Electricity Distribution

ANM Balancing Coordination Demonstration (ABCD)

Dissemination Webinar

11th May 2023

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Introductions

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Today's presenters

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Smarter Grid Solutions

Mazher Syed
Power Systems Lead Scotland
WSP UK

Denis Rono
Product Owner Networks
NG ESO

ABCD Project – Key Objectives

To develop and demonstrate solutions that can be implemented to manage the conflict between Balancing Services, also known as the Balancing Mechanism (BM), and Active Network Management (ANM) Schemes.

These will include:

- The development of the required algorithms for enabling the ANM Schemes to coordinate interactions with the Balancing Services
- Develop specifications of the required communications and coordination requirements
- Proof of concept of technical solution(s) development and demonstration
- Assessment of the likely financial and commercial impact of changes to the coordination of ANM

Project Team

- Mazher Syed
- Abdullah Emhemed

- Jenny Woodruff

- Denis Rono

- David Smith
- Michael Dolan
- Colin MacKenzie

ABCD Project – Structure

The project partners NGED, NG ESO, WSP and SGS, delivered the project via the following six work packages:

- WP1: Specification and Design
- WP2: Commercial Evaluation
- WP3: System Development
- WP4: Factory Acceptance Test
- WP5: Solution Testing
- WP6: Evaluation and Dissemination

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Conflict in Future System Operation - Balancing Mechanism Coordination

Mazher Syed
Power Systems Team Lead, Scotland
WSP UK

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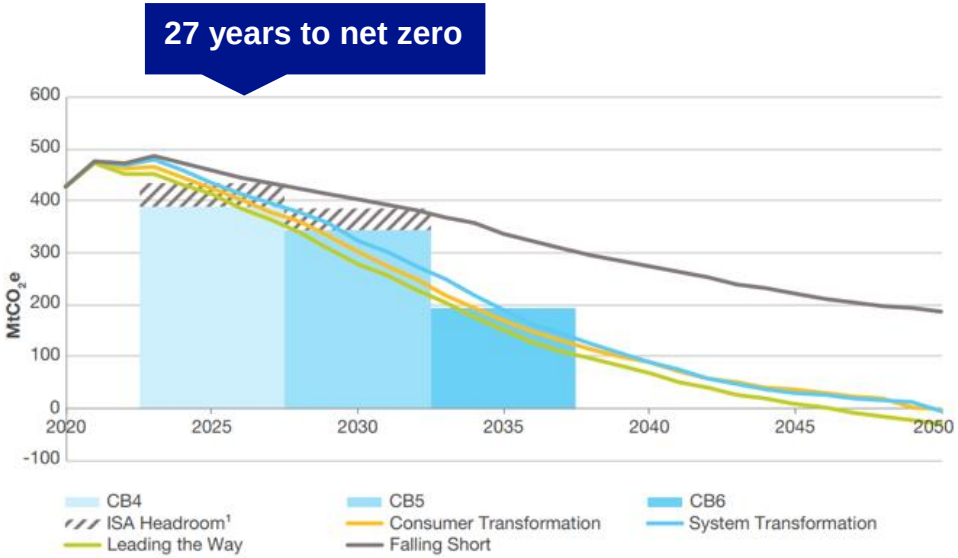
Transformation of GB Power System

Net Zero Target 2050

- Operation and control increasingly challenging
- Novel services continuously explored and developed
- Extensively harnessing capabilities of Distributed Energy Resources (DER) and flexibility within Distribution networks



