LV Engine – Smart Energy Hub Providing Hybrid LVDC/LVAC Networks

James Yu – Head of Innovation

Future Networks
SP Energy Networks

• TNO and DNO for Southern and Central Scotland
• DNO for Merseyside and North Wales
• 44,000km Overhead Lines
• 65,000km Underground Cables
• Over 3000 substations
• A Total of 3.5 Million Customers
Innovation Strategy

The Future Networks team are delivering our innovation strategy through;

• Industry leading expertise
• Concentrating on creating a positive and lasting impact on the future of distribution and transmission
• Two major fields of focus – black start and power electronics

**Black Start**
- Black Start since 2015
- Range of partners
- Built expertise and capabilities

**Power Electronics**
- Implementation across voltages on transmission and distribution networks
Phoenix

Synchronous condensers + static compensator technologies - manage reduced inertia and voltage control on Transmission Network.

Angle-DC

Medium Voltage DC (MVDC) link to Anglesey, increased renewable generation integration.

LV Engine

Trial of innovative Smart Transformers for the connection of LCTs

£120m investment in RIIO-2 Business plan - implementation of synchronous condensers at Eccles

3 further sites planned to roll out LV Engine Technology within RIIO-ED2
Transmission Network Reliability/Security

**VISOR**
Greater visibility of network state and assets

**FITNESS**
Efficient and effective digital substation

**Distributed Restart**
DERs supporting the network and restoring power

**Synthesis**
Advanced analytics and real-time control enabling rapid response to system disturbances

£13.59m further investment for SPT, estimated £40m for other GB Transmission business

£54m investment in RIIO-2 Business plan - digital substations - Westfield and Hunterston

£5m Green Recovery Fund: Synergy 2023-SIF: Black-start from the offshore
LV Network operation - background
Growing Voltage and Thermal Issues
- Distribution Networks

- Increase in demand and LV DG connections
- The additional demand caused by EVs and heat pumps
- Uncertainties in LCTs growth (when, where, how much..)
- Increasing demand for the supply of DC power
LV Engine

Better Use of Assets
- Capacity Sharing between substations and on AC and DC
- Increases available transformers capacity

Intelligent LV Voltage Regulation
- Voltage regulation based on voltage profile
- Alleviates LV voltage depression

Public LVDC Network
- Low voltage DC network for, better efficiency,
- Allows Rapid Chargers to connect directly to DC network

£8.3m Project funded through NIC mechanism. Completion by end of 2024
LV Engine

• **Globally innovative trial** of power electronic technologies

• Distribution network at secondary substations

• **Enhance** network flexibility and Controllability

• For **additional capacity** and facilitate the implementation of Low Carbon Technologies
Project partners
Design optioneering

- Improved performance during the fault
- Improved efficiency
- Smaller power electronics power rating
- Bypass possibility
- Smaller dimensions
- Improved overall reliability
Products – PED (UPFC)
• Voltage control: **36.8 V boost/ buck**

• Power factor correction: **0.9 (lead/lag) to unity**

• Load imbalance cancelation: **30%**

• LV DC supply: **150 kW**

• Control power flow: **P and Q control**

<table>
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<th>Priority</th>
<th>Total load</th>
<th>Total Imbalance cancelation</th>
<th>PF target</th>
<th>Voltage control (boost/buck)</th>
<th>DC</th>
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Electrical Design
LV Engine test bay in PNDC 2023
Supplying AC and DC load

Phase Voltage Regulation for each phase independently

AC and DC Loads
Trial Sites

Supplying an LVDC customer (150kW ultra-rapid EV) charger)
What’s next for LV Engine?

- Installation and Commissioning being planned - three sites until end of 2024.
- Performance monitoring, operational experience, more documentations for BAU adoption.
- Manufacturing another unit (next gen) based on learnings in live trial.
- More disseminations and site visits for stakeholders.
- Project replications and BAU integration.