

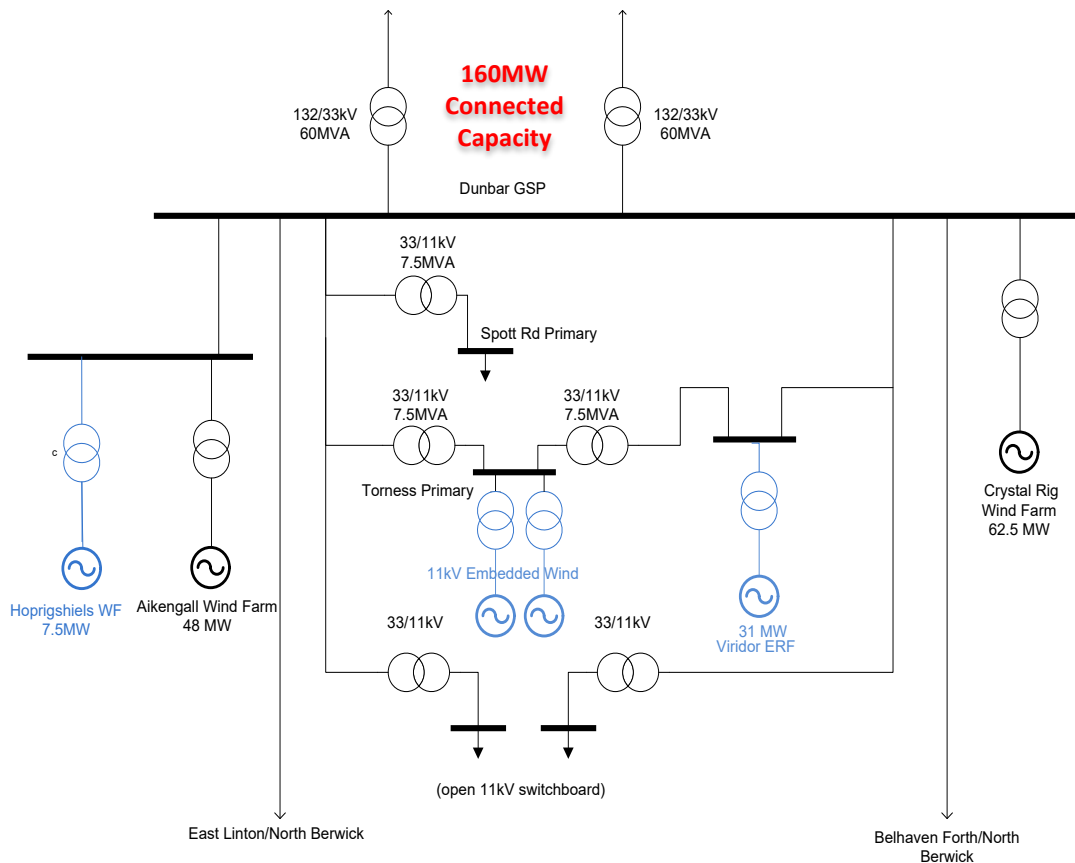
Accelerating Renewable Connections – Implementation of Active Network Management



Project Overview – Accelerating Renewable Connections (ARC)

- **ARC - £8.4M project commenced in January 2013 and which completed in December 2016**
- **Project Objective - Implementation of alternative innovative connection solutions to support renewable generation access within parts of the network considered to be constrained through conventional connection solutions**
- **Project Achievements**
 - Accelerated **100MW** of renewable generation capacity across **13** individual projects
 - Mitigated or deferred in excess of **£30M** of network reinforcement capital investment
- **Customer & Community Benefits**
 - Supported **£285M** of private capital investment in renewable energy projects across the trial area of East Lothian and the Borders of Scotland
 - Connected projects will support the creation of in excess of **55** full time jobs which is estimated will create a **£10M** economic boost across the trial area
 - Connected Europe's largest Community Owned Wind Farm, developed jointly by Berwickshire Housing Association & Community Energy Scotland, profits from which will support the construction of **500** affordable homes over the next 20-years
 - Facilitated the construction of a new Energy Recovery Facility which over the next 25 years will process waste from the Clyde Valley region of Scotland and is estimated will divert **4.25M** tons of waste from landfill
 - Supported a range of agricultural enterprises to diversity their business and create new revenue streams securing existing jobs and creating new employment across rural communities

Project Objective - Facilitating growth in DER connecting to existing network



Project Scope:

Connect 50MW of generation across 4 new generation sites to manage load flows across GSP

Network Constraint:

Transmission Access

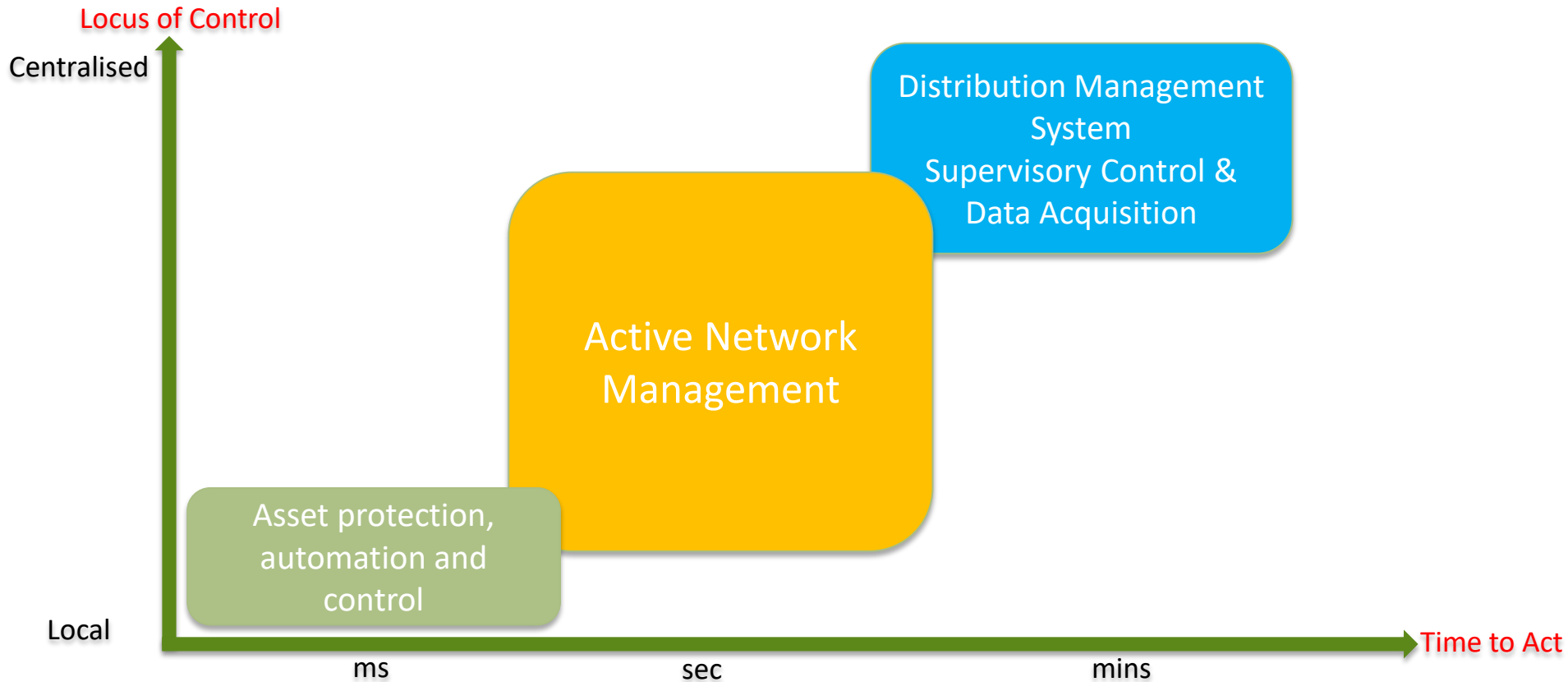
Original Offer

Transmission reinforcement required, connection date advised 2021, total costs £20M

Flexible Connection Solution

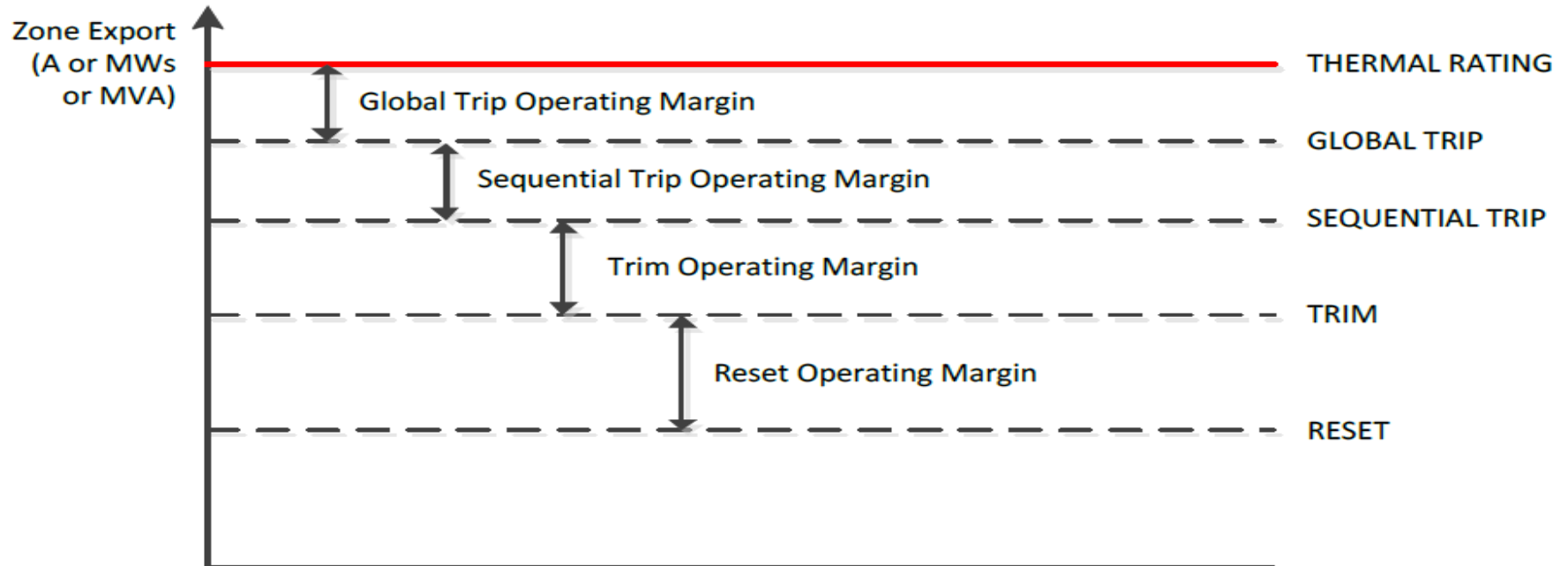
- Wide area ANM scheme deployed at Dunbar GSP
- Principles of Access – LIFO
- Total ANM scheme capital costs:£0.5M
- Currently 3 out of 4 generators connected, final customer will connect February 2018
- ANM accelerated connection to network by 3 years
- ANM supported by generation investors, SPT, NGET and most of all customers

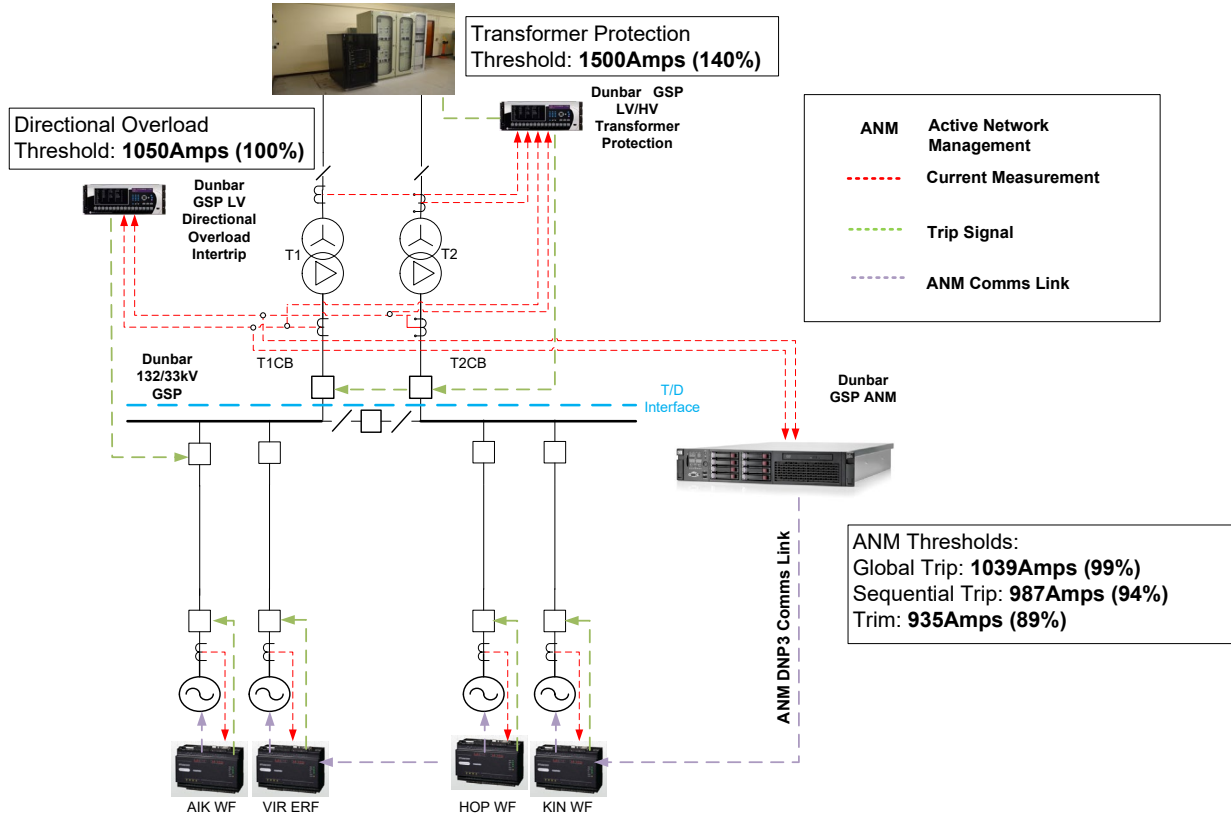
Guiding Principles of Active Network Management Deployment