Source: FES in Five July 2022

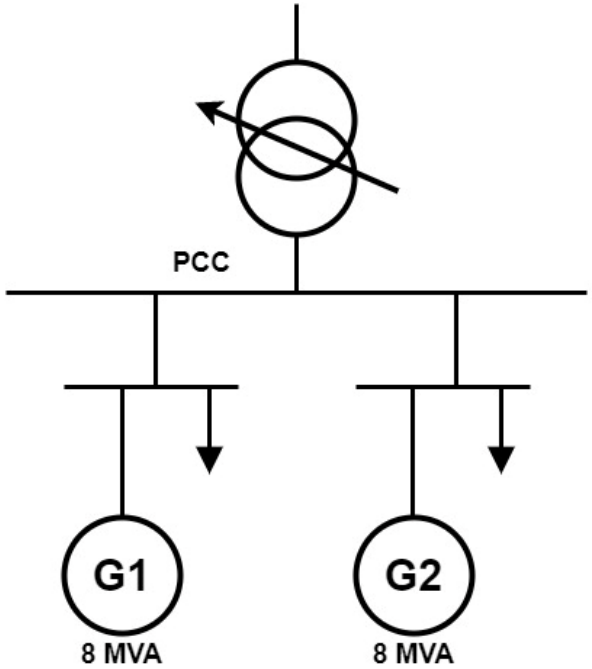
Problem Statement

ANM schemes which are not coordinated with wider Balancing Services markets will increase costs to consumers and may pose a risk to security of supply

Potential Conflict between BM and ANM

Sample Distribution Network

- Two Generators rated at 8MVA
- ANM implemented with objective to controlling power export at PCC* (9MW)
- Generator G1 non-curtailable
- Generator G2 curtailable – ANM
- No load variations



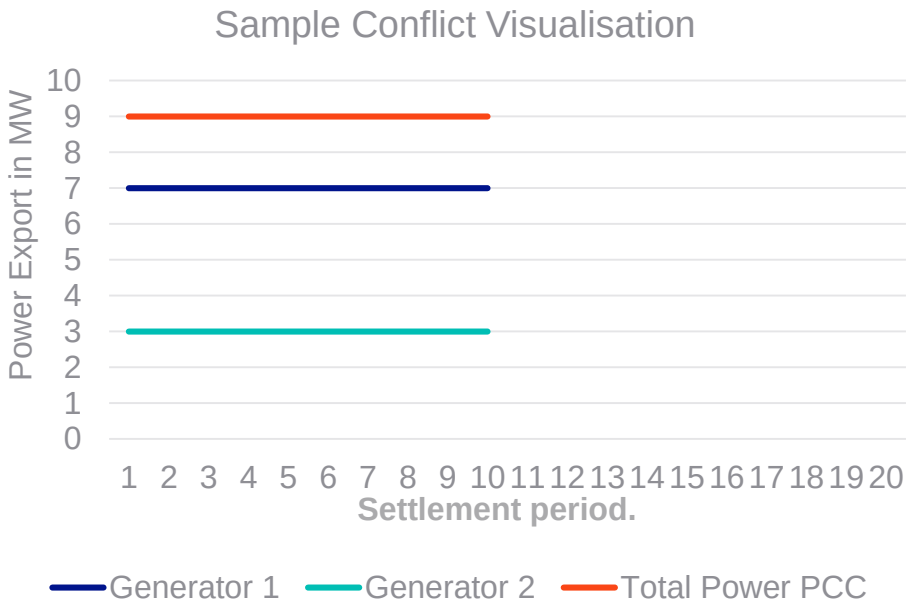
*PCC = point of common coupling

Potential Conflict between BM and ANM

Sequence Leading to Conflict:

1. Normal operating conditions

   ANM controlling power at PCC



Potential Conflict between BM and ANM

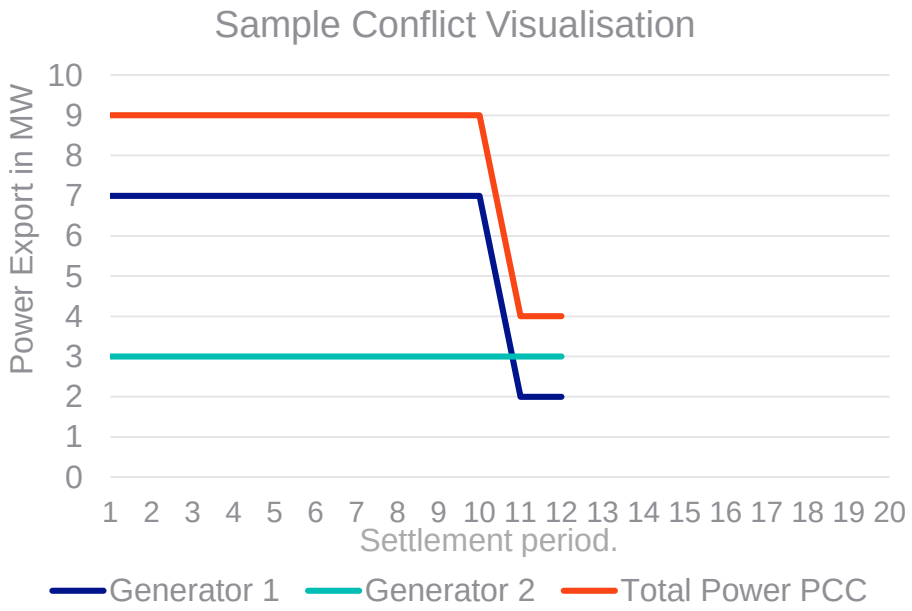
Sequence Leading to Conflict:

1. Normal operating conditions

   ANM controlling power at PCC

2. NGESO issues command to Generator 1 to reduce power by 5MW

   Generator 1 responds by reducing power output from 7MW to 2MW



Potential Conflict between BM and ANM

Sequence Leading to Conflict:

1. Normal operating conditions

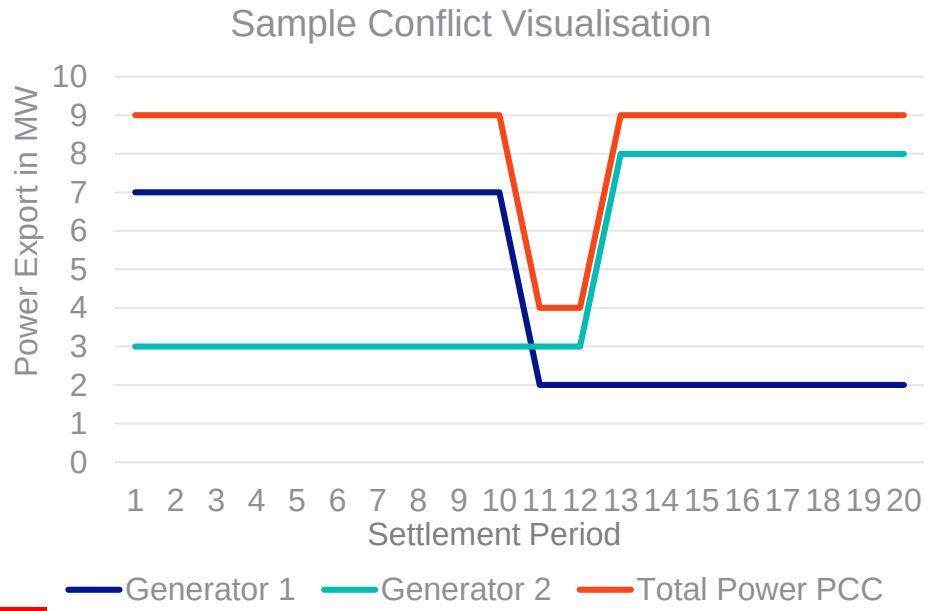
   ANM controlling power at PCC

2. NGESO issues command to Generator 1 to reduce power by 5MW

   Generator 1 responds by reducing power output from 7MW to 2MW

3. ANM observes the reduction in uncontrolled Generator 1 and releases headroom for Generator 2

   Generator 2 ramps up power to 8MW



Impact of BM nullified

Potential Solutions

Previous NIA :

- Nine solutions proposed under four categories for conflicts identified.
- Solutions evaluated based on cost benefit analysis and their technical feasibility.
- Solution W1 (technical) taken forward for proof of concept implementation and demonstration.

