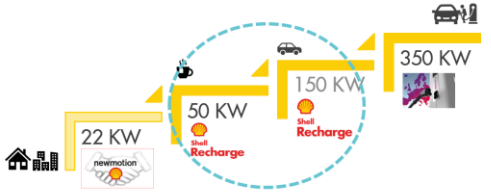
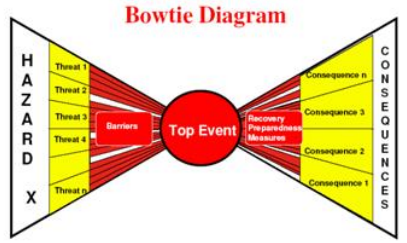
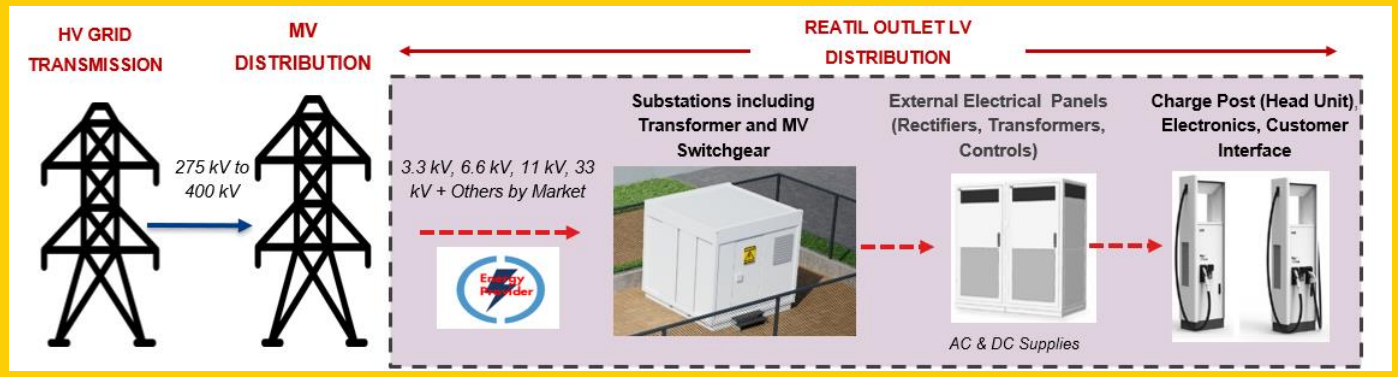


EV Charging - DOE Session



Paul Nichols Snr Design Engineer Shell

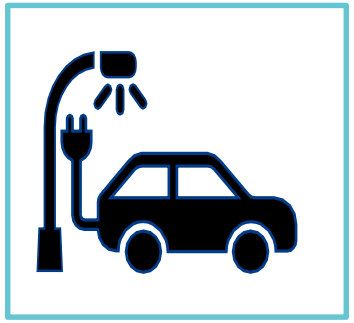
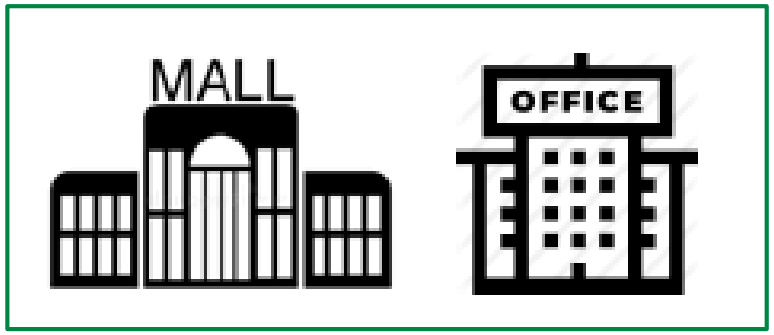


Times Are Changing !