Active Network Management Curtailment Thresholds

- To allow control of power flow across the identified constraint location(s), ANM control systems rely upon a series of escalating control actions to ensure network power flows remain within safe operating limits
- Control actions are triggered by power flow breaching a pre-defined or dynamic limit known as Thresholds
- A typical ANM system configuration will have four Threshold levels set for each constraint location as shown below;






Dunbar & Berwick ANM Schemes

- Manages circa 150MW of Distributed Generation against a transmission thermal constraint
- 7 generation projects connected
- Two de-centralised ANM systems installed in Dunbar & Berwick GSPs
- ANM Platform talks directly to each ANM Connect box installed at customer's site
- ANM system takes direct control of customer's assets
- Dedicated measurement points take current loadings from transformers and input directly into ANM platform
- Available capacity calculated by ANM system every 600m/s and refreshed maximum export value passed to generator

Flexible Connections & Principles Of Access Policy Development – Published February 2017

 **Flexible Connections and Principles Of Access Policy** ESDD-01-009
Issue No. 1

1. SCOPE

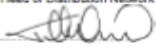
This document defines the Policy for Flexible Connection Solutions and their Principles Of Access to be adopted throughout SP Energy Networks from 28th February 2017. The purpose of this document is to ensure that network access for Users makes full use of the existing network and maximises its utilisation before the requirement for network reinforcement.

2. ISSUE RECORD

This is a Controlled document. The current version is held on the EN Document Library.
It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
February 2017	1	Malcolm Bebbington	Initial Issue

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Malcolm Bebbington Distribution Network Manager, SPM	Malcolm Bebbington Distribution Network Manager, SPM David Neilson Distribution Network Manager, SPD	Jim McMahon Head of Distribution Network  Date: 28 th February 2017

4. REVIEW

This is a Controlled document and shall be reviewed as dictated by business / legislative change but as a period of no greater than 3 years from the last issue date.

5. DISTRIBUTION

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Improved network visibility through enhanced network monitoring

Development of new commercial mechanisms to support flexible connection solutions & transparent network access priority

Implementation of wide area communications & autonomous control enabling infrastructure

Interoperability with third party / customer assets in order to exercise real-time control of export/demand

