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Electric mobility workshop

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Crown Plaza hotel, Nairobi

Innovation & Capacity Building along the E-mobility value chain

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E-Mobility Value chain

Value Chain - definition

value chain is a business model that describes the full range of activities needed to create a product or service.

Value chain – AEPEA-ACADEMIA definition

- A value chain is a business model that encompasses activities needed to create, add-value and/or adapt products and services to improve livelihoods and ensure sustainability

Key aspects of a value chain

- It is a step-by-step business and innovation model for transforming a product or service from idea to reality
- Value chains help in delivering value at the least possible costs
- The end goal of the value chain is to create a competitive advantage

E-mobility value chain

- Not a single value chain but a coalescing of 3 distinct one

Value chain of vehicles
- Vehicular conversions – motor vehicles & cycles
- Fiscal & Tax structure, Dumping of IC cars
- Drones as part of E-mobility – precursor to flying cars

Value chain of charging
- Charging stations
- Battery Swaps
- Battery types & recycling
- Hybrids of Electric + CNG or CBG or fuel cells or hydrogen

Value chain of supporting infrastructure
- Reliable Grid
- E-vehicles as grid backup &/or generators

- Funding incentives for RD&D, innovation
- Legislation & regulation
- Capacity building

National System of Innovation & Capacity building on E-mobility

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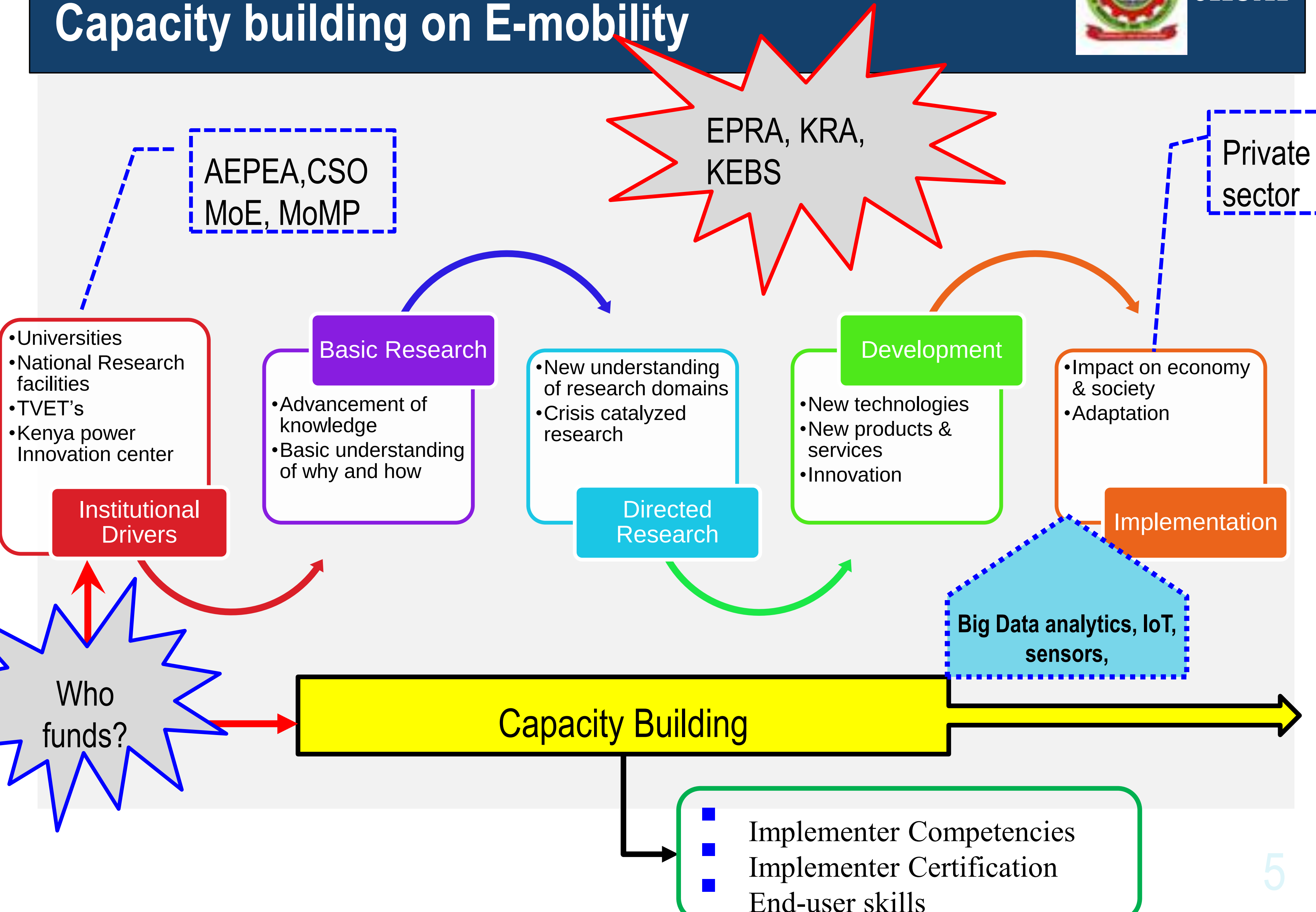