EV Customer Segments



"Make EV drivers' lives as simple and stress-free as possible, through meeting all their charging needs, at home, at work, at destination and on-the-go"

Engineering Approach To EV Deployment

All Equipment 3rd Party Independently Assured to The Following Regional Standards:

Region	Applicable Standards
For Europe/Africa	IEC Standards
East Markets	IEC Standards
China	GBT Standards
USA & Canada	UL Standards

Peer Review Undertaken By Central Teams

Equipment Assured – 3rd Party IEC Certs

Safe Charging Control
Real Time Monitoring
(Car to Post)

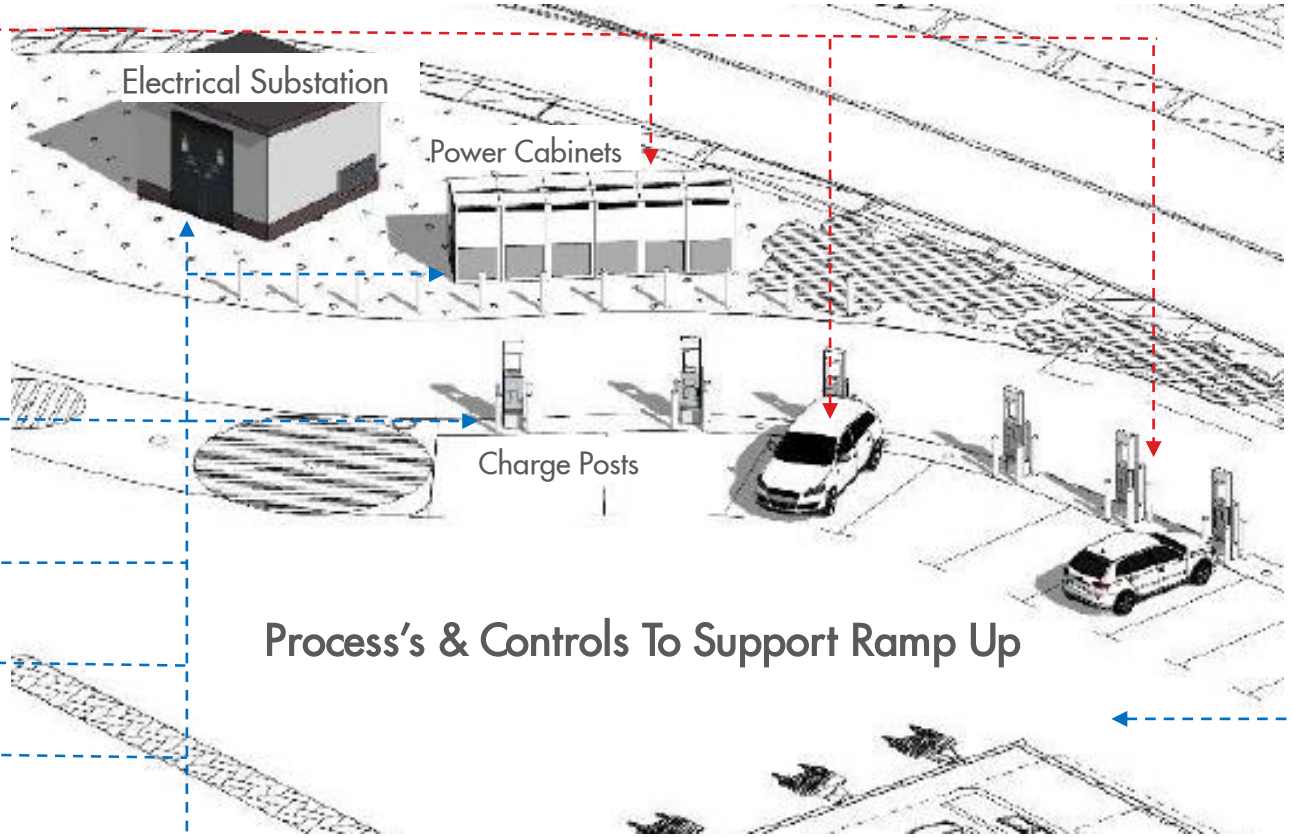
EV – Electrical Standards

Controlled Access

Infrastructure Design

Safety Interlocks

Equipment Impact Protection



Process's & Controls To Support Ramp Up

Separation Distances Hazardous Zones

Customer On Site Safety

E2E Project Management

Contractor Accreditation

Installation Standards, Process's & Controls

Site Acceptance Testing

Site Staff Training

Site Specific ERP

Maintenance Process's & Procedures – CEI

Safe Execution

Safe Operations

EV Technical Assurance Peer Review

Technical Assurance Process (Peer Review)

Step A: Charging Equipment

Step B: Site Design (3 Parts)

Step C: Installation, Commissioning & Handover

GFA 2019

STAGE 1	STAGE 2	
Site layout and design (Haz Zones)	Routing of Services, Cables & Incoming Feed	End-to-End (E2E) Integration of Electrical Infrastructure – Protection & Control Measures

Green Banding

Challenges, Known and Unknown Unknowns !

- Fast Moving Space with limited standardisation across:- Car Types, Charging Solutions, (AC/DC, Charge Rates 5.5Kw to 350Kw, Connectivity CCS, GBT, Chademo, Equipment Architecture, Multiple Regulators & Stakeholders.
- Wide Range of Equipment Suppliers for Charging Equipment & Infrastructure.