“W” solutions
Reconfiguration of ANM schemes

“X” solutions
Improved information exchange between DNOs and generators

“Y” solutions
Changes to Balancing Services procurement

“Z” solutions
Coordinating CLASS and ANM systems

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Proposed Solution – ANM Coordinating Balancing Mechanism Delivery

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Delivery Architect
Smarter Grid Solutions

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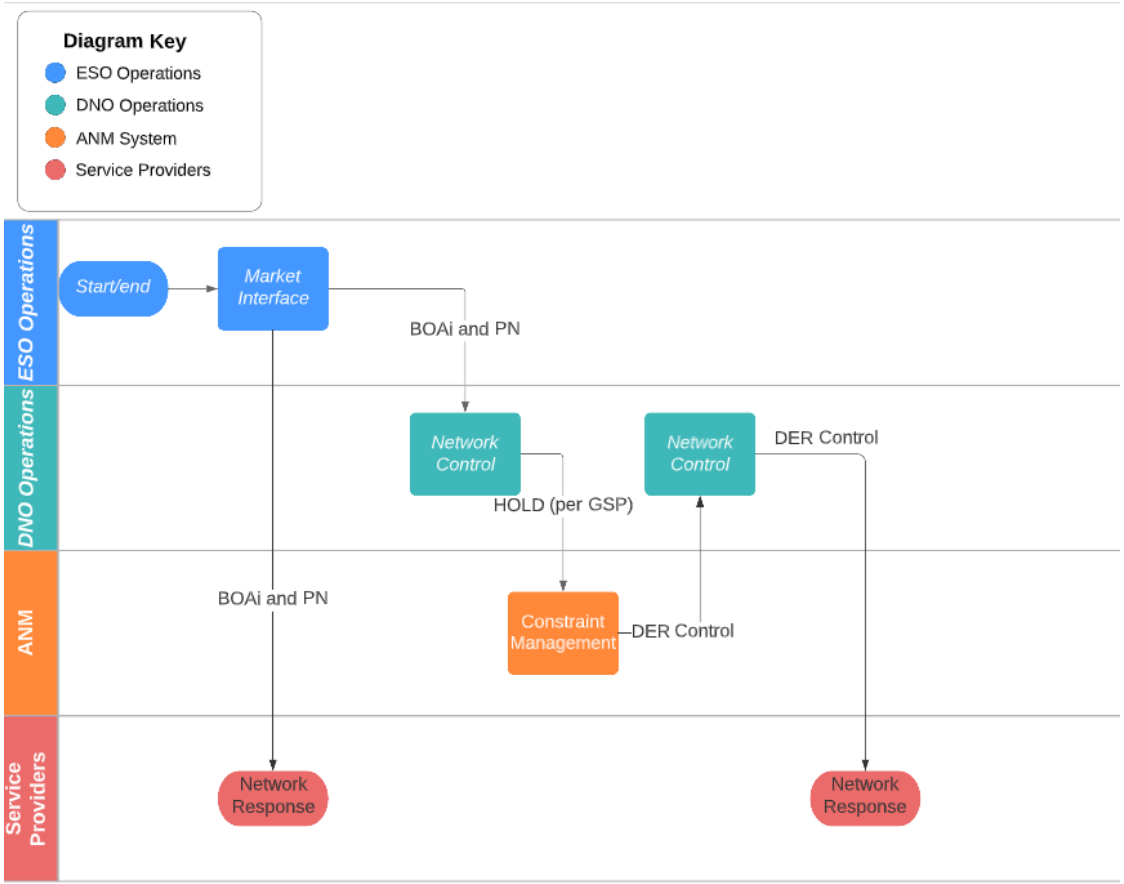
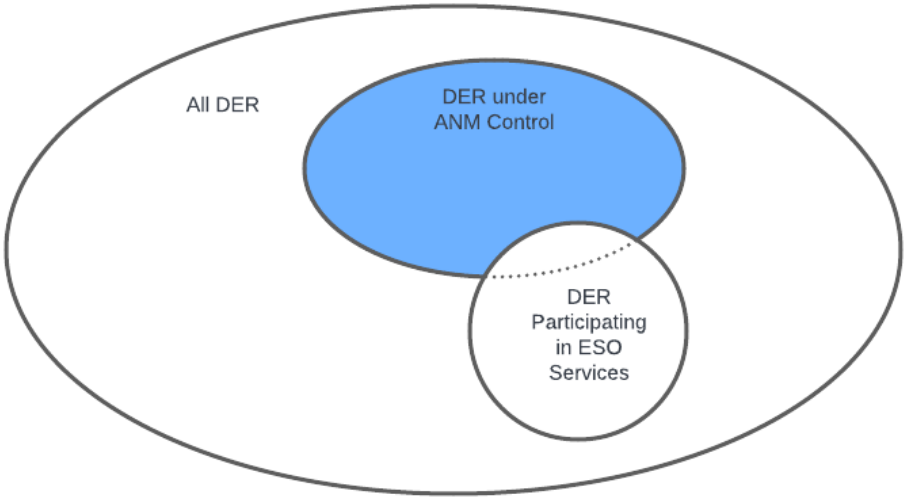
The Solution