Development of IT / Energy Mgt Systems to host and access enhanced network data

Implementation of Flexible Connection Solutions

Constraint Analysis & Financing Managed Connections



Active Network Management – Equipment Overview

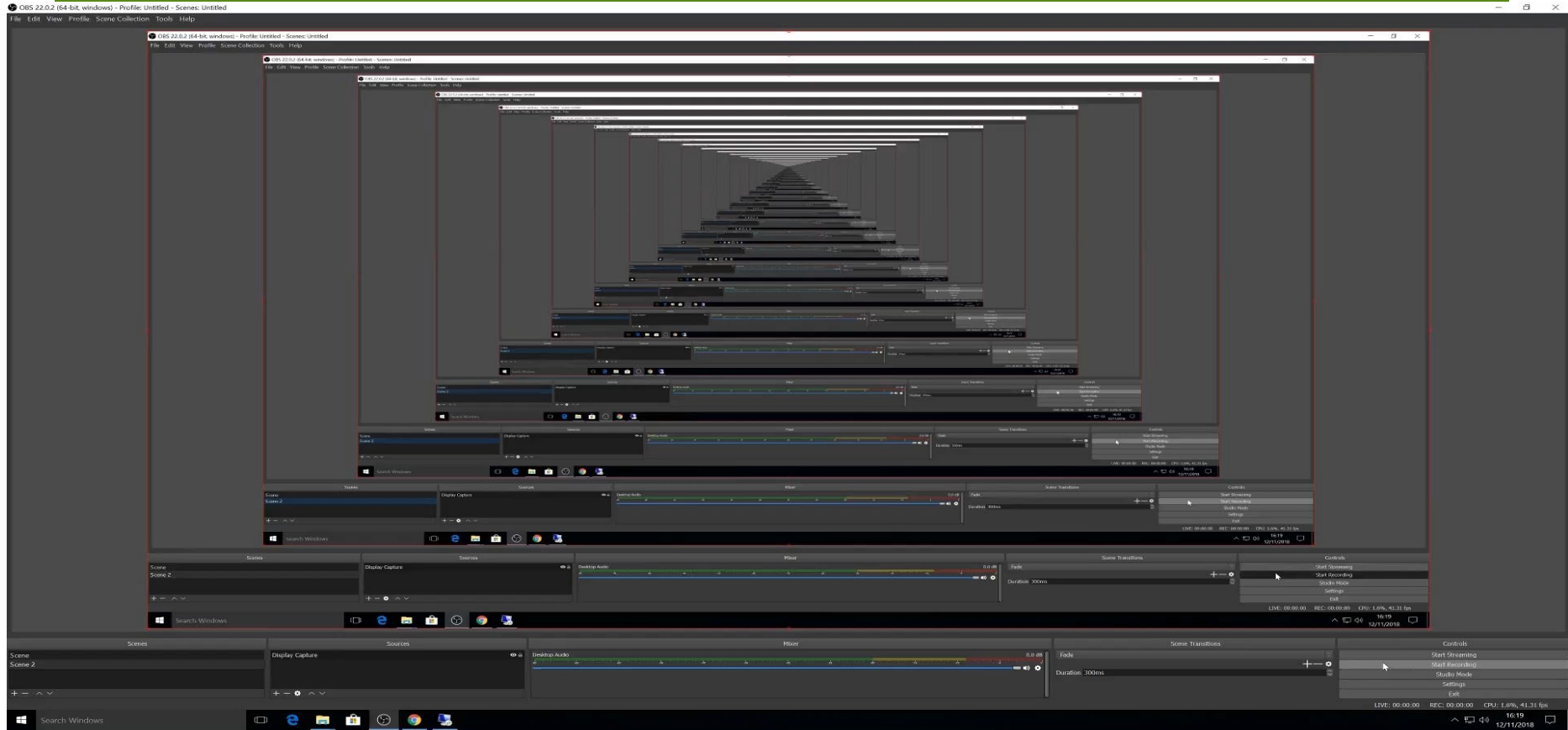


Centralised ANM System

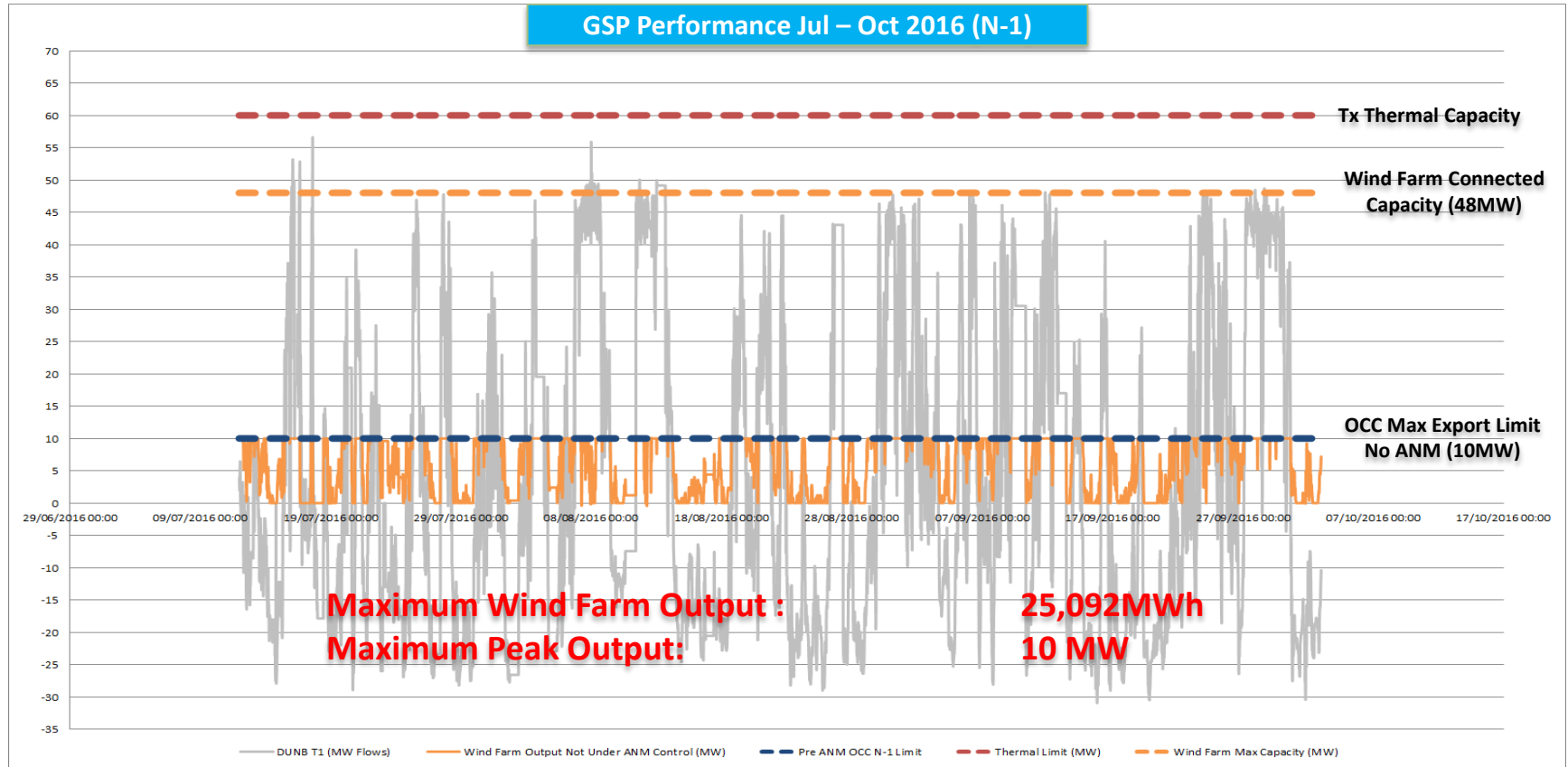


ANM Customer Interface

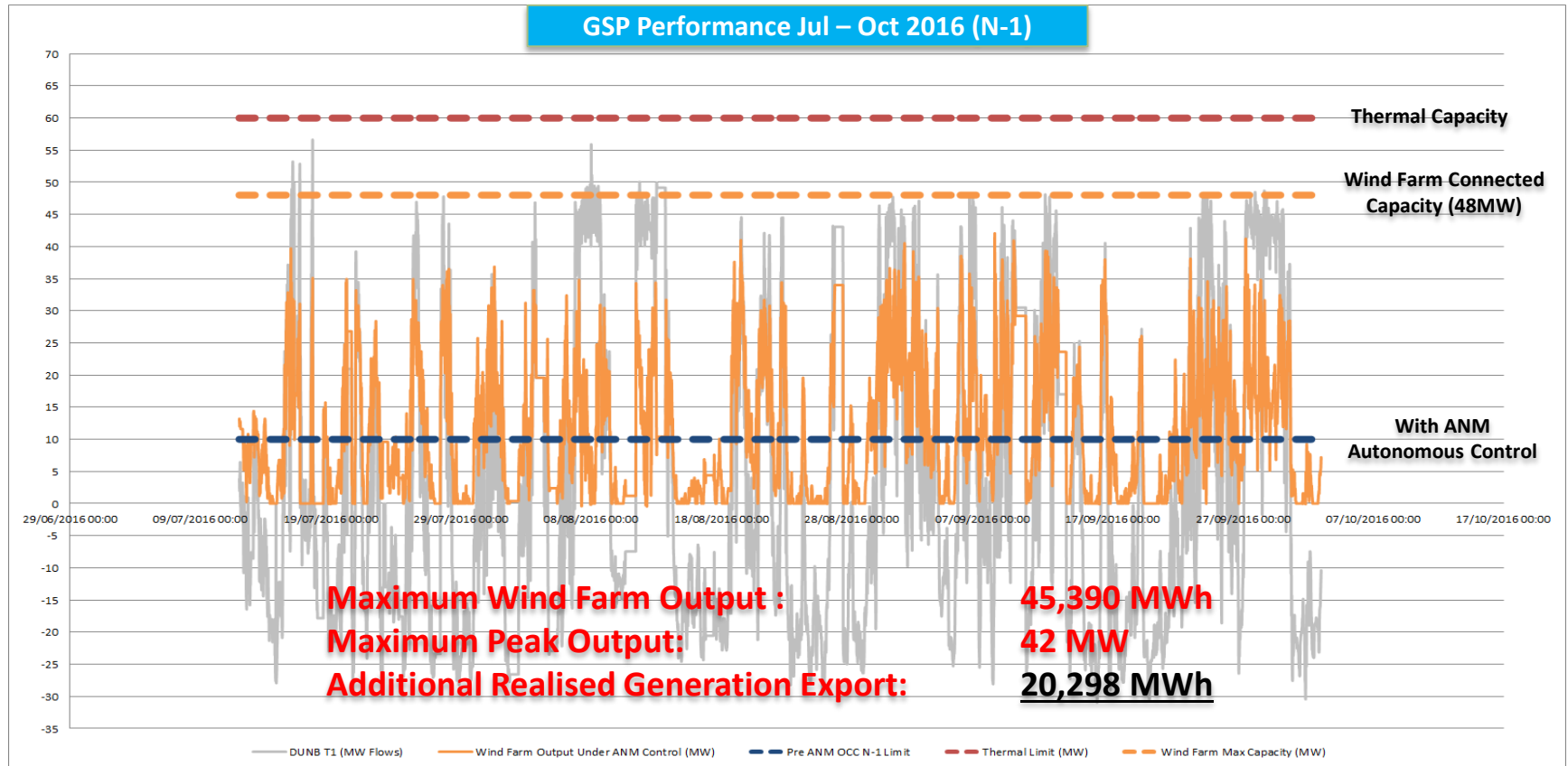
Active Network Management – Live Operational Experience



