WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

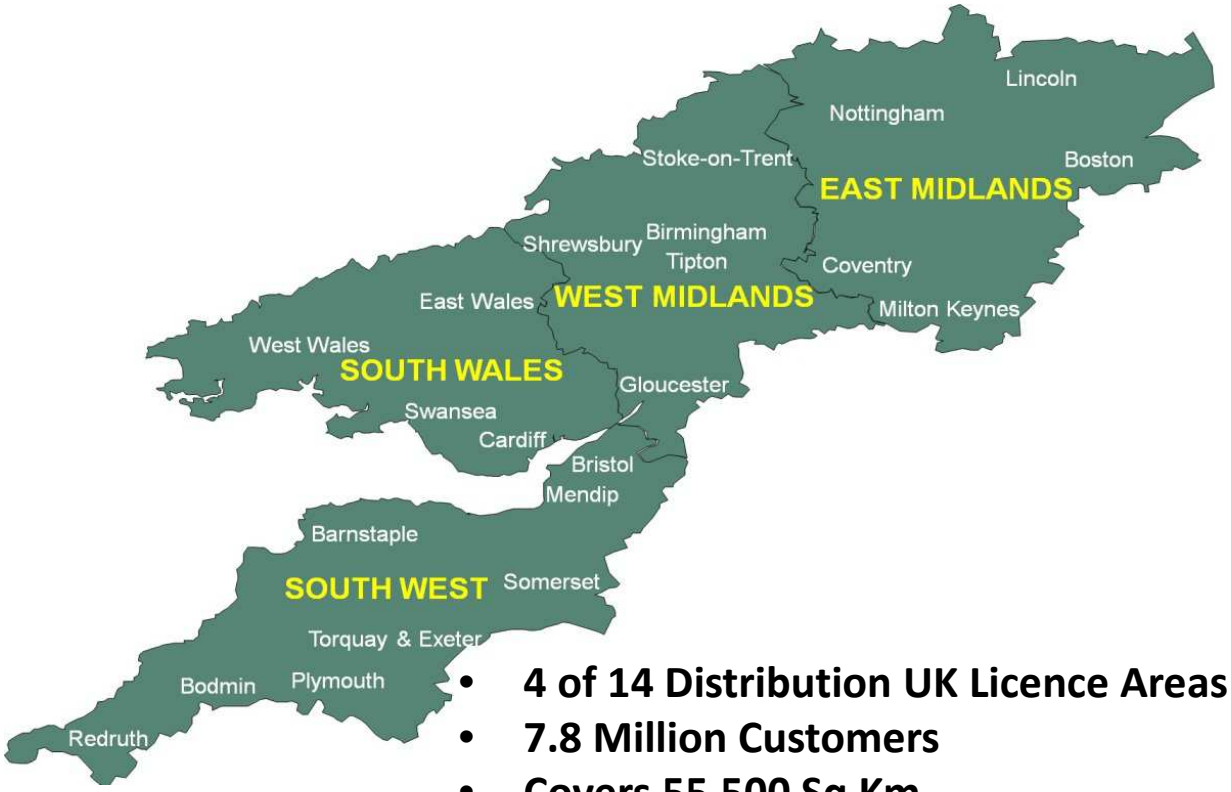
DG Connections

14th April 2015

Agenda

- Introduction
  - WPD area
  - Current levels of DG activity
- Current Network Constraints – S West
- Queue Arrangements
- Alternative Connection Options
- Interface with National Grid, including Statement of Works

WPD – Who are we



- **4 of 14 Distribution UK Licence Areas**
- **7.8 Million Customers**
- **Covers 55,500 Sq Km**
- **220,000km of Network**
- **185,000 Substations**

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Currently Connected Capacity

Generation Type	Western Power Distribution Connected Generation Per Licence Area (MVA)				Total (MVA)
	West Midlands	East Midlands	South Wales	South West	
Photovoltaic	273.9	650.4	283.9	778.9	1,987.0
Wind	4.3	445.3	126.1	190.3	765.9
LandfillGas, Sewage Gas, Biogas, Waste Incineration	303.5	293.3	47.4	40.7	685.0
CHP	23.7	133.1	0.7	12.3	169.8
Biomass & Energy Crops	18.8	69.8	0.6	0.2	89.4
Hydro, Tidal & Wave Power	0.6	2.9	0.2	3.7	7.4
Other Generation	211.4	109.8	338.6	353.1	1,012.9
Total	836.3	1,704.5	797.5	1,379.1	4,717.4

Currently Accepted Capacity

Generation Type	Western Power Distribution Committed Generation Per Licence Area (MVA)				Total (MVA)
	West Midlands	East Midlands	South Wales	South West	
Photovoltaic	1,273.0	2,411.9	1,330.9	1,255.8	6,271.7
Wind	47.3	483.7	538.0	181.4	1,250.3
LandfillGas, Sewage Gas, Biogas, Waste Incineration	64.9	104.8	26.4	77.9	274.0
CHP	16.1	9.2	9.6	6.4	41.3
Biomass & Energy Crops	33.6	62.1	72.5	110.5	278.7
Hydro, Tidal & Wave Power	-	0.5	16.3	30.1	46.9
Other Generation	86.5	85.7	404.1	142.6	719.0
Total	1,521.5	3,157.9	2,397.8	1,804.7	8,882.0

Currently Offered Capacity

Generation Type	Western Power Distribution Offered Generation Per Licence Area (MVA)				Total (MVA)
	West Midlands	East Midlands	South Wales	South West	
Photovoltaic	900.7	1,529.9	400.8	559.3	3,390.6
Wind	9.6	187.4	308.1	12.1	517.2
LandfillGas, Sewage Gas, Biogas, Waste Incineration	-	2.5	1.1	10.7	14.2
CHP	2.8	11.1	2.8	50.0	66.7
Biomass & Energy Crops	31.7	30.0	1.2	0.4	63.3
Hydro, Tidal & Wave Power	0.6	-	-	0.1	0.7
Other Generation	203.4	53.3	69.8	106.4	432.9
Total	1,148.8	1,814.2	783.7	738.9	4,485.6

South West Summary

Generation Type	Western Power Distribution - South West Generator Connections (MVA)			Total (MVA)
	Connected	Committed	Offered	
Photovoltaic	778.9	1,255.8	559.3	2,593.9
Wind	190.3	181.4	12.1	383.8
Landfill Gas, Sewage Gas, Biogas, Waste Incineration	40.7	77.9	10.7	129.3
CHP	12.3	6.4	50.0	68.6
Biomass & Energy Crops	0.2	110.5	0.4	111.1
Hydro, Tidal & Wave Power	3.7	30.1	0.1	33.9
Other Generation	353.1	142.6	106.4	602.1
Total	1,379.1	1,804.7	738.9	3,922.7