Research Areas : E-Mobilty value chain

End-use services: RD&D in Transportation

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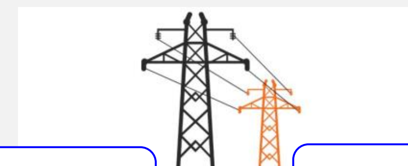
Market Model

Current status

Intermediate status

Co-existing future status

RE-filling / Recharging stations



Off-grid

Micro-grid

Fuel

Fossil Fuels
- Coal
- Petroleum
- Gas
- Oil Shale

CNG (Compressed Natural Gas)

or

CBM (Compressed Biomethane)

Renewable energy
- Biomass
- Geothermal
- Solar & Wind
- Hydro

R&C

Resource identification using remote sensing

Car conversions (USD 143,000)

CBM containerization (USD 57,000)

Mesoscale resource mapping (USD 55,000)

Table 3.1 Comparison of Different Battery Energy Storage Systems

	Lead acid	Nickel cadmium	Sodium sulphur	Lithium ion	Sodium nickel chloride
Achieved/demonstrated upper limit power	Multiple tens of MW	Tens of MW	MW scale	Tens of kW	Tens/low hundreds of kW
Specific energy (Wh/kg)	35 to 50	75	150 to 240	150 to 200	125
Specific power (W/kg)	75 to 300	150 to 300	90 to 230	200 to 315	130 to 160
Cycle life (cycles)	500 to 1500	2,500	2,500	1,000 to 10,000+	2,500+
Charge/discharge energy efficiency (%)	~80	~70	up to 90	~95	~90
Self discharge	2 to 5% per month	5 to 20% per month	#	~1% per month	#

Storage vs. conversion technologies

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Battery Type	Gravimetric Specific Energy [Wh/kg]	Volumetric Specific Energy [Wh/m^3]	Energy Efficiency [%]	Cycle Life	Self Discharge [%]
Hydrocarbon					
Gasoline	12,890	9.5×10^6	<30	-	0*
Hydrogen	39,720	Liquid: 2.8×10^6 700 bar: 1.6×10^6	Combustion: <25 Fuel cell: 50	-	0**
Natural Gas (250 bar)	14,890	10.1×10^4	?	-	0*
Kinetic					
Flywheel	12-30	?	80	-	100***
Electrostatic					
Ultracapacitors	3-5.5	6.8×10^3	>95	500,000	1
Electrochemical					
Lead/acid	35-50	1×10^5	>80	500-1000	0.6
Nickel/cadmium	50-60	3×10^5	75	800	1
Nickel/metal Hydride	70-95	1.4×10^5	70	750-1200+	6
Lithium-ion	118-196	$2\text{-}4 \times 10^5$	>95	1000+	0.7

*Leakage and/or vaporization is possible
**Diffusion through pressure vessel walls is common
***Flywheel spin-down time is approximately 30 minutes