- Different Technical Standards – IEC, GBT, UL, Multiple CPO's Communication, Payment & Operation.
- Evolving Customer Needs, Changing Use Cases – Limited Data on EV Customer Behaviour. Market needs Expanding "Vertically and Horizontally". High Risk of Regret Costs or Higher Upfront Investment to Future Proof or Re-Investment.
- Growing knowledge base across industry, fast ramp up in parallel with innovation & changing legislation
- Space and Grid Constraints Across Existing Sites. Multiple Utility Interfaces, Time Bound Activities (26 to 103 w)
- System Losses & Equipment Efficiencies, Variable Tariffs ! High Cost Investment & Challenging Return on Investment.
- Supply Chain Under Pressure, Delays on Sub-Components – Expanding Lead times on Equipment





Safety Features/Risk Mitigation: Charging Equipment

EV Chargers OEM: Equipment Assurance Complete + Full Verification from 3rd Party Independent Test Houses

For CHARGE POSTS in TERRITORIES Complying to UL Standards

UL2594 Safety Electric Vehicle Supply Equipment

UL2231-1 Safety Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements

UL2231-2 Personal Protection Systems for Electric Vehicle Supply Circuits – Protective Devices for Use in Charging Systems

UL2202 Safety Electric Vehicle (EV) Charging System Equipment

UL2251 Plugs, Receptacles, and Couplers for Electric Vehicles

SAE J1772 SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler

CAN/CSA C22.1 (specially for CA.)

AC, the required 3rd party certificates include IEC 61851-1, IEC-62196-1, IEC-62196-2 (latest version). Or **UL2594 for US.**

DC, the required 3rd party certificates include IEC 61851-1 , IEC 61851-23, IEC 61851-21-2, IEC 61851-24, IEC 62196-1 , IEC 62196-3. Or UL 2594, UL 2202, UL 2251, UL 2231-1/-2 or SAE J 1722 for US (North America certification request from a Nationally Recognized Test Lab (NRTL).)