1. **ESO notifies DNO about service requests**
2. **DNO calculates whether conflict is possible**
3. **If conflict is possible DNO puts ANM into "Hold Mode"**
4. **ANM actively manages Flexible DER Contribution**



Application of Control Mode

Condition(s)	Hold Mode Status
For the associated Settlement Period (SP), • Services instructed by Bid Offer Acceptance instruction (BOAi) is export decrementing (positive). AND • Physical Notification (PN) of participating DER is positive. AND • BOAi instructed MW < PN MW (overall decrease in export of DER)	Hold Mode Enabled
For the associated Settlement Period (SP), • Services instructed by BOAi is negative OR • PN of participating DER is negative. OR • BOAi instructed MW > = PN MW	Hold Mode Disabled



Operation of Hold Mode

The Hold Mode maintains the overall effect of flexible DER on the ESO/DNO boundary for the duration of ESO service utilisation.

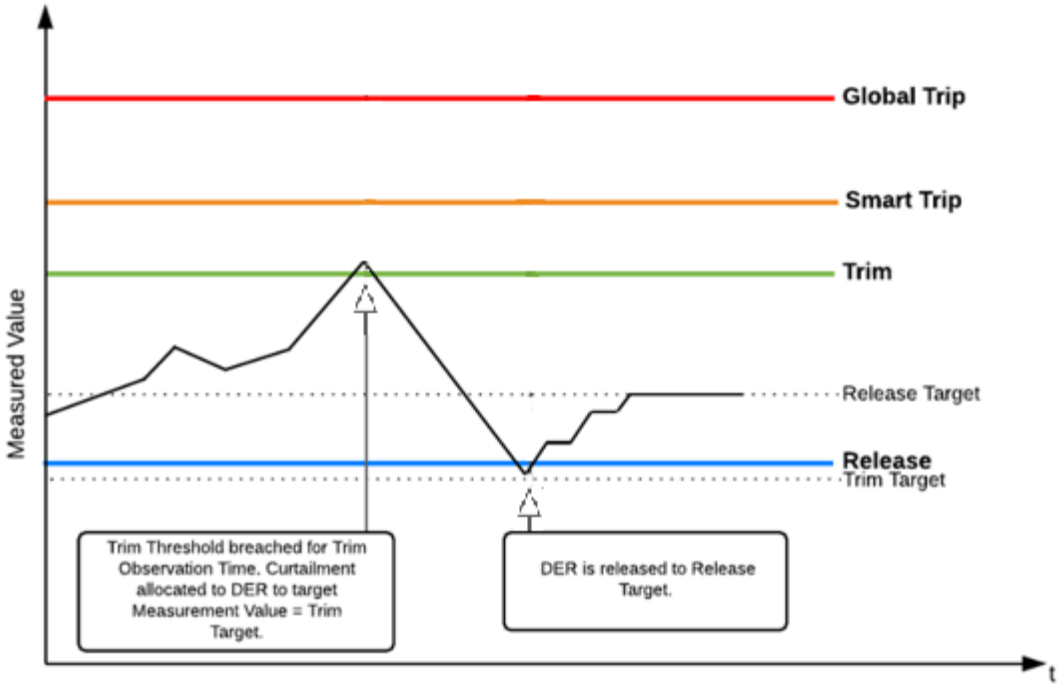
Benefits:

- Principles Of Access (PoA) ordering is maintained,
    - If a high-priority flexible DER starts to export more, then lower-priority flexible DER will be curtailed
    - If a high-priority flexible DER decreases its export, then more lower priority flexible DER will be released
- Other distribution constraints can still be resolved but the overall impact of flexible DER on the ESO/DNO boundary will not increase beyond what was calculated at the start of Hold Mode.
- There will not be an increase of power at the boundary because of flexible DER during the Hold mode.

Normal ANM Operation

Constraint locations are managed in real time by *Measurement Points (MP)*

1. **Measured Value exceeds trim threshold.**
2. **Flexible DER are curtailed**
3. **Measured Value reaches Release threshold**
4. **Some Flexible DER are released & safe margin is maintained.**



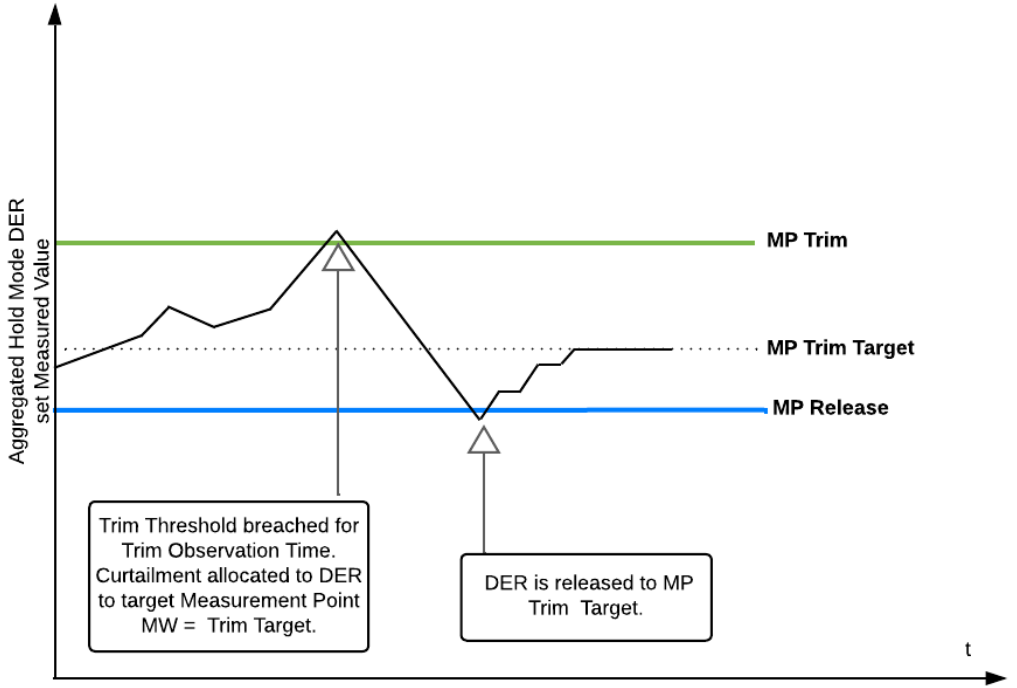
Hold Operation

Extension to Normal ANM Operation. A *Virtual Measurement Point* is enabled in Hold Mode.