Battery cell comparisons

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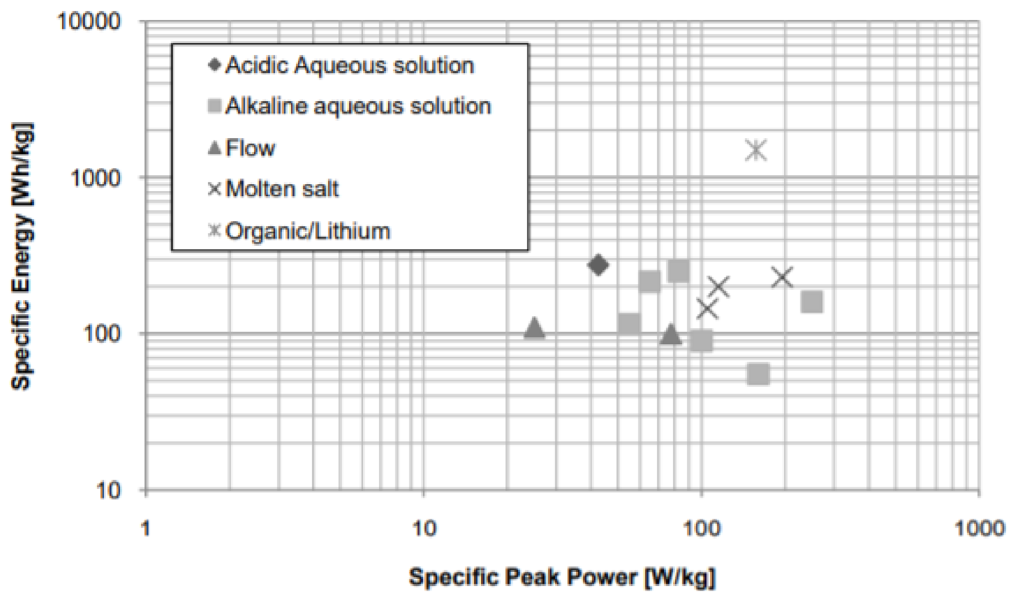
Battery Type	Specific Energy [Wh/kg]	Peak Power [W/kg]	Energy Efficiency [%]	Cycle Life	Self discharge [% per 48hr]	Cost [US$/kWhr]
Acidic aqueous solution						
Lead/acid	35-50	150-400	>80	500-1000	0.6	120-150
Alkaline aqueous solution						
Nickel/cadmium	50-60	80-150	75	800	1	250-350
Nickel/iron	50-60	80-150	75	1500-2000	3	200-400
Nickel/zinc	55-75	170-260	65	300	1.6	100-300
Nickel/metal Hydride	70-95	200-300	70	750-1200+	6	200-350
Aluminum/air	200-300	160	<50	?	?	?
Iron/air	80-120	90	60	500+	?	50
Zinc/air	100-220	30-80	60	600+	?	90-120
Flow						
Zinc/bromine	70-85	90-110	65-70	500-2000	?	200-250
Vanadium redox	20-30	110	75-85	-	-	400-450
Molten salt						
Sodium/sulfur	150-240	230	80	800+	0*	250-450
Sodium/nickel chloride	90-120	130-160	80	1200+	0*	230-345
Lithium/iron sulfide (FeS)	100-130	150-250	80	1000+	?	110
Organic/Lithium						
Lithium-ion	118-196	400-2600	>95	1000+	0.7	700