Active Network Management – Releasing Greater Network Capacity for Customers



Active Network Management – Releasing Greater Network Capacity for Customers



Customer Feedback; Connected via Active Network Management Network Solution

"Without the support of SP Energy Networks the wind farm would never have been constructed, quite simply without SP Energy Networks and Active Network Management there would be no Community Wind Farm"

Alan Hobbett, Project Director, Berwickshire Housing Association , Hoprigshiels 7.5MW Community Wind Farm



Opening of Hoprigshiels 7.5MW Community Wind Farm, by Paul Wheelhouse MSP, Minister for Business, Innovation & Energy



HRH Princess Royal at the Official Opening of Standhill Farm 200 kW AD Plant & Glasshouse, September 2017

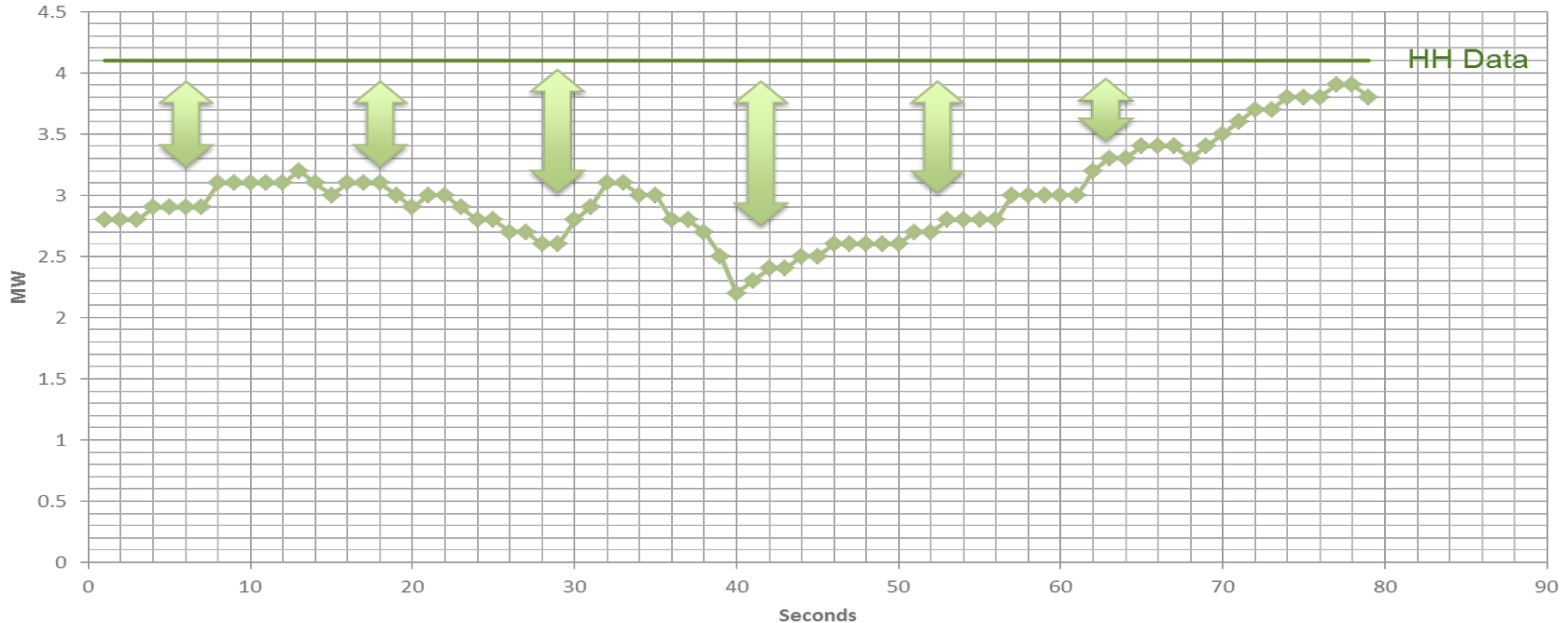


"Without the support of SP Energy Networks I'm sure I 'd never have managed to get to first base. We've managed to create a lot of jobs and we've turned an average dairy farm into a hub of production both in terms of food and energy"

Jim Shanks, Farmer Standhill Farm, Scottish Borders, Standhill 200kW AD Connection & Glasshouse