	South West Maximum Demand (MVA)
Winter	2,530.0
Summer	980.0

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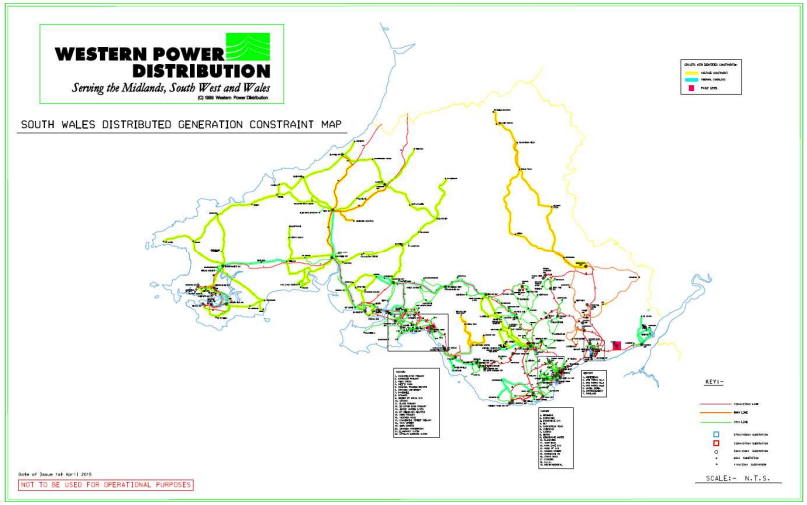
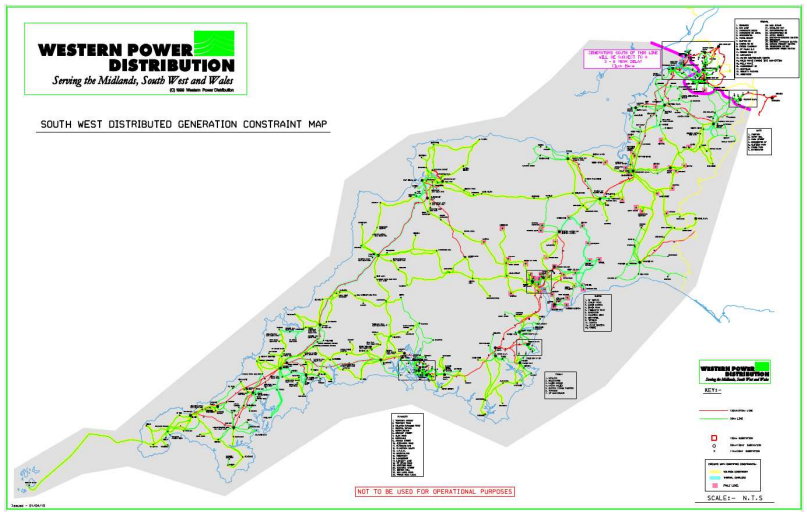
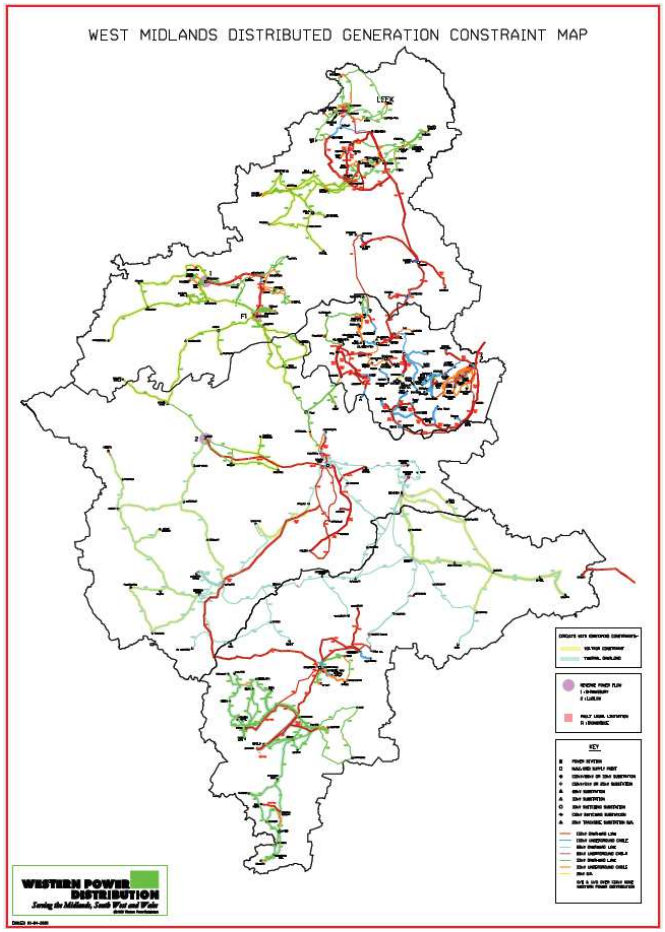
Current Constraints