Renewable Energy Network

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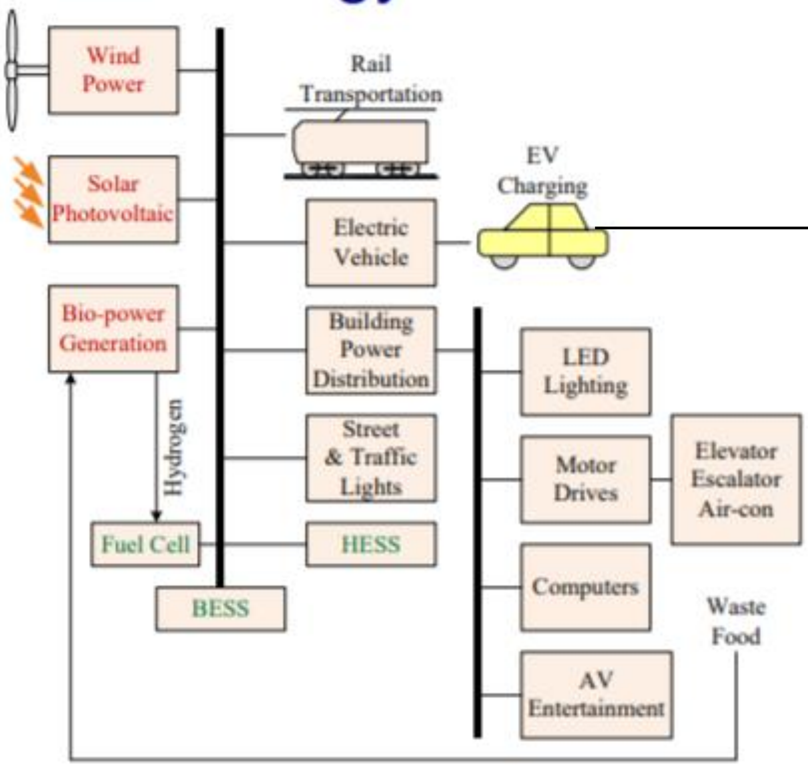
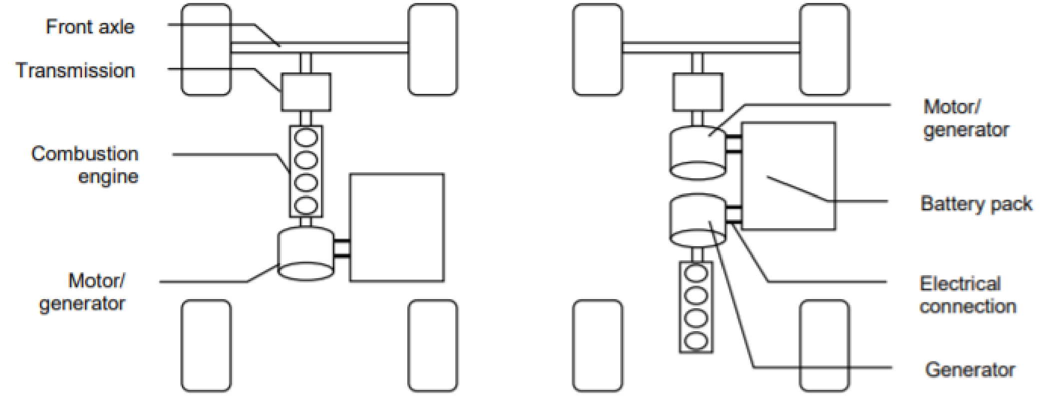


Electrical vehicle parallel or hybrid series configurations



parallel configurations

hybrid series configurations

Proposed drive topology for some Electrical vehicles

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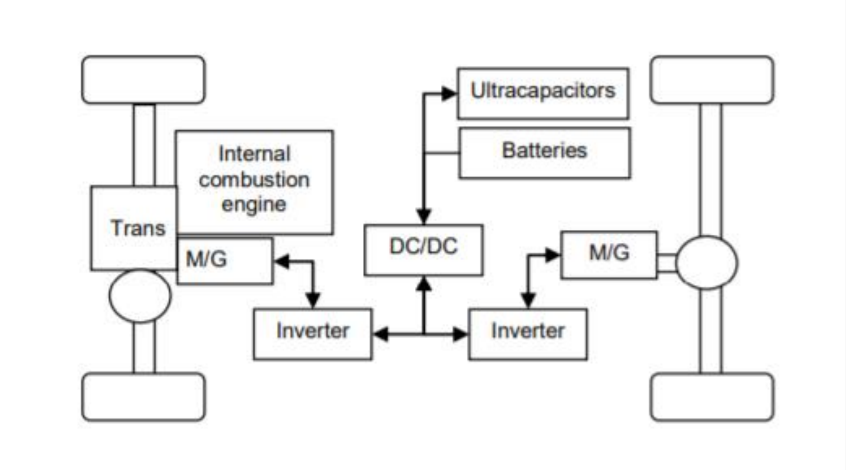