All Equipment 3rd Party Independently Assured to The Following Regional Standards:

Region	Applicable Standards
For Europe & Africa	IEC Standards
East Markets	IEC Standards
China	GBT Standards
USA & Canada	Ul Standards

Peer Review Undertaken By Central Teams


IEC 61851-23

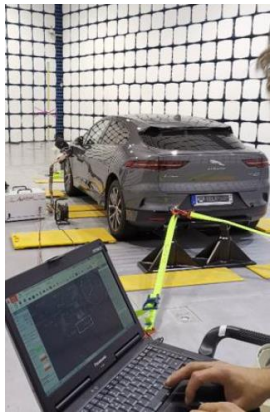
Edition 1.0 2014-03

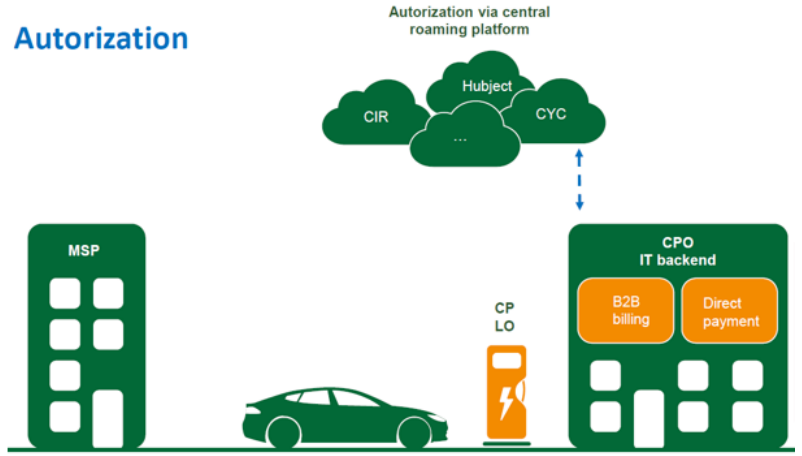
INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electric vehicle conductive charging system – Part 23: DC electric vehicle charging station

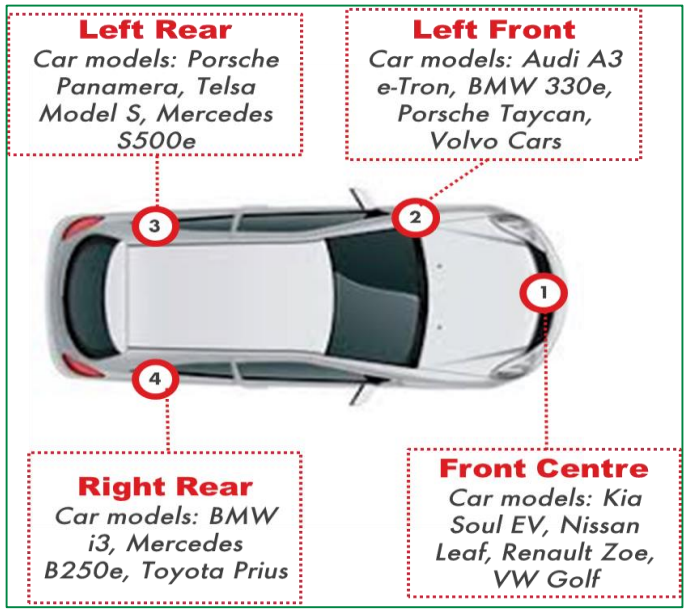
Système de charge conductive pour véhicules électriques – Partie 23: Borne de charge en courant continu pour véhicules électriques





Charge Bay Design – Connector Location

Charge inlet on a car can be located at different positions: Front Centre, Left Front, Left Rear & Right Rear, considerations need to be given to the position the charger and optimum charger cable length to guarantee access to all inlet positions.



Bay Dimensions & Topology

Minimum sizes of charge bays need to support charging activity and size of vehicles.