Project Key Exploitable Results, Added Value, Quantifiable Benefits

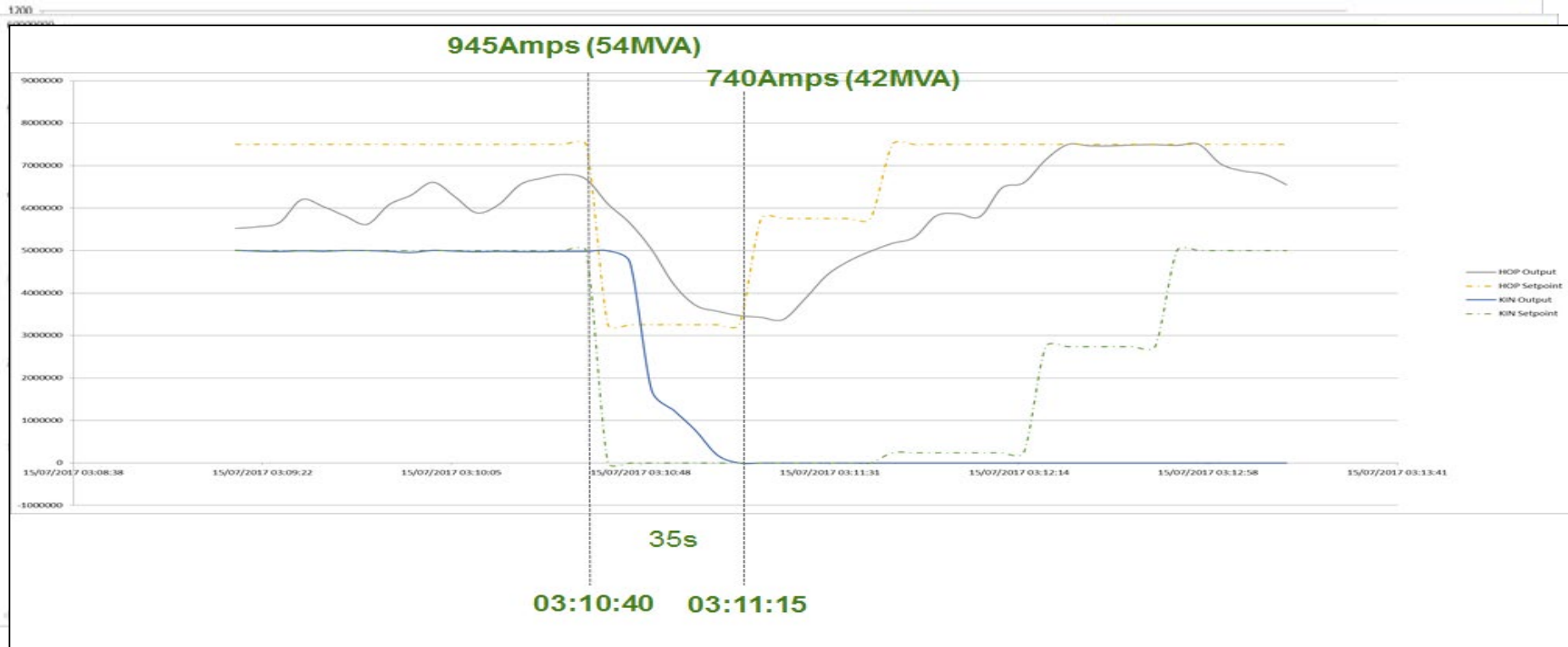
- Conventional network planning, design and modelling needs to evolve to take greater account of the operating characteristics of the technologies now seeking to connect to the network to realise greater efficiencies



Real-time Data vs. Design Assumption

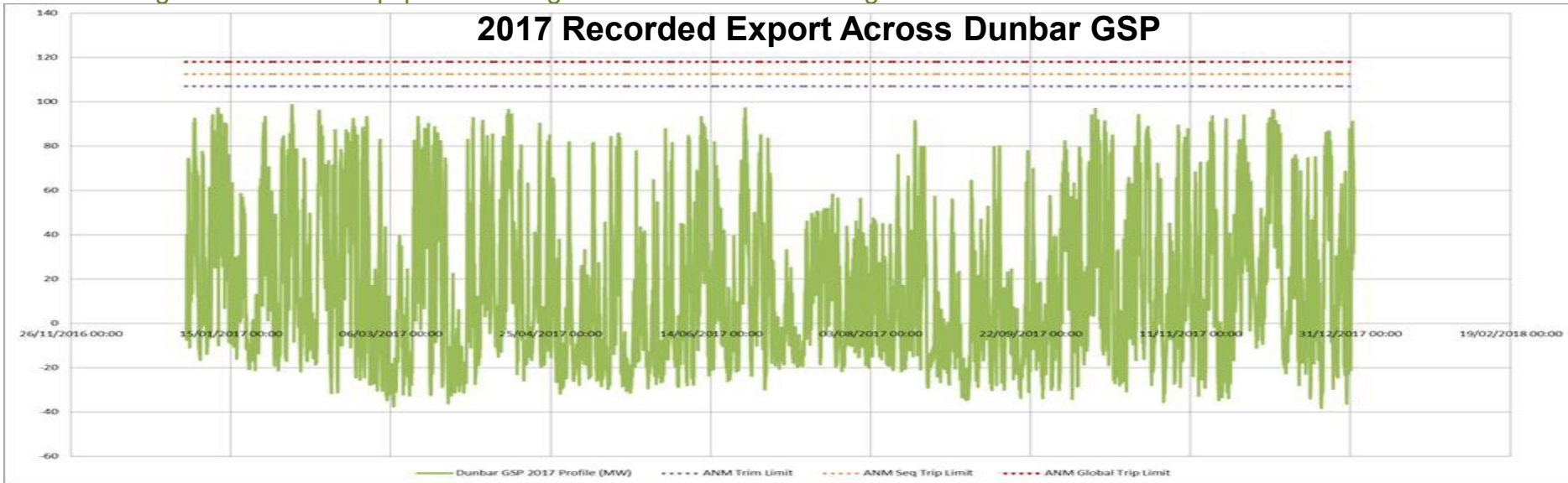
Project Key Exploitable Results, Added Value, Quantifiable Benefits

- The network is more than capable of hosting a greater level of connected generation capacity beyond the name plate rating of the network equipment through real-time network management