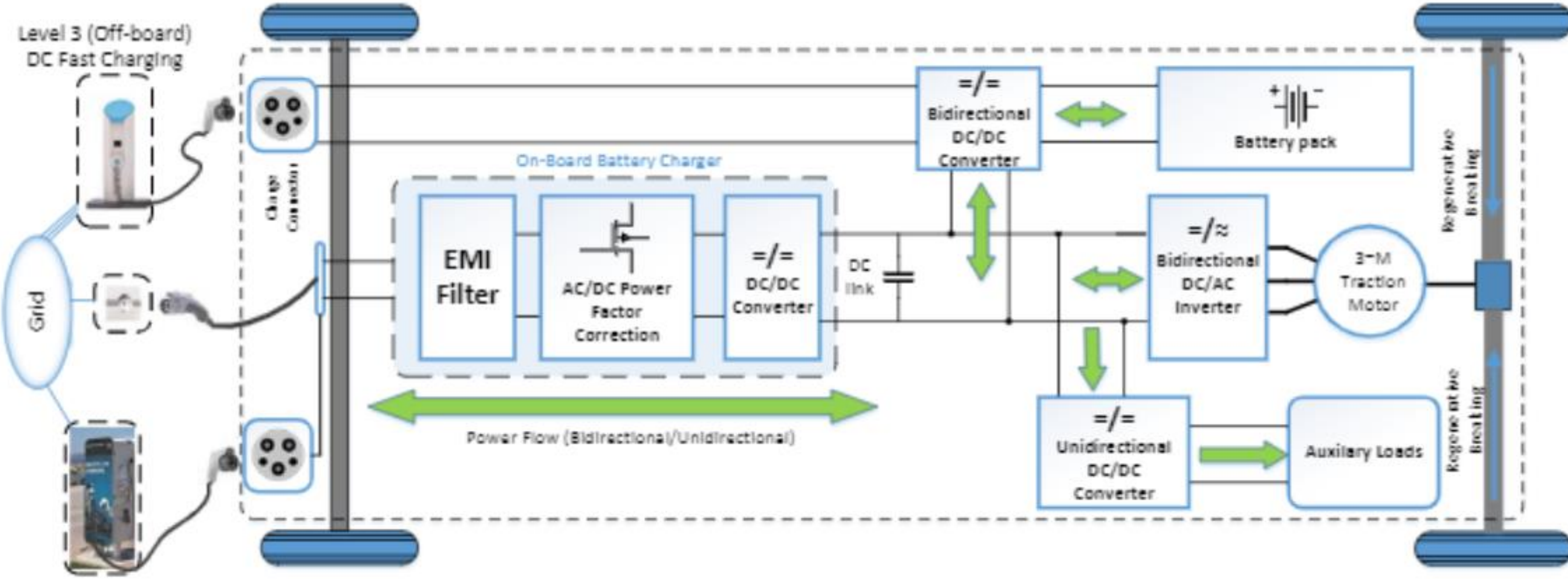

EV infrastructure - basic