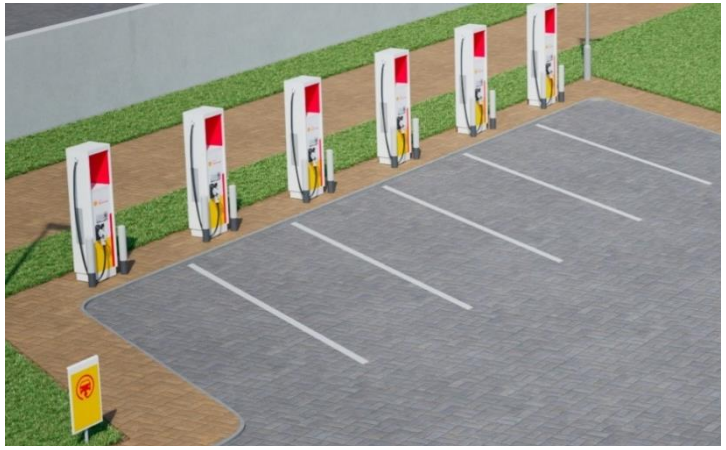
DDA Compliance for Selected Bays.

Align Topology to number of connector types Reqd.

- 1 to 1 Topology offer 2 connector types per Bay.
- 1 to 2 Topology offers 1 connector type per bay

Charge Bay Design

End Bay – 90° Parking (Most Common)



Advantage

- The headpost is located on a kerb, at the end of the bay, in the centre. Each head post shall be protected with bollards. This arrangement is an easy retrofitting option for existing car parking space.
- It is also suitable for sites with limited space.

Disadvantage:

- EVs with charging inlets on left rear or right rear, need to reverse into the charge bay in order to connect – or use longer Cables.

Alternative Designs

End Bay – 60° Angled Parking

Very similar to the 90 degree end bay design, but not ideal as difficult to perform reverse parking

Mid Bay

Advantage:

- Shorter cable length required (< 4 m)
- EV drivers do not need to reverse in or out.

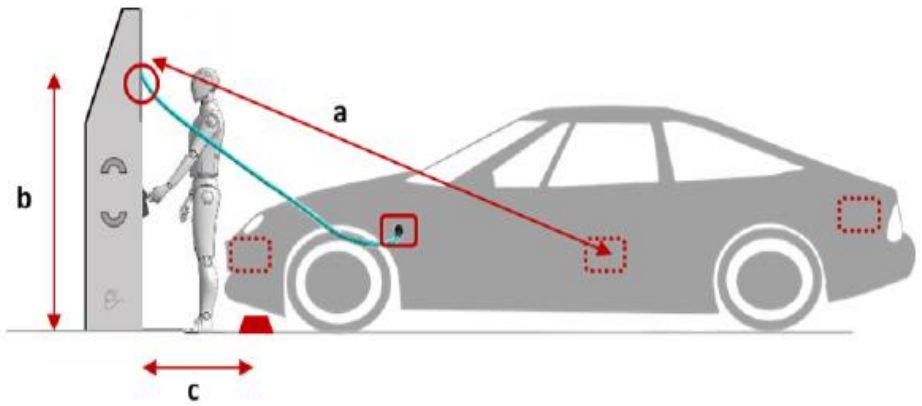
Disadvantage:

- Larger space requirement due to the additional of mid-islands.
- Confusion for EV drivers for which charger to connect to
- Risk of car door knocking on to bollards which are located in front of the charger

Drive Through – Starter Gate

Drive Through – Petrol station design

Charger Cable Length

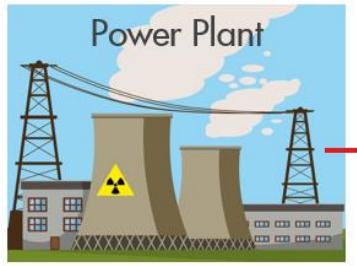


EV Charger from different suppliers offer varying cable lengths and extension options. When choosing a suitable cable length, considerations should be given to ensure that the cable can reach the charge inlet on EV vehicles of all variant and it does not touch the ground (high risk of being tangled and faster wear and tear).

Cable weight should also be taken into consideration as it affects customer experience.

For End Bay (90°) Design, the recommended cable length is 4m. For practical purpose (weight and trip hazard considerations), please note that cables shall be no more than 4m in length, otherwise an active cable management system needs to be considered.

