-use services for employees and visitors.

Public Parking Garages:
Convenient public charging solutions along with payment options.

Public Parking:
Public charging provides easy access to recharge vehicles, combining parking and charging facilities in the same infrastructure.

Choose the color of your energy!

Source: Schneider Electric
eMobility Infrastructure – Charging Scenarios

**Mobile:** Charge time 6 – 8 hours

**Public:** Charge time 1 – 6 hours

**Residential:** Charge time 6 – 8 hours

**Public:** Fast Charging 15 – 30 minutes
eMobility Infrastructure – New technologies

**Battery swap stations**

Stationary wireless charging

Drivers will charge wirelessly when parked

Dynamic wireless charging

Charge While in Motion

Port city of Qingdao (China) battery units of over 40 buses are replaced two or three times each day.

Dynamic Wireless Power Transfer (DWPT) systems on the Strategic Road Network (SRN)
Vehicle-to-Grid (V2G)

- Using vehicle battery as storage
- Scheduling charging

**Benefits for Electricity Supplier:**
- Energy flow optimization during peak hours
  - The household sends power back to the grid during peak hours
  - The household has decreased energy consumption from the grid during peak hours

**Benefits for EV Users:**
- Lower energy price
- Increased security from blackouts
eMobility Infrastructure – Vehicle-to-Everything (V2X)

- Vehicle-to-Infrastructure (V2I) - vehicle communication with infrastructure elements
- Vehicle-to-Vehicle Communication (V2V) - data between vehicles (IoT)
- Vehicle-to-Pedestrians (V2P) - communication between the vehicles and pedestrians
- Vehicle-to-Everything (V2X) - data exchange with other vehicles and roadside units and infrastructure
Overall Scenario

**Sustainability** is about creating an *awareness* of our *impacts* on the people and the planet, to change *behavioural patterns* and *innovate* in ways to find *solutions* to *environmental*, *social* and *economic* issues, so that we can help to benefit the people and the planet today and in the *future*.

**Air quality** is one of the most pressing *global issues* of our time for human beings. The cities of the world contribute disproportionately to environmental damage, as they currently produce around 75% of carbon emissions.

With the present *energy* intensive modes of *urban development* and the predicted addition of three billion more city-dwellers by 2050, there is a *need* to take *quick* and large scale *action* to limit *climate change*.

According to various reports from the UN, in 2015 the *transport sector* was responsible for around one quarter of energy related *global greenhouse emissions* from fossil fuel combustion, and one fifth of total energy use. The transport sector has the highest CO₂ emissions growth of all sectors and is expected to grow one third by 2050.

*Transport* touches almost every one of our lives on a *daily* basis. Whether you are driving your kids to school, riding on the train or bus to work, taking a flight to a well-deserved holiday destination. The importance of transport to *economy* and *social wellbeing* is undeniable, as is transport’s impact on the environment as a major contributor of damaging climate *emissions* and air pollution *worldwide*. 
Future Trends

Today’s economies are dramatically changing, triggered by development in emerging markets, the accelerated rise of new technologies, sustainability policies, and changing consumer preferences around ownership. Digitization, increasing automation, and new business models have revolutionized other industries, and automotive will be no exception. These forces are giving rise to four disruptive technology-driven trends in the automotive sector: diverse mobility, autonomous driving, electrification, and connectivity. Most industry players and experts agree that the four trends will reinforce and accelerate one another, and that the automotive industry is ripe for disruption.

Electric vehicles are one of the most important ways to reduce motoring costs, reduce carbon use in transport, improve air quality and reduce global warming. Expect battery-powered vehicles to be 10% of the global market by 2020. Much of government economic stimulus packages for the auto industry have been linked to green tech, of which a huge proportion is things like battery technology.

16 million new cars a year are sold in EU alone. If we assume that up to 25% of the smallest car market could be electric cars within 10 years, that would mean over 1 million sold each year, at an average cost of EU11,000. Electric car sales would then be worth at least EU11bn a year in the EU.
Public transport options with zero emissions

Public transport’s GHG emissions can be broken down into two categories:

- emissions directly or indirectly by public transport operations and,
- emissions avoided as a result of its operations in a given region

The net carbon avoided is a result of the following:

Mode shift – avoided car trips through more use of public transport. On a per-passenger kilometer basis, emissions from single-occupancy vehicles are on average four times higher than the per-passenger kilometer emissions of public transport; these figures are even higher during peak times.

Congestion relief – reduced fossil fuel emissions as a result of reduced congestion.