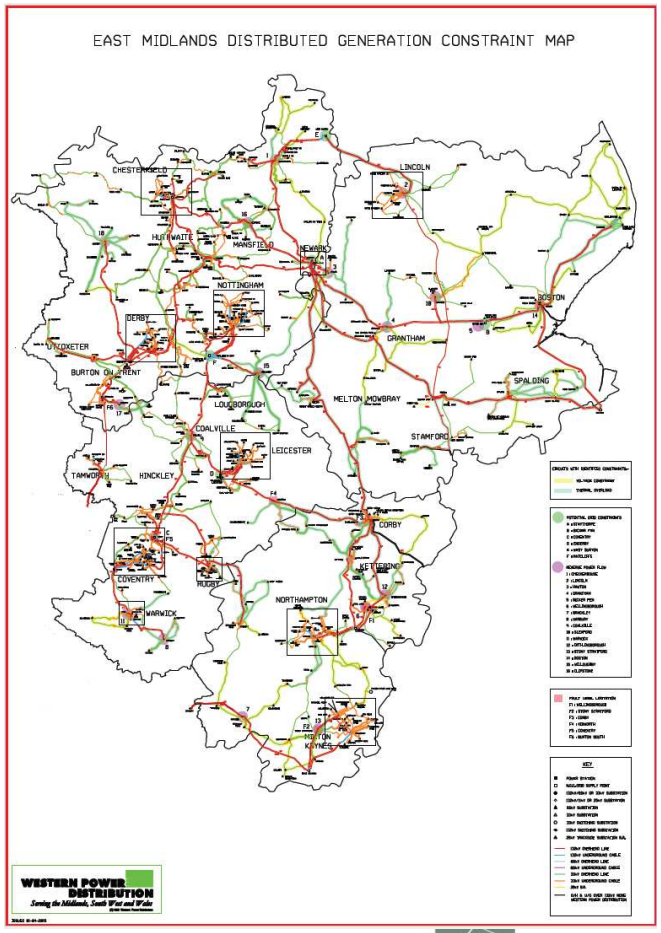
Constraints across WPD

- There are now many constraints across WPD – maps published on our website









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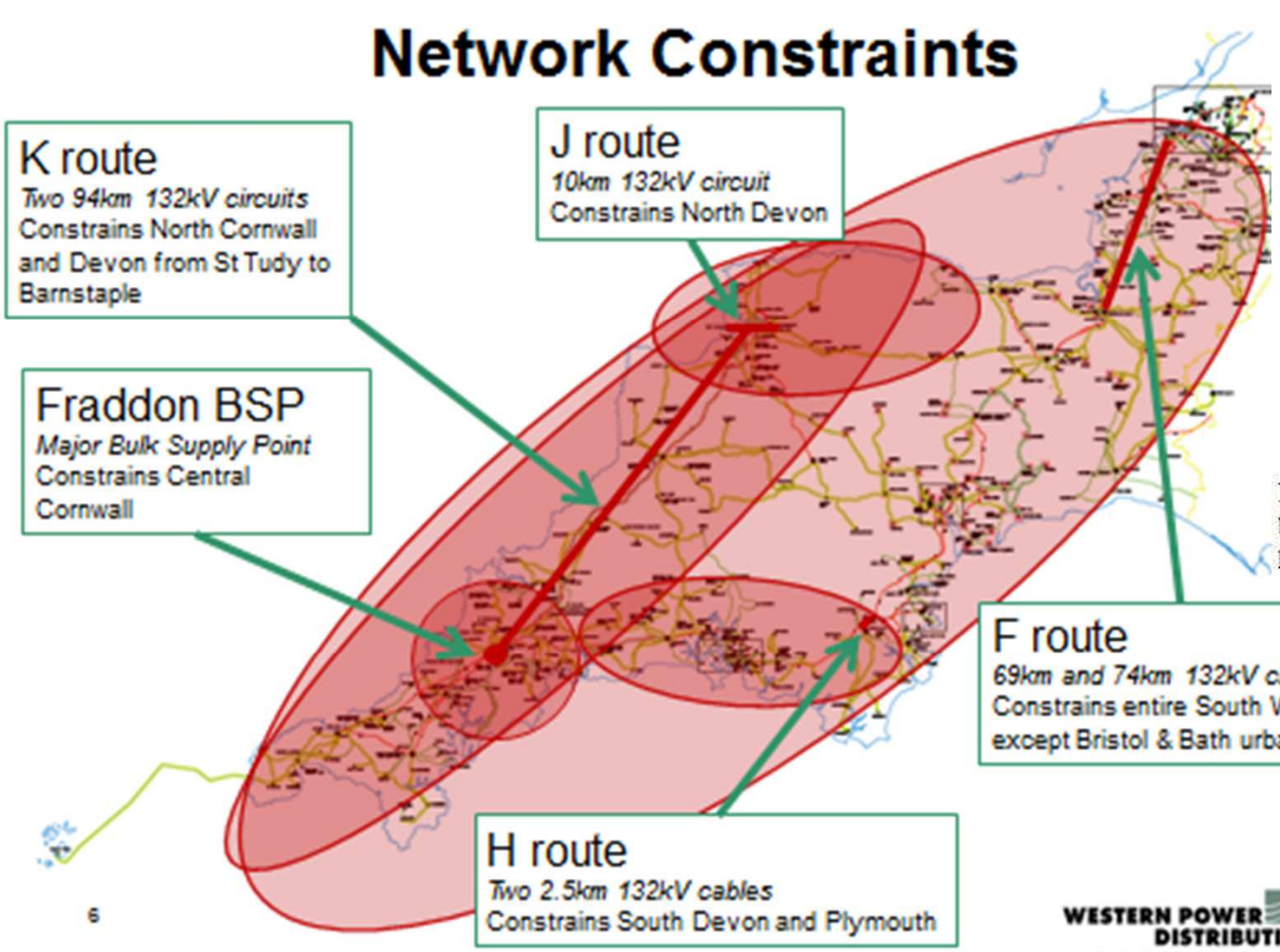
Charging arrangements

- Generation connection charges consist of:
  - The full cost of assets that will be used solely by the connecting customer
  - A proportion of the cost of network reinforcement where required, subject to a one voltage level above rule
  - A rebate to the DNO or a previously connected customer under the Electricity (Connection Charges) Regulations 2002
  - The cost of reinforcement in excess of £200/kW
- Ofgem are currently consulting on different ways to fund necessary reinforcement

Major constraints / issues in S West



Location	Approx Cost	Approx Timescale	Comments
Fraddon BSP	£3m	3 years	Additional Transformer capacity
K Route	£15m	3 - 5 years	Does not provide significant extra capacity, this would need a new GSP in the Pyworthy area together with work at other NGT sites.
J Route	£2m	2 years	Reconductoring costs
H Route Cables	£6m	2 years	Cables under river Dart
F Route	£30m	4 - 5 years	This is the reconductoring cost should the NGT works for Hinckley not proceed and does not provide significant extra capacity. Options for significant rearrangement of the 132kV network/new GSPs would need to be considered as alternatives.

Note: There are significant NGT voltage control issues to be addressed before this capacity could be used and may be NGT thermal issues at higher levels of DG