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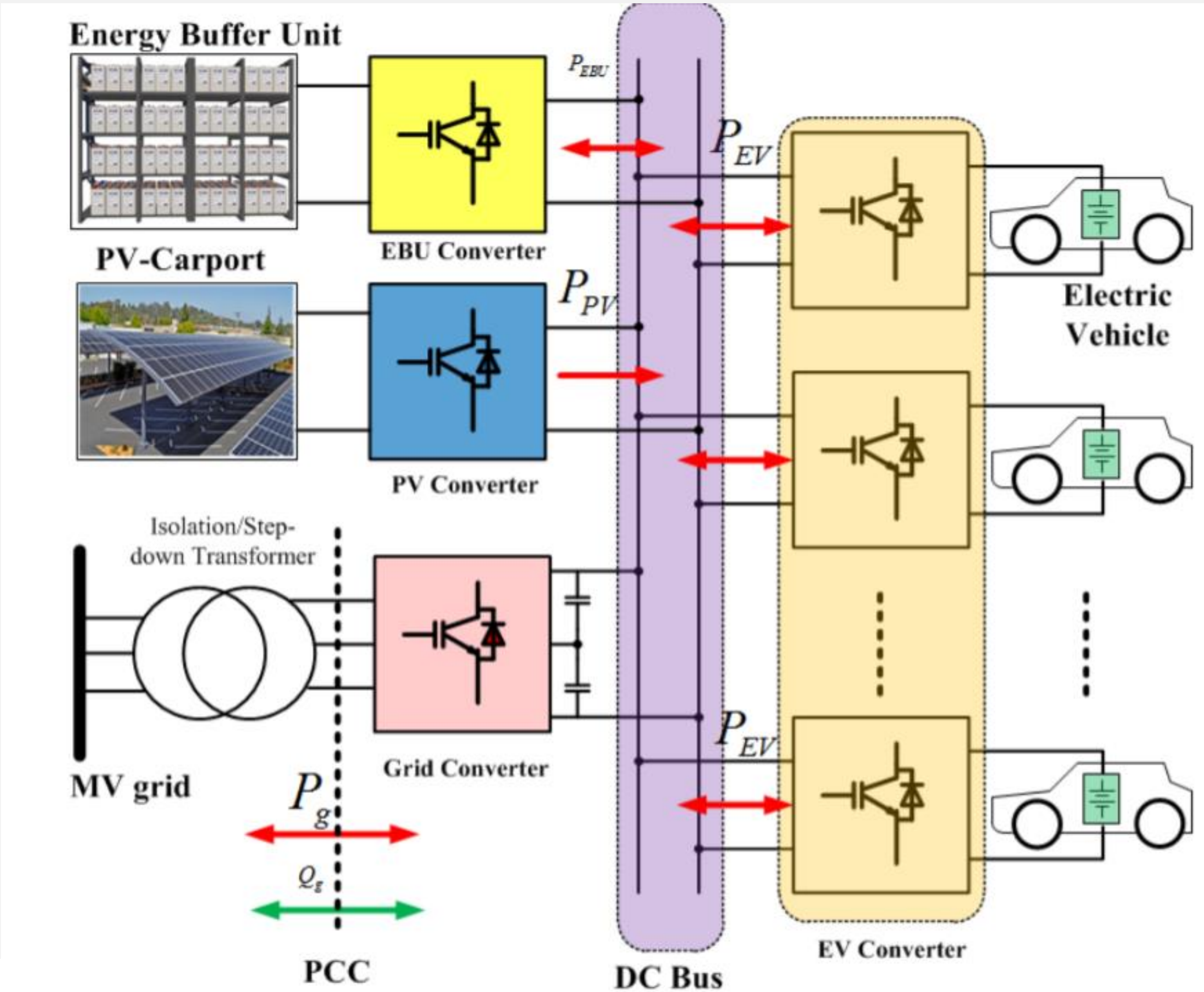