Project Key Exploitable Results, Added Value, Quantifiable Benefits

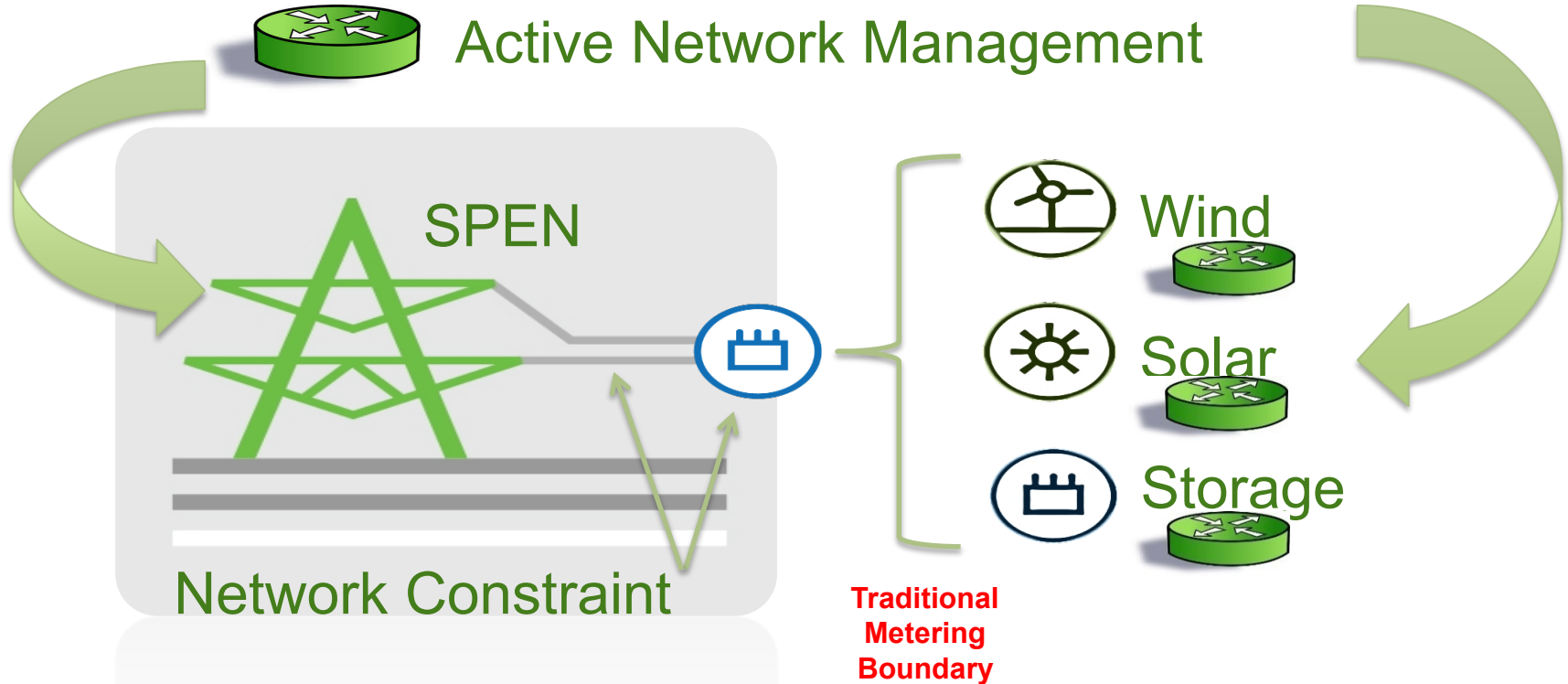
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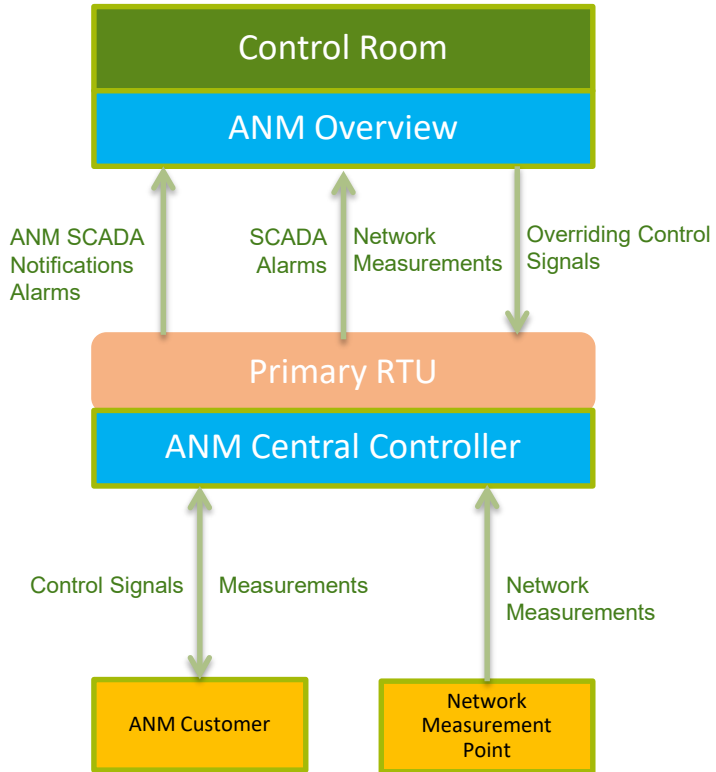
Condition	Max (MW)
Export (64%)	98.7
Import (36%)	37.6

Network Control and Automation of Customer Assets

- Recognition of a changing customer relationship

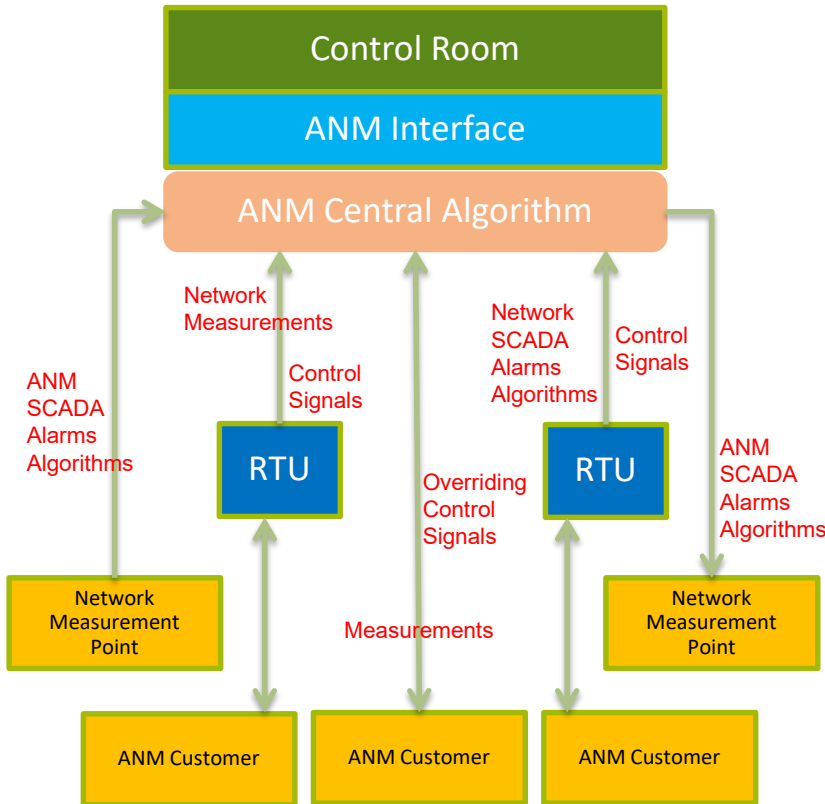


Centralised vs. Decentralised ANM Schemes (Decentralised System)



	Decentralised ANM Characteristics
Scheme Location	Well suited to remote locations where communications with central control may not be robust or reliable
Constraint Type	More suited for localised constraints although a decentralised ANM “zone” could address wider grid constraints
Response Time	A decentralised architecture can be specified to provide a response that is more rapid than the SCADA system if required i.e. 600m/s vs. 5-10 seconds
Controllability & Visibility	Can be lower visibility and controllability if communications with central network control is not reliable and/or robust
Reliability	Multiple hardware devices mean more likely for one or more to be in fault state at any one time, although less chance of single catastrophic failure
Cost	“Plug and Play” on existing hardware reduces costs but there is a greater number of hardware devices (although some could be customer owned)
Security	Easily segregated from DMS so connection of customer assets and control systems should not affect DMS security