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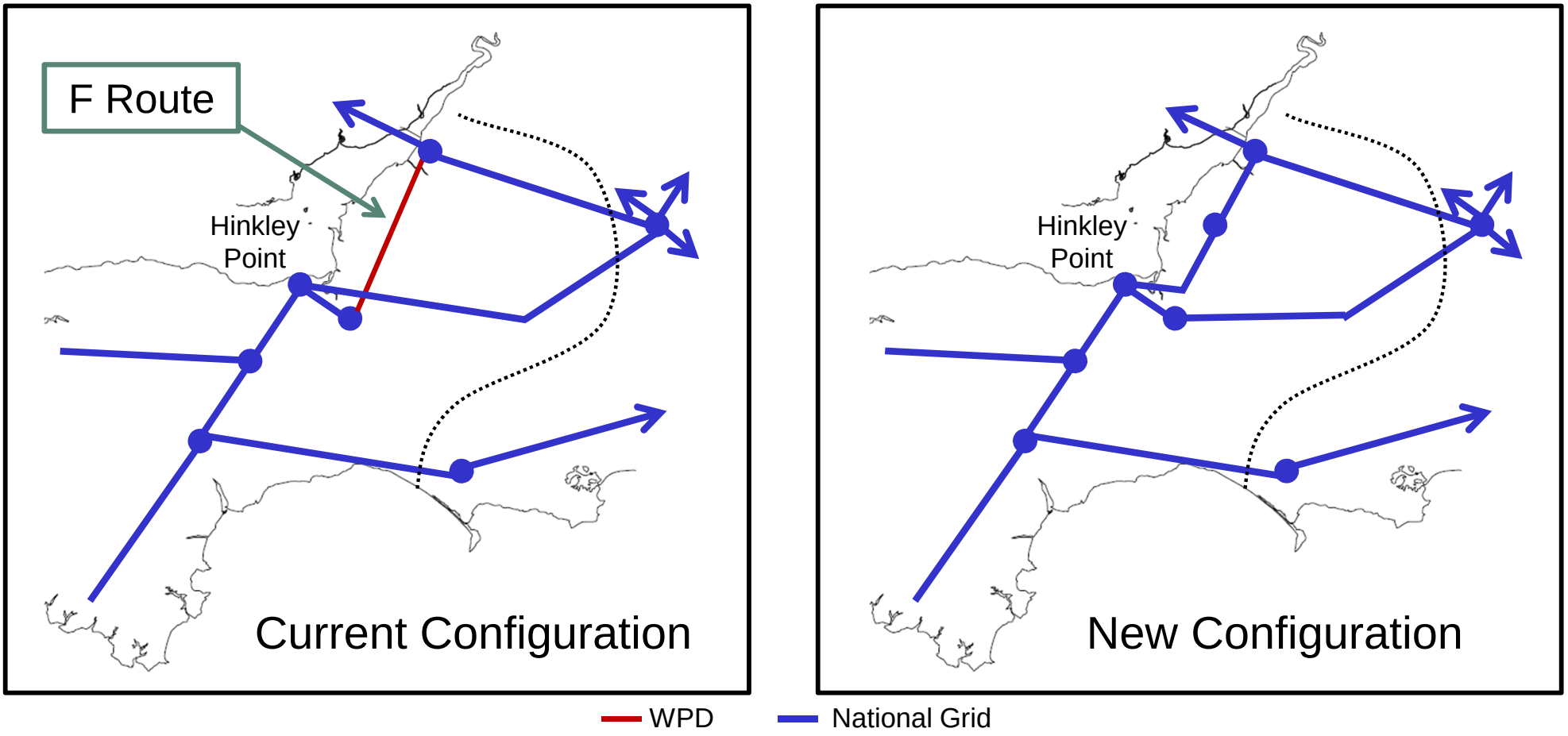
Hinkley Point C and F route



- New 3.3GW nuclear power station planned by EDF for existing Hinkley Point site in Somerset due for completion by 2023
- Requires major National Grid reinforcement including new 400kV double circuit tower line between Bridgwater and Seabank (northwest Bristol) which requires removal of 132kV F route, leading to major reconfiguration of WPD's network

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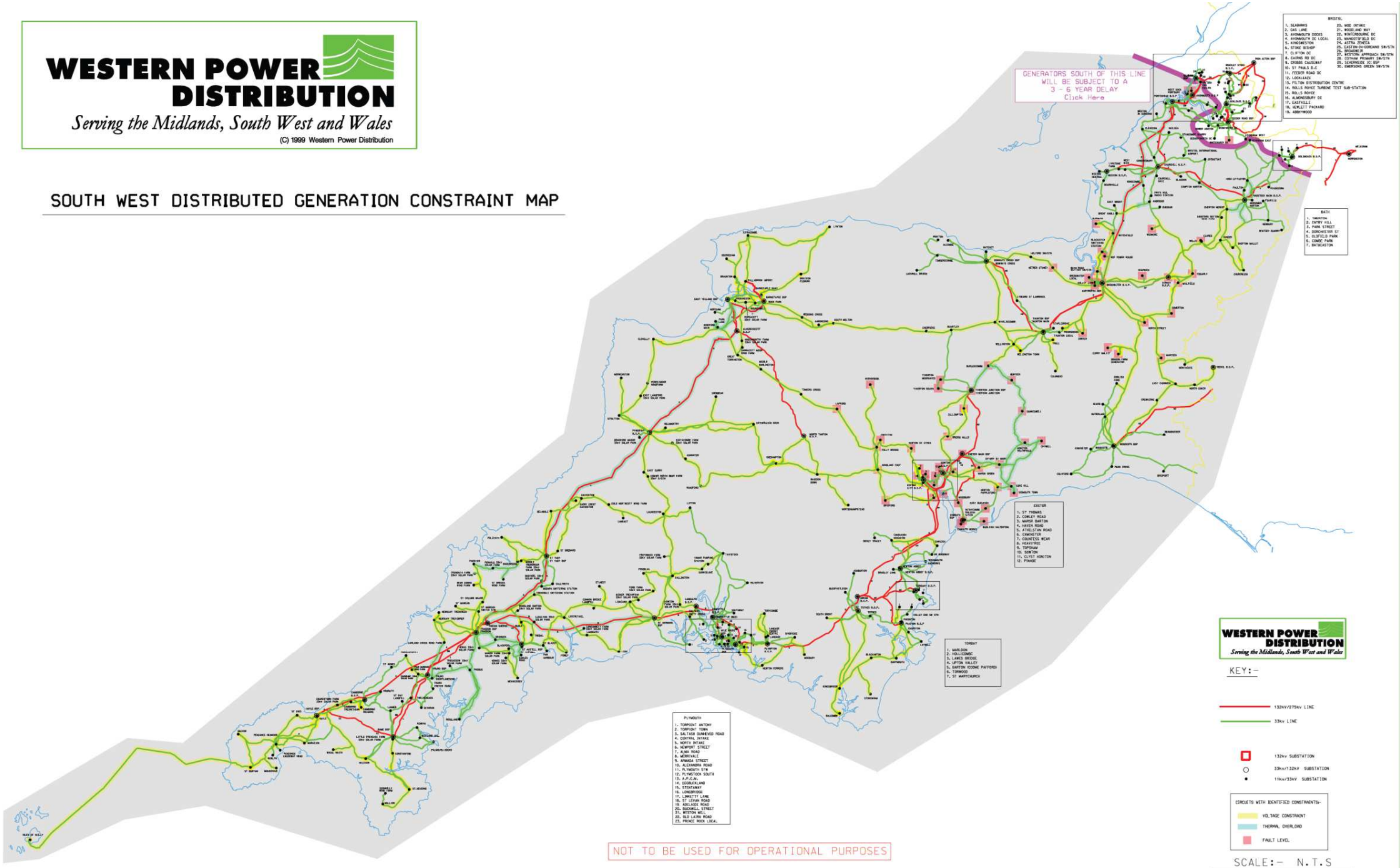
SOUTH WEST DISTRIBUTED GENERATION CONSTRAINT MAP



