Appendix #	Subject	Reference in proforma
Appendix 1	University of Bath letter of engagement and support, and their data analysis methodology	Boxes 1, 18
Appendix 2	Memorandum of Understanding between WPD and npower	Box 25
Appendix 3	Customer communications pack	Box 2
Appendix 4	Installing monitoring in LV substations	Box 4
Appendix 5	Support letters – University of Bristol / WAG	Boxes 18, 23
Appendix 6	Sample extract of Arbed data (anonymised)	Box 23
Appendix 7	RFQ issued to meter installers re the installation of voltage sensors at end of feeders / Provisional design of end-of-feeder voltage monitors	Box 25
Appendix 8	**An overview on the concept of network templates**	**Box 1**

Appendix 8: An overview on the concept of network templates

Research and consultancy bodies have put forward the concept of classifying networks into various types having regard to both the nature of the network itself and the types of customer demand connected to those.

The ENA commissioned work in early 2010 lead by by Goran Strabac the Centre for Sustainable Energy and Distributed Generation at Imperial College; " Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks " . This work studied the impacts of low carbon stresses arsing from the roll out of electric vehicles and heat pumps across network topographies representing urban, semi urban and rural networks having demand densities of 8, 2 and 0.5 MVA per sq km. It concluded that very substantial savings could be made though employment of smart network management techniques including demand side management time shifting. It postulated further benefits from voltage optimisation and a widening of acceptable UK voltage bandwidth from 230V +10/-6% to 230V +/- 10%.

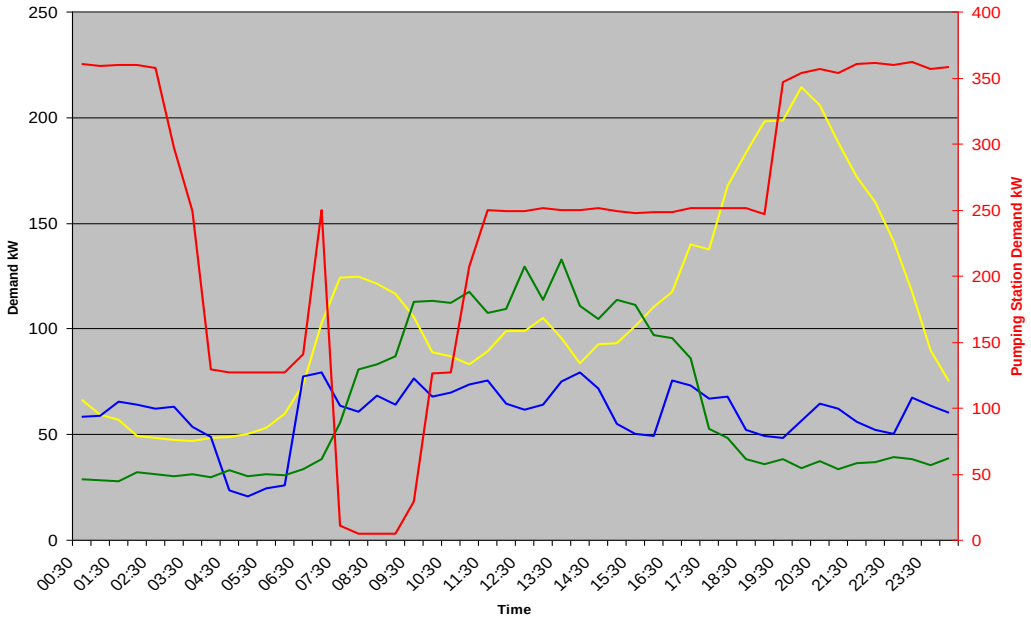
The ENA Energy Futures Strategy Group (ENFG) appointed KEMA consulting, and proposed a more granular approach using so called network "templates" ; these characterise the combinations of network topography and customer demand type. Extracts from their work with ENA are presented in the following four pages.

The ENA / KEMA approach meshed well with substation monitoring proposals that WPD have discussed with Ofgem and DECC during the past two years, and the experience gained by WPD during the Pontypool IFI project. Sample daily load curves from that project output are attached.

Whilst it is patently clear that some groupings of customer demand afford the potential for demand time shifting, it is equally evident that some others, notably dense urban retail areas, are unlikely to provide such capability during the times when customers need additional energy to charge electric vehicles during shopping trips or during the working day. There are different network topographies, types and densities and little is known, at scale, of the voltage behaviours associated with these combinations of networks and customers.