Typical Infrastructure - Serving Shell Sites for EV



STEP-UP TRANSFORMER

Country Wide HV Transmission Grid (275KV to 400KV)

Grid Reinforcement Very High Cost – Long Duration

Country Wide Transmission High Voltage Grid 400 Kv

MV Distribution Network (DNO) (133Kv, 33Kv or 11Kv)

Network (Grid) Upgrade (New Supply)

HV / MV Step Down Sub Station 400Kv To 133Kv, 33Kv or 11KV

Regional / Local Distribution Network Medium Voltage 133, 33 or 11Kv

Option a) DNO Owned & Operated Substation – LV Supply To Shell

Option b) DNO MV Supply Shell Owned & Operated Substation

MV / LV Step Down Sub Station 133/33/11KV to 415V

MV / LV Step Down Sub Station 133/33/11KV to 415V

415v AC

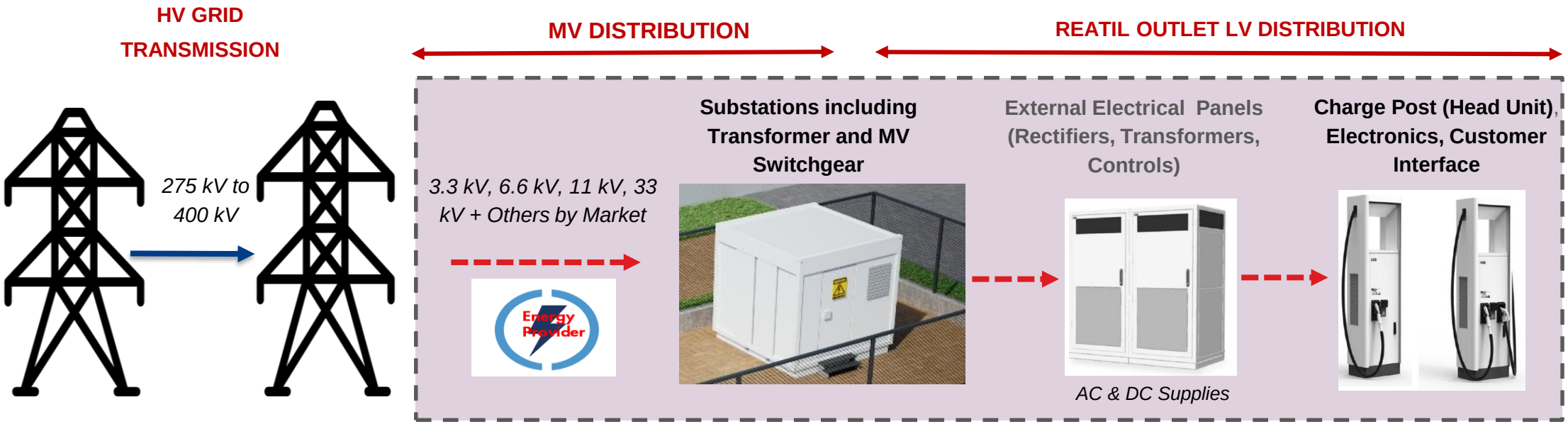
415v AC

480v DC

Customer Load Requirements Low Voltage Equipment's 415 & 240v AC, 480V to 1000 v DC

Site Electrical Arrangements for High-Power Charging

150kW HPC Chargers (DC)



- Higher Connected Loads Require MV distribution onto Retail Sites and include additional Assets (Transformer & MV Switchgear) Shell Owned – Or by Others.
- Increasing EV Loads (630KVA Up to 2MW) Vs typical current site load of 100kW
- DNO's/DSO's Manage applications for any increases requirements in site Load.