NOT TO BE USED FOR OPERATIONAL PURPOSES

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Resulting delays/exemptions

- A delay of 3-6 years will apply to all generator connections requiring works at HV (i.e. 6.6kV or 11kV) or above
- In addition, there are likely to be other reinforcement works included in the connection offers (for more localised issues), plus a requirement to obtain a Statement of Works from National Grid indicating works required on the transmission system
- As we expect some accepted offers to not proceed and that smaller DG connections individually have significantly lower impact, we are currently exempting restrictions from the following:
  - Connection where only LV works are involved
  - Generation on predominantly demand connections as long as the load offsets the generation requirements at all times and there is no expectation to export to the distribution system
  - Small Scale Embedded Generation (SSEG) – G83 stage 1
  - Multiple SSEG's – G83 stage 2 - will also be allowed to connect subject to the completion of any HV reinforcement that is required
- We will track resulting impact and may have to increase the restrictions depending on the cumulative effect

The use of Export Capping schemes

- DG developers are required to keep their DG export levels within the Maximum Export Capacity specified in their Connection Agreement
- The DG developer may over install generation plant but cap the export in line with their Connection Agreement
- WPD will permit additional generation connections to be made to existing DG sites subject to application and technical assessment

The South West Transmission Network
The issues

- The 400kV network is not an infinite bus bar and has technical limits
- Network reinforcement or changes to the operating procedures will be required avoid the restrictions
- NGET modelling has shown the 400kV Network in the South West is at capacity due to Steady State High Voltage issues
  - Connecting further DG at unity Power Factor will exacerbate the issues
- Further connections must be modelled by WPD and NGET to ensure they do not exceed the other Transmission System limits:
  - Thermal transformer capacity at Grid Supply Points,
  - Thermal capacity of the Transmission Network,
  - Fault Level headroom of switchgear,
  - Transmission Network Transient Over-voltages and
  - Overall Transmission System Stability

Queue Management

Recovering Committed Capacity

- DG Developers are required to demonstrate that their scheme is progressing
- Where evidence of progression is not provided to our reasonable satisfaction we will terminate the Offer
- Relinquished capacity will be made available to other applicants in strict order
- When a DG developer does not install their full offered capacity, the unutilised capacity will be recovered unless it can be demonstrated that the capacity will be utilised within 12 months

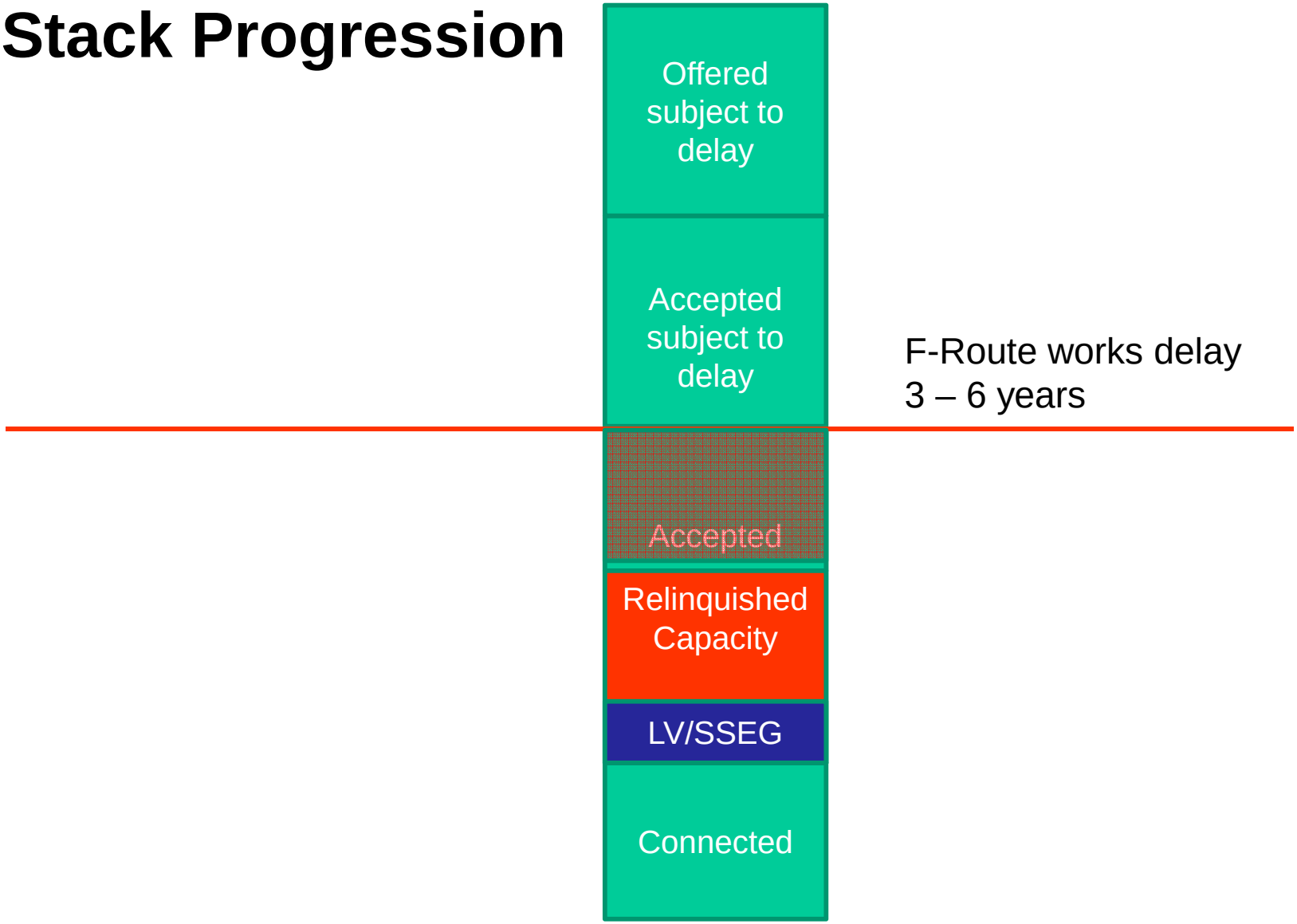
Queue Order

When a DG Developer or WPD terminates an accepted Offer which releases capacity WPD will make that capacity available to others in the following order:

i) Accepted Offers awaiting reinforcement
ii) Applicants with valid Offers (not yet accepted)
iii) New applicants