Coincident monitoring of substation demand, voltage together with LV end of feeder voltages will provide the data to test the statistical robustness of the template proposition.

WPD example daily load profiles on individual HV/LV substations in Pontypool IFI project



Key:

Red = Water Pumping Station	Blue = 24hr Shift
Green = Business	Yellow = Domestic

energynetworks association

KEMA

Template	Building Blocks for: Smart Urban			
Variant	Variant 1: **City Centre**	Variant 2: **Town**	Variant 3: **Residential Suburb**	Variant 4: **Super urban**
Social character	Large Public buildings Large shops Large offices/Commuters Car parks – multi deck Theatres, museums, cinemas Transport Hubs High-rise Housing Street Lighting	Community housing Shops and supermarkets Small car parks Medium Public building High rise commercial/residential Lower profile public transport Leisure centres	Domestic housing Home charging Local supermarkets Small public building/Schools Limited street charging High rise residential Parks/Green Areas	Super Commuters Investment banks Government Offices Data/Server Centres (MW scale)
Network character	Dense UGC HV network with multiple open rings and potential interconnection. Supplied from two or more grids. Many opportunities for reconfiguration at LV using link boxes or street pillars. EHV/HV Interconnection opportunities Summer loading Higher security (CBD) HILP MGT Different daily load profile Risk of high ambient periods on cyclic rating High value of summer DSM	UGC HV network with open rings. Less dense (i.e. fewer circuits and secondary subs) than city centre variant. Many opportunities for reconfiguration at LV with link boxes or street pillars, commercial DG / export. Supplied from two or more primary substations. Note difference within MANWEB licence area.	LV UGC distribution from several secondary substations. Supplied from open HV ring main. Reconfiguration possible at LV with link boxes or street pillars, Home DG / export Community scheme generation School-based DG	Dense EHV Cable Tunnel Infrastructure Very high load density 132/11kV Direct transformation Difficult network access Multi-level UG grid substations High security (P2/6+) Interconnected LV/MV networks
Element 1: **Buildings**	• Building controller interface (multi function) • Smart street lighting • Flood lighting • Air Cooling/CCHP • Limited standby generation	• Building controller interface (medium function) • Leisure centres (CHP) • Centrally Controlled Heating (community housing)	• Building controller interface (basic function) • Home controller interface • Export DG/PV/Microgeneration • Smart Appliances/White Goods	•Standby generation •Building controller interface (multi function)
Element 2: **Transport**	• Multi storey car park charging • Street charging posts • Fast charging facility • Smart public transport (trams, buses)	• Car park charging • Street charging posts • Fast charging facility • Residential charging • Supermarket charging	• Home charging • Street charging posts • Fast charging facility? • Bike charging post	
Element 3: **Network**	• Capacity management • Active Network Mgt • DG and VPP services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Fault current limiter • Dispersed storage • Centralised storage • Smart Metering (Residential/SME)	• Capacity management • Active Network Mgt • DG and VPP services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Fault current limiter • Dispersed storage • Centralised storage • Smart Metering (Residential/SME)	• Capacity management • Active Network Mgt • DG and VPP services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Smart Metering (Residential)	

Further possible variants:

New Towns with integrated housing, commerce and leisure

Industrial

Template	Building Blocks for: Smart Village			
Variant	Variant 1: **Satellite Village**	Variant 2: **Deep Rural Village***	Variant 3: **Large Rural Village**	Variant 4: Small Town
Social character	Close to a town Short journeys (EV) Low and medium rise houses Small shops On street charging Charging at home Public e-transport	Low rise houses Farms Small shops Charging at home No public transport Strong local identity Agriculture related load and DG	Low rise houses Small shops Small supermarkets On street charging Charging at home Limited public transport Strong local identity SME Agriculture/processors and DG	Low rise houses Small shops Larger supermarkets On street charging Charging at home Trains, more transport links than large rural village Local energy saving schemes New Ecotowns - DG
Network character	UGC supply, 11kV. Reconfiguration possible at LV with link boxes or street pillars. Mix GMT and PMT. Primary substation (as town evolved to meet it) and some overhead HV and LV	11kV and LV OHL supply. Fed from rural primary substation. PMTs. Potential for a single source of supply (may be spur). May have two phase supplies used for small isolated loads. Farm loads. Medium scale wind DG, long OHL feeders. Fewer communication options. No main gas	33 or 11kV OHL supply depending on demand. LV overhead and underground. GMT and PMTs. Two sources of supply likely. Reconfiguration possible at LV with link boxes or street pillars. Farm loads. Medium scale wind DG. Fewer communication options. No main gas	Primary substation – feeds underground central and external rural overheads – Hamlets, villages, farms. Mainly GMT, PMT boundary. Variable broadband speed available Small CHP, sewage plant
Element 1: **Buildings**	• Building controller interface • Smart street lighting • Home controller interface • DG/PV export	• Building controller interface • Home controller interface • Mansion / estate interface • DG / PV export	• Building controller interface • Home controller interface • Mansion / estate interface • DG / PV export • Water/sewage plants infrastructure • CHP	• Building controller interface • Home controller interface • Mansion / estate interface • DG / PV export • Water/sewage plants infrastructure • CHP
Element 2: **Transport**	• Car park • Home charging • Street charging posts • Fast charging facility • Bike charging post • Smart public e-transport (trams, trains, bus)	• Home charging • Fast charging facility	• Street charging posts • Fast charging facility • Home charging • Rail?	• Street charging posts • Fast charging facility • Home charging • Rail
Element 3: **Network**	• Capacity management • Active Network Mgt • DG and VPP services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Centralised storage • Smart Metering (Residential/SME)	• Capacity management • Active Network Mgt • DG and VPP services** • Remote DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed micro storage • Centralised medium storage • Intentional islanding • Intelligent voltage control • Comms, sensor nodes, quantity, distances differ for multiple PMTs vs GMTs • Diff ratio DG/demand? • Smart Metering (Residential)	• Capacity management • Active Network Mgt • DG and VPP services** • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Centralised storage • Intelligent voltage control • Comms, sensor nodes, quantity, distances differ for multiple PMTs vs GMTs • Different ratio DG/demand? • Smart Metering (Residential/SME)	•Capacity management •Active Network Mgt •DG and VPP services/ DG for satellite •DA & DM of 33/11 kV SS •DA & DM of 11/LV kV SS •Dynamic rating equipment 33 kV, 11 kV and lower •Dispersed storage •Centralised storage •Intelligent voltage control •Smart Metering (Residential/SME)

**Different mix/size of DG compared to satellite

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KEMA

Template	Building Blocks for: Smart Community			
Variant	Variant 1: **Campus**	Variant 2: (Common Landlord) **Retail Park**	Variant 3: **Island**	Variant 4: Industrial Park
Social character	Low/medium rise accommodation with multiple small units and common services Large academic buildings Small shops Medium offices Sports/social venues Car parks Probably good social engagement	Out of town shopping centre Large shops Medium shops Car parking Cinema/sports venue Transient population	Geographic island with / without mainland connection (or intentional islanding capability) Mixed community of users Marine/harbour environments Sever weather No mains gas	More constant population
Network character	11 kV and LV network, mainly UGC. Main load in centralised locations + DG	Large loads in concentrated locations, UGC networks, heating/cooling demands, daytime/night time patterns distinct + DG	Mixed OHL and UGC, 33, 11 kV & LV, frequency control required, fewer communication options + DG	Large loads in concentrated locations, UGC networks, heating/cooling demands, daytime/night time patterns distinct , DG, PQ, embedded networks, additional security
Element 1: **Buildings**	• Building controller interface • Smart street lighting • Large DG / export • CHP + heat network	•Building controller interface •Smart security / external lighting •Large DG / export •CHP + heat network	• Stored heat interface control • CHP • Heat • DG	• CHP • Heat network • DG
Element 2: **Transport**	• Car park charging posts • Fast charging facility • Bike charging post • Smart public transport (bus)/ others	• Multi storey car park charging • Fast charging facility • Bike charging post • Electric public transport (tram, bus) • Inductive charging EV • Commercial (delivery) EV charging	• EV cars • EV light goods	• Commercial vehicle transport
Element 3: **Network**	• Smart voltage control • Capacity management • Active Network Mgt • DG and VPP services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Centralised storage • Heat networks • Substation energy management	• Smart voltage control • Capacity management • Active Network Mgt • DG and VPP services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Centralised storage • Heat networks • Substation energy management	• Smart voltage control • Capacity management • Active Network Mgt • DG services • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Centralised storage • Frequency control • Stability detection • Substation energy management	• Smart voltage control • Capacity management • Active Network Mgt • DA & DM of 33/11 kV SS • DA & DM of 11/LV kV SS • Dynamic rating equipment 33 kV, 11 kV and lower • Dispersed storage • Heat networks • Substation energy management

Further possible variant:

engaged community
Eco Village