Modelling & Simulation

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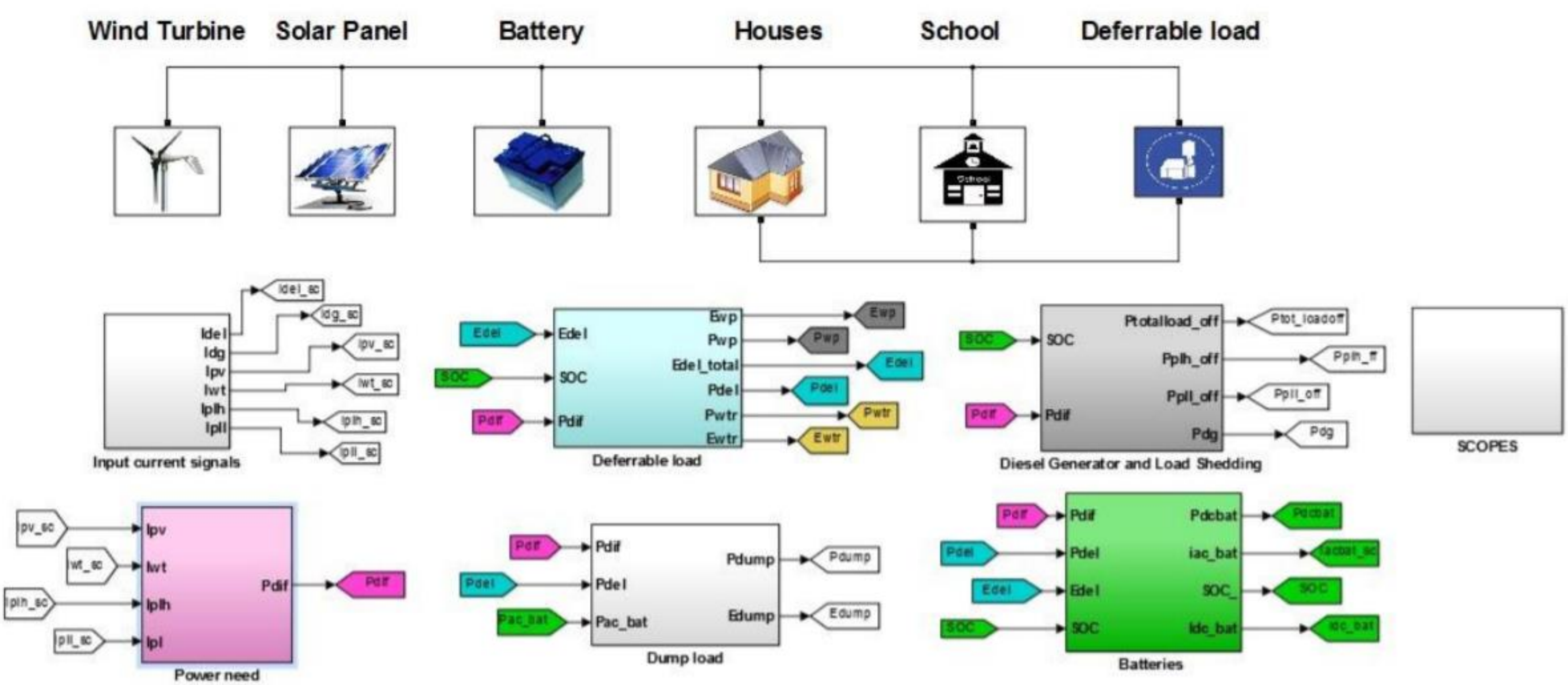

Figure 20. A general view of the model in Simulink-MATLAB

Challenges within the e-mobility value chain

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- Policy, Legislation & Regulations
  - Current status of E-mobility: KS ISO 8715:2001, 12405 – 1:2011, 23273:2013
- Costs – CAPEX (EV purchase, infrastructure support, modelling), OPEX
- Public awareness vs. Energy Service
- Environmental Concerns – vide LCA
- Sustainability & livelihoods improvements

Challenges

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- Capacity building – skills & Knowledge gap
- Poor infrastructure,
- Public awareness
- Lack of e-mobility policy / regulatory framework
- Research and innovation funding

Initial low hanging fruits

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1. Comprehensive **state of art and Future study** of Market, Taxation, fiscal support and regulatory state for E-mobility in Kenya (USD 40,000)
2. **Innovative funding** for study on Techno-economic internal combustion vehicular conversion to Electric vehicle (full or hybrid) (USD 250,000)
3. Establishment of **training & Certification courses**- Urgent Capacity needs assessment and skills gap identification study (USD 54,000) *** not including equipment support
4. **Establishment of E-mobility taskforce** with KEBS, KRA, AEPEA, IEET-JKUAT, Moi University to address targets, incentives, Policy, regulatory and legislative aspects (USD 250,000)
5. Undertaking of a current and future life cycle analysis of E-mobility value chain in Kenya (USD 70,000)
6. Establishment of an Innovators Research fund for research and innovation on E-Mobility and IP (USD 2,000,000)
7. Funding for IEET-JKUAT to undertake **an E-mobility infrastructure modelling and simulation** (USD 100,000)

WE need a paradigm shift, to consider appropriate approaches towards energy storage in Africa

Thank you