Offers will be ordered by date of application

Scheme Stack Progression



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Alternative Connections

Recap of Alternative Connections Available

TIMED

- **Generation curtailed within specific times**
- Sub 1MVA
- Modelled seasonal capacity variations
- Localised control only
- No comms
  - May have for voltage constraint
- Non-optimised

SOFT-INTERTRIP

- **Releases pre-fault capacity with trip facility**
- 11kV and 33kV
- Real-time monitored values
- Small clusters of generation or simple pinch points
- Existing monitoring with localised control

ACTIVE NETWORK MANAGEMENT

- **Fully optimises capacity based on all constraints**
- Management of generation using LIFO principles
- Real-time granular control of output
- Requires new Active Network Management control and monitoring systems

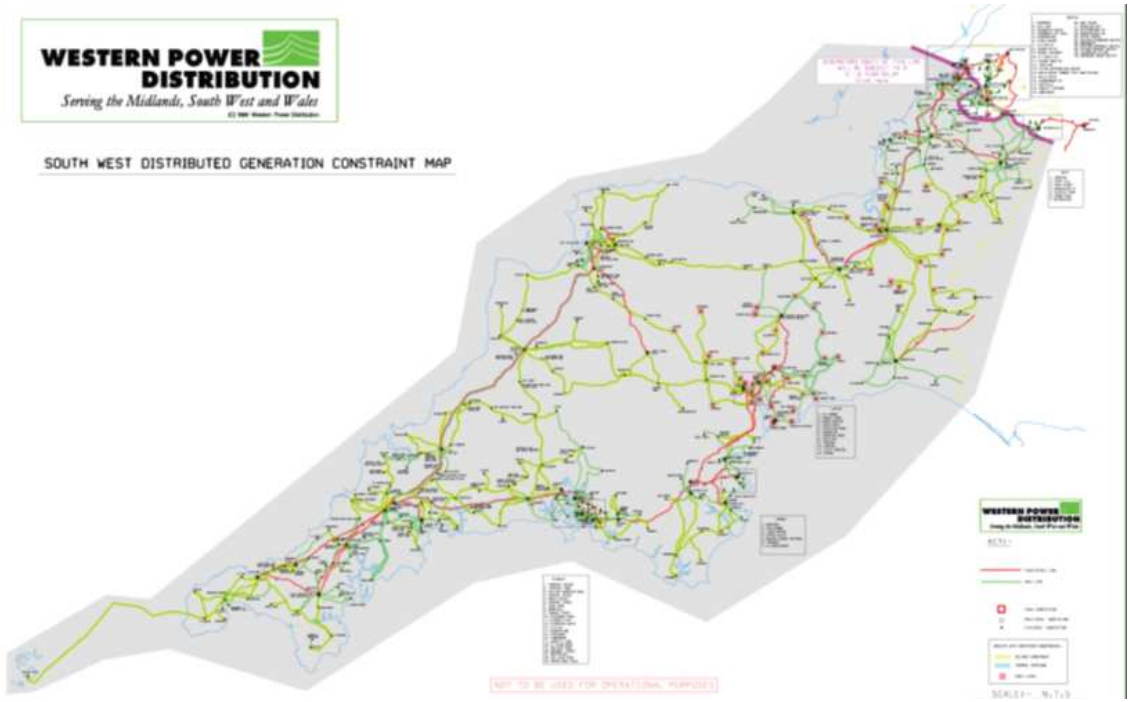
Costs, Complexity & Network Optimisation

Timed Connections in the South West

- Will be available in the whole of the South-West area – this includes ANM zones,
- Available for LV & HV connected generators < 1MVA in export capacity,
- Limited to 20% of installed PV capacity per constraint
- Restricted export limits:
  - October to March – No constraint
  - April & September – 30% Output 10am to 4pm
  - May to August – 0% Output 10am to 4pm
- All Subject to Review

Soft Intertrip – South West

- Soft Intertrip is suitable for small clusters of generation behind one simple pinch point
- The areas highlighted in grey are affected by complex constraints
- We are no longer able to support Soft Intertrip connections in these areas



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Active Network Management

- Single generators affecting a single network pinch point can be managed by a simple intertrip scheme
- More complex networks, involving many generators across different circuits and voltage levels require constant monitoring to ensure the capacity is available and is shared optimally
- Excursions of the limits would increase the risk of faults or circuit tripping, affecting a number of adjacent customers
- In order to manage the risk effectively, the system must be secure, robust and encompass all affected areas
- An advanced deployment of intelligent monitoring and distributed control systems will be underpinned by a fail-safe communications network, allowing the network to accommodate more connections, whilst maintaining the quality and security of supply for existing customers