Centralised vs. Decentralised ANM Schemes (Centralised System)



	Centralised ANM Characteristics
Scheme Location	Locations already served by SCADA and also where it is not feasible to install a software based scheme at generator location
Constraint Type	A centralised approach is well suited to management of a wider grid constraint due to increased visibility/controllability requirements
Response Time	The required response time will be slower than decentralised system if using existing SCADA infrastructure
Controllability & Visibility	Increased visibility and controllability of assets located across the distribution network, currently invisible to Control Room
Reliability	Dual SCADA or separate communications infrastructure is required with full redundancy, however central system increases chance of 'single point of failure' of distribution ANM system
Cost	Costs to fully integrate, support and maintain are greatly reduced for the overall system by centralising
Security	Where existing SCADA is used, integration of customer assets and control systems presents a security challenge, however managing multiple generator from a single ANM system behind a single corporate firewall can be easily implemented

ARC pilot project concluded December 2016, now focus is on supporting wider SPEN business in delivering similar schemes across SPD & SPM

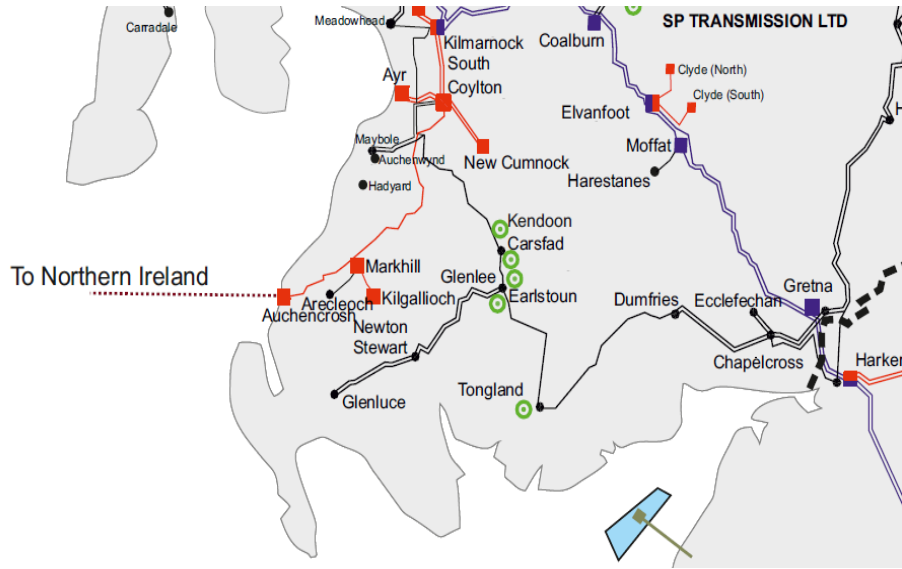
ANM Achievements

- ANM Technology successfully deployed across two Grid Supply Points (GSP) (Dunbar & Berwick)
- **100%** of connection offers issued in trial area accepted
- Connected **13** new generation projects across trial area representing an additional **100MW** of additional renewable generation capacity
- Retrofitted ANM control to an existing **48MW** wind farm
- Connected **Europe's largest community owned** wind farm
- Delivered **new design techniques** and **commercial mechanisms** for connecting renewable generation
- **Winner** at 2015 Green Energy Rewards for Best Innovation

Supporting Wider Business & Customer Goals

- SPEN's Flexible Connections Policy developed at end of December 2016
- ICE Plan deliverable for 2017
- Wider Industry Benefits: **£283M** of customer investment in renewable projects across trial area in last 4-years; directly responsible for the creation of **>55** jobs
- Community Benefits: **£700M** waste contract secured that will divert 4.25M tons of waste from landfill; estimated economic boost of renewables **£10M**, support the construction of **500** new homes rented by social landlord
- Removed requirement for around **30km** of OHL assets, reducing costs and environmental impact

Full Scale Deployment Centralised Active Network Management Scheme – Dumfries & Galloway



- **Manage Distribution and Transmission constraints**

- **Over 300 MW capacity**

- **Currently in Procurement Process – Delivery 2019/20**

- **Enables transition to DSO**

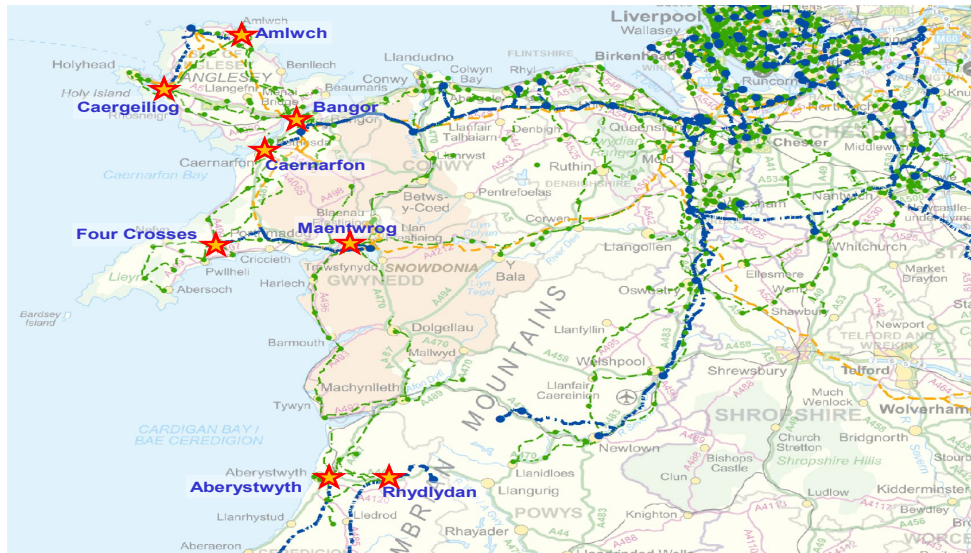
11 GSPs (with the capability to be rolled out across SPD's network area)

Designed to alleviate transmission constraints using DG and the first to interface with the SO

The first multi-GSP ANM scheme of this scale in the UK

Full Scale Deployment Centralised Active Network Management Scheme – North Wales

- **Funded from SPM Load Related Budget**
- **Manage DER in fully interconnected network**
- **Provide 150 MW capacity**
- **Extendable to further CMZs**
- **Completion through 2019/2020**
- **Enables transition to DSO**



Releasing a minimum of 8 Constraint Management Zones (CMZs)

Alternative traditional reinforcement cost approximately £11m