Land use – infrastructure and urban form are strongly linked to climate mitigation. As urban areas become denser and come to rely more on public transport, CO2 emissions are reduced.

Source: UITP
Public transport options with zero emissions

Public transport modes: buses
- Increase routes / Efficiency
- Cleaner fuels
- Electric buses / Hybrid buses / Hydrogen buses
- Fuel-efficient driving
- New bus lines / BRT
- Technological enhancements

Public transport modes: trains, trams ("shift" and "improve")
- New lines and extensions
- Increased efficiency: technological enhancements, eco-driving and regenerative breaking

Combined mobility:
- Taxi
- Shared Transport Systems : Car-sharing / Bike-sharing
- Walking
- Cycling
Public transport options with zero emissions

Improvements and investments in infrastructure
- Green procurement
- Energy efficiency
- Station enhancements
- Office building eco-design
- Energy production

Awareness and action
- Stakeholder engagement
- External stakeholder engagement
- Carbon reduction strategies
Charging infrastructure options for electric city transport

Automated fast charging system

Source: ABB

Typical charge time of 4–6 minutes

Fully automated rooftop charging connection

Zurich, Switzerland

Battery Swapping

Source: Phoenix Contact

Battery units replaced two or three times each day

Port city of Qingdao, China
Charging infrastructure options for electric city transport

Dynamic charging

Inductive charging (Wireless)

Conductive charging includes the use of physical connections

Transfers power through a magnetic field

Sweden
SMART Revolution

CITIES AROUND THE WORLD ARE PLANNING A REVOLUTION IN THE NEXT 10 YEARS

SMART Buildings: At least 50% of buildings will be Green and Intelligent built with BIPV. Around 20% of the buildings will be Net Zero Buildings.

SMART Infrastructure: Multimodal Transport Hubs Providing Excellent Air, Rail, Road Connectivity to Other Mega Cities

SMART Energy: 20% of Energy Produced in the City will be Renewable (Wind, Solar etc)

SMART GRID: Infrastructure to Enable Real-time monitoring of power flow and Provide Energy Surplus Back to the Grid

Satellite Towns: Main City Centre will Merge with Several Satellite Towns to form ONE BIG MEGA CITY

SMART Cars: At least 10% of Cars will be Electric Vehicles, Free Fast Charging Stations at every half mile

Source: Google images

eMobility holds great promise for economic growth
uYilo eMobility Technology Innovation Programme

- Initiated in 2013 as a national multi-stakeholder technology development programme to support the creation of products and services for the eMobility industry in South Africa

- Provide Engineering Services, Specialised Facilities and Seed Funding for eMobility technology development

- Facilitate and co-ordinate eMobility Projects and Initiatives

- Seek to create multi-disciplinary teams that encompass government, industry and academia to support eMobility in South Africa

Key focus areas: battery technologies / systems, charging systems / grid integration and drive train technologies, enveloped by skills development
uYilo’s Multi-Departmental Approach

Science & Technology
- Support Primary Research
  - Energy storage & advance propulsion

Transport
- Legislation through NRCS
  - Green Transport Strategy
  - NMT Strategy

dti
- Drivers of EV Industry in SA through roadmap (IPAP)
  - Incentives; Supplier Development; Infrastructure Planning & Development; Market stimulation

Research Pipe to be Commercialised
- Storage Testing Centre (can become hub in Energy Storage Programme) & Other Engineering Services

Advisement
- DOT on relevant plugs and Charging Protocols; uYilo development of standards required for infrastructure

Collaborative project to meet KPA (such as infrastructure development & storage technologies)
- Responsible for execution

Sonedi
- Fuel Policies
  - Cleaner Mobility Programme
  - International Energy Agency

Climate Mitigation
- Business models, services & products for funding by IDC

E-Mobility Programme
- Champion for eMobility

IDC
- Funding for new EV Enterprise
Integrate and accelerate development and commercialisation of the various technology areas

Source: P3 Engineering (Pty) Ltd
Internal and External Activities

1. National Battery Testing Laboratory
2. Electric Vehicle Systems Laboratory for component support
3. Live Testing Environment for Research, Testing, Development and Demonstration

- Electric Vehicle Industry Association (EVIA)
  - Public Private Sector consortium to shape and simulate the local EV environment

- SABS / NAAMSA working group representation
  - Battery system standards
  - EV charging standards

- uYilo Kick Start Fund
  - An agile mechanism to fund demonstration, product development or research in:
    - Energy Storage
    - Niche EV Components
    - Charging Network Infrastructure
Thank You