ANM – South West

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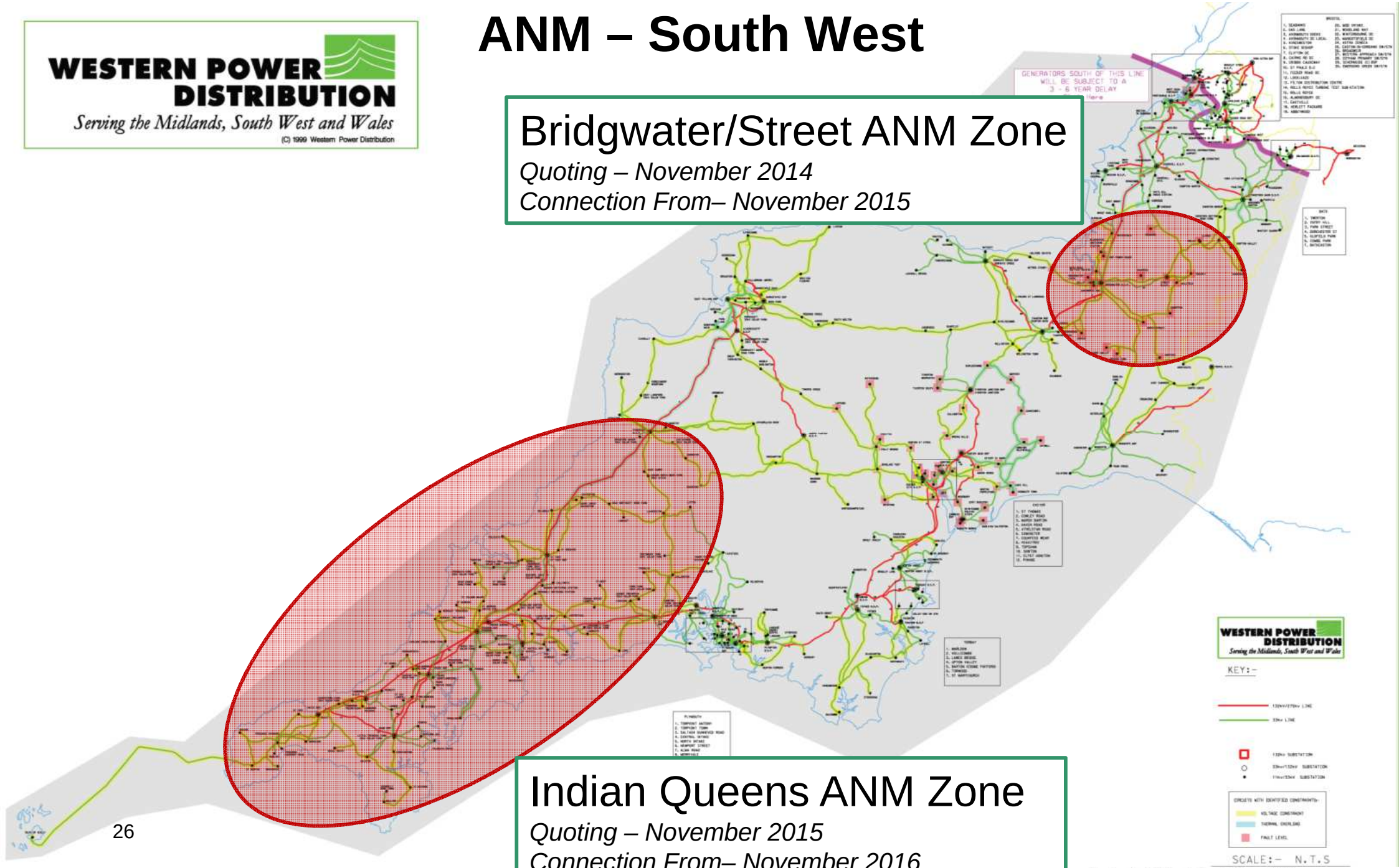
Bridgwater/Street ANM Zone

Quoting – November 2014
Connection From– November 2015



Indian Queens ANM Zone

Quoting – November 2015
Connection From– November 2016

Stack Management

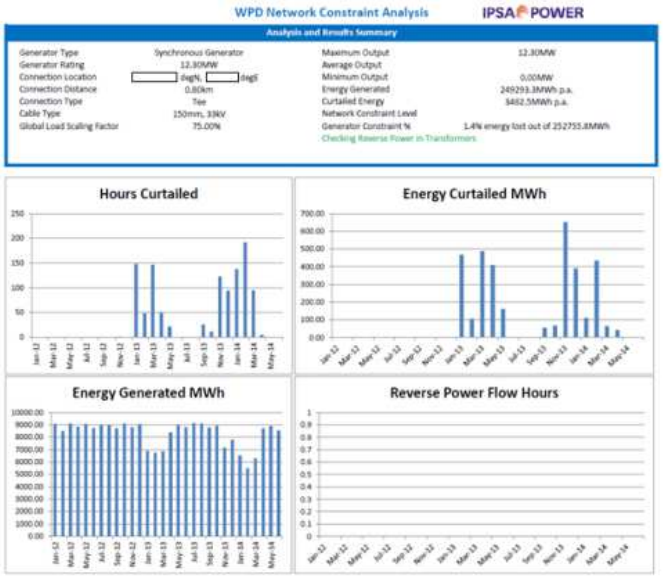
- Alternative Applications -
  - WPD offers Alternative Connections based on a Last In, First Out (LIFO) principle
  - Your position in the stack is secured on receipt of all minimum Section 15 or 16 application information by WPD
  - Each customers calculated curtailment is based on all connected, committed and offered capacity which sits ahead of them in the queue at that moment in time
  - If generation ahead of you in the stack drops out, you will move up the stack and the potential for curtailment will reduce
  - Committed and offered capacity within the stack changes daily

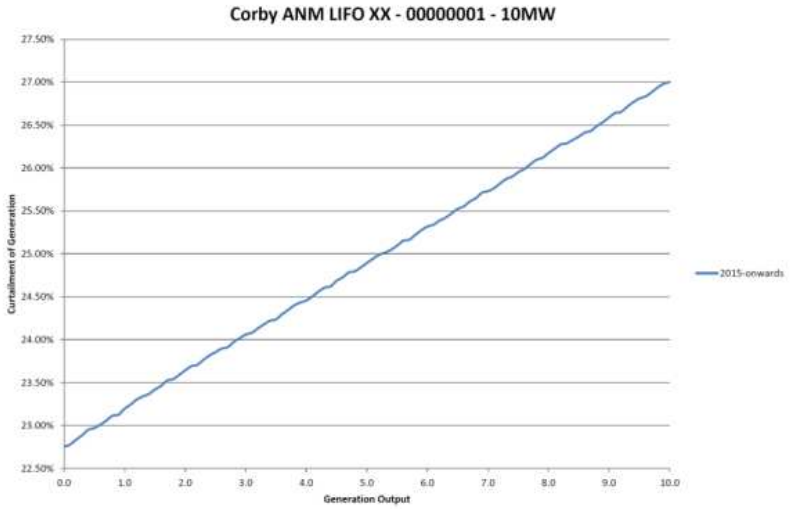
Estimating Curtailment

- WPD use historic load and generation data, together with the assumed profiles of future generation in the area to estimate the level of curtailment a new alternative application will receive

- The curtailment tools can provide a generation developer an indication of the level of constraints a site will experience and the associated risk

- We would expect developers to also do their own estimates as part of due diligence before committing to an investment





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Interface with National Grid Statement of Works

Statement of Works (SoW) Process

- Both individual and cumulative embedded generation within WPD's network is having an impact on the National Electricity Transmission System (NETS)

- The SoW is the formal process to assess the impact on the Transmission System and to identify if any Transmission reinforcement works are required

- The SoW is a requirement on WPD where it 'reasonably believes it may have a significant effect on the NETS'

Statement of Works (SoW) Process

- Due to the significant increase in DG across WPD's licence areas, WPD have submitted a number of bulk SoW applications to assess the cumulative impact

- The submission of these bulk SoW applications allows NGET to consider the wider effect on the Transmission Network