Key Infrastructure Components

Transmission Substation Step Down 400KV to 133, 33 or 11KV to (Primary)

Medium Voltage Switchgear

Packaged Sub Station – MV Side

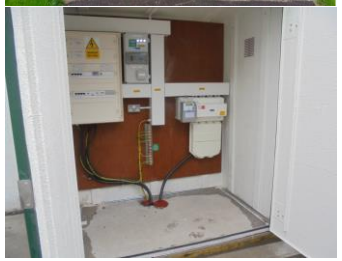
Packaged Sub Station – LV Panels

Transformer 800KVA

Liquid Filled Transformer – 1000KVA

Battery Energy Storage System (350KW)

Civilis Works Trenching, Foundations, Ducting & Charge Bays



Grid Cabinet & Metering

Low Voltage Electrical Panel

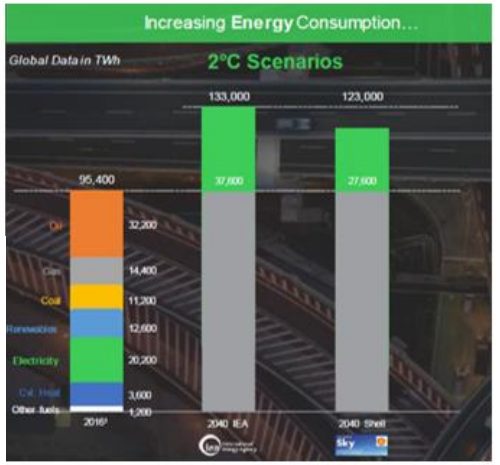
Air Circuit Breaker

Moulded Case Circuit Breaker

Opportunities Across Electrification of the Transport Sector

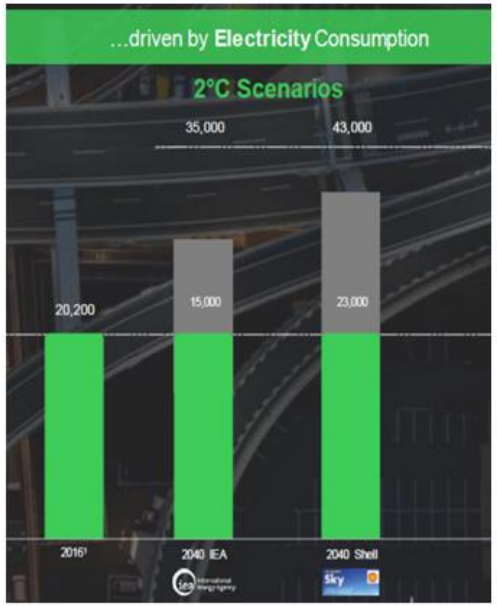
*Electrification of Transport Sector is Dependant upon the **Availability of Capacity** from Distribution Network Operators Markets moving to Zero Carbon Energy Sources. Use of Renewables, adoption of Distributed Energy Resources (DER's) is driving the Evolution of Transmission & Distribution Networks*

Multiple Entities involved, Limited Standardisation. Fast Moving Space, Innovation driven.



Sky Scenarios – Doubles the amount of Electrical Energy needed by 2040

- Stronger Collaboration Across all players – Car OEMS, EVSE Manufacturers, Utility Company's, Regulatory Bodies, Academia, Installers, Operators, Investors & Asset Owners.
- Wider understanding of "Pain Points" – Common approach to solutions. Continual Improvement - Hardware, Infrastructure and Maintenance.
- Affordable Flexibility of Solutions, To Enable Fast Moving Space – (No Regret Costs or Stranded Assets) Modularize Solutions.
- De-constrain Grid Dependency – Battery Storage DC Ready Grids For Renewables
- Robust & Resilient equipment, TCO focus - high efficiency low leakage on performance and operating costs.
- Base Line – Must Scale Safely across applications both OTG, Hub, Car Parks and other Destinations.
- Industry Accreditation, Training and Upskilling Teams & Partners.
- Sustainable Solutions across Supply Chain (EG SF6 Free products) – EOL Disposals – Battery Re-purposing and Recycling.



Thank You

Paul Nichols

Shell Recharge