- WPD and NGET are working together studying the impact strategically and identifying short and long term plans to alleviate Transmission issues at the lowest costs for customers

Statement of Works (SoW)
(South West Outcome)

- NGET have identified that the embedded generation does have a significant impact on the Transmission System

- The effective load reduction leads to high voltage issues on the 400kV and 275kV system. Reactive compensation is required to restore the Transmission System to compliance

- In addition, some GSP sites will require more detailed fault level studies

Short Term Solution

Revised operational requirements

- Customer Installations shall operate at a 0.95 leading power factor when exporting real power, and at a 0.95 lagging power factor when importing real power

- Connections at 33kV and above shall have the facility to constrain output at NGET request

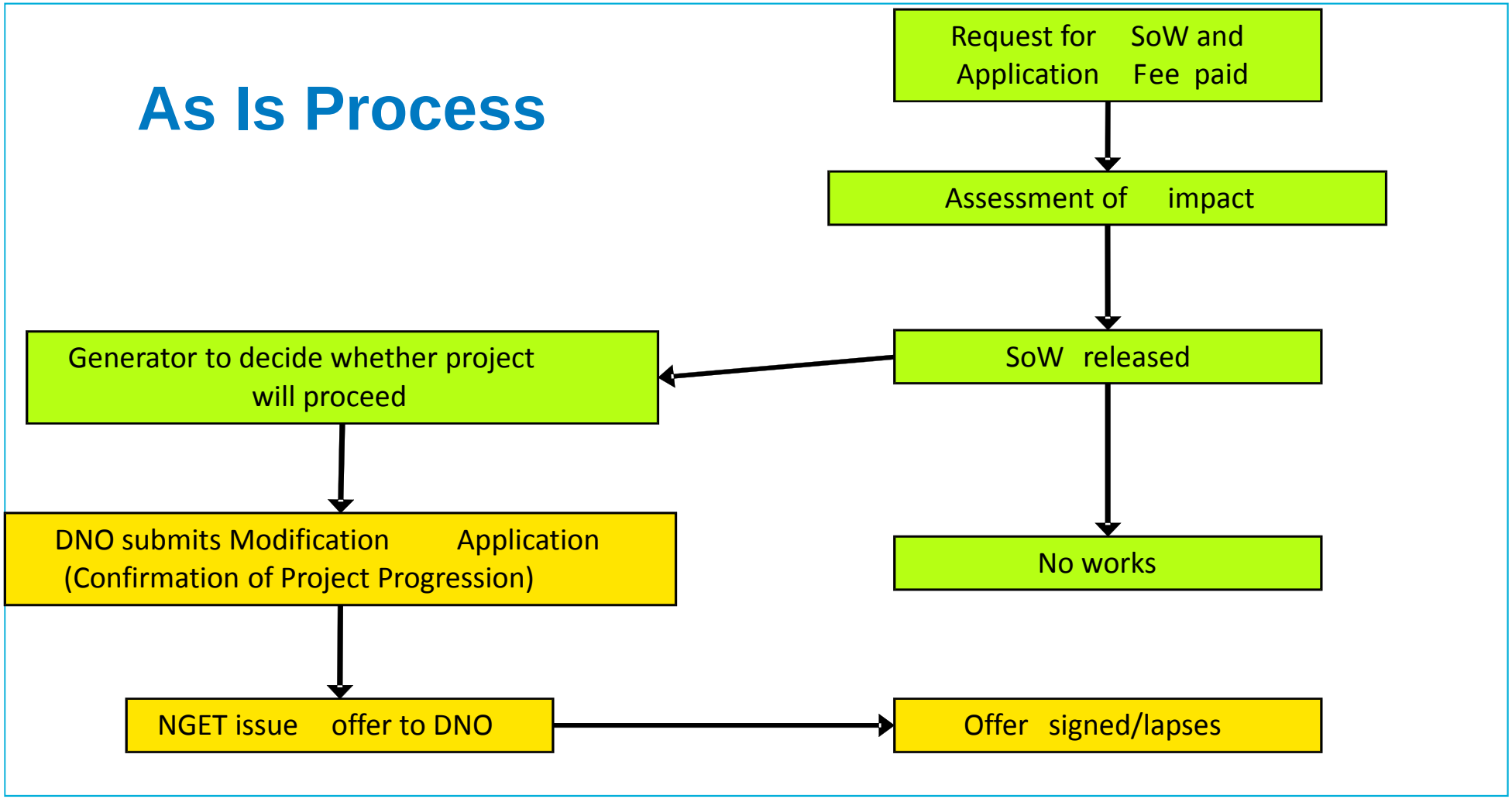
Medium and Long Term solutions

- WPD is working with NGET on a range of options which will ensure both the Transmission and Distribution System operate within their design parameters
  - trialling the reduction of the 132kV network voltage to reduce Transmission System impact
  - reviewing the use of, and need for, existing reactive compensation equipment
  - assessing the potential for reactive compensation through transformer tap operation
  - assessing the installation of further reactive compensation equipment
  - assessing further compensation that embedded generation can provide to the system

National Grid

Luke Wainwright
Electricity Customer Manager - England and Wales

Statement of Works – High Level Process



Statement of Works Update

- SOW Trial ends May 2015 and will make Code change recommendation

- NG has worked with WPD to collate extensive technical data to allow them to carryout bulk SOW studies at GSP level across the South West and South Wales

- Current recommendations include operating at leading power factors and constraint mitigation via control rooms

- Going forward, NG are working with DNO's to improve the SOW process for embedded generation to make decision making and submissions less onerous

Wider Transmission Impacts

- **High Voltage** – known issue on the Transmission System, of which EG is a contributing factor effecting the stability and compliance of the system
    - High Voltage workshops held with each DNO to look at solutions at both Transmission and Distribution level
- **Hinkley Point C Nuclear Power Station Connection**:
    - Current Contracted Connection Date June 2022
    - 3.3GW of generation – supplying around 5 million homes
    - EDF spend alone £16 billion
    - NG currently in DCO – decision due Jan 2016
    - Use of the F Route deemed the most efficient solution and minimises impact
    - NG working closely with WPD to coordinate works and impacts

Summary & Next steps

- WPD will continue to allow G83 Stage 1 and Stage 2 connections, those with LV works only and ‘non-exporting’ DG on demand sites

- WPD cannot permit additional new DG connections requiring work at HV or EHV to be made until Transmission Network reinforcement is carried out between Seabank and Bridgwater. This is estimated to be a 3 to 6 year delay

- WPD will allow Timed and Active Network Management connections where this is appropriate

- WPD will continue to work with NGET to alleviate further Transmission System restrictions