Measured Value = Aggregated Generator Contribution (AGC)

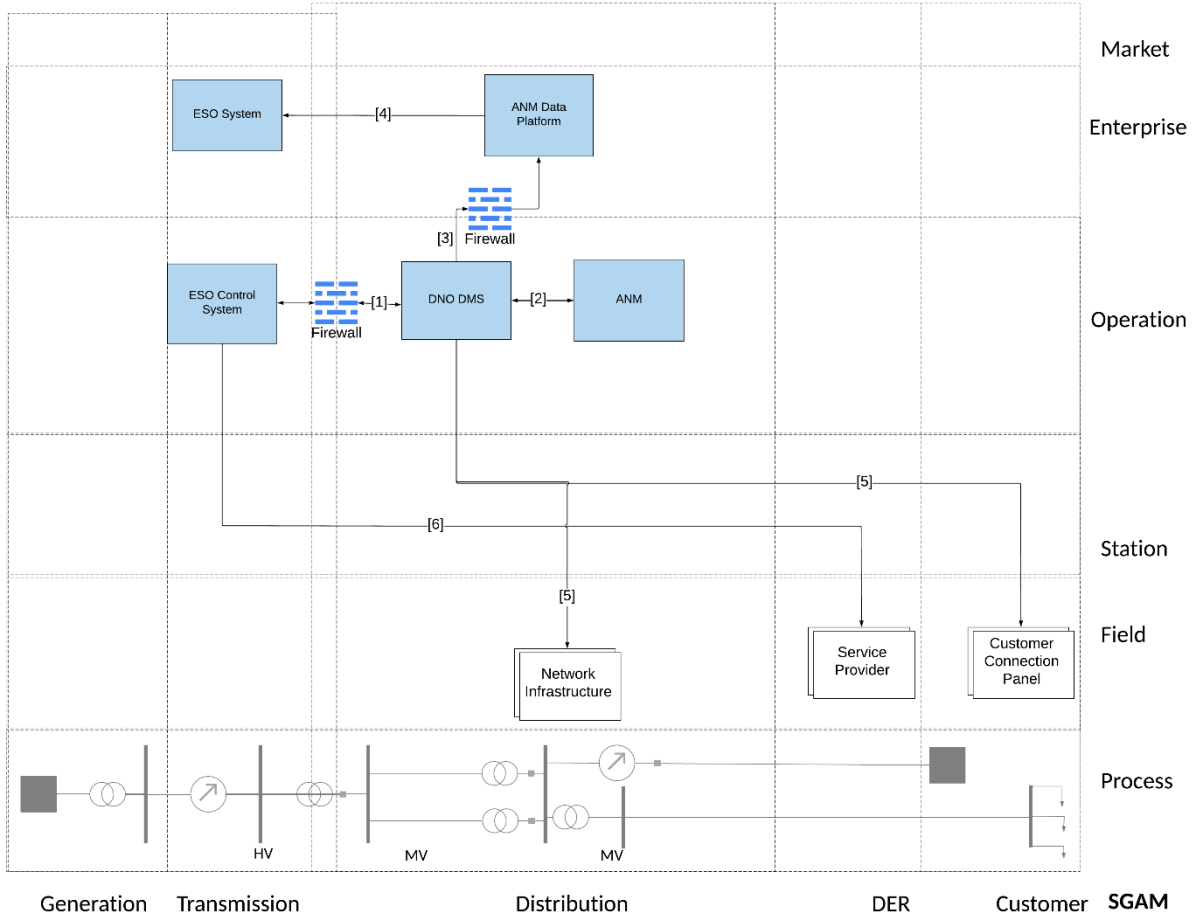
Trim = AGC when Hold is enabled

1. **Measured Value exceeds trim threshold.**
2. **Flexible DER are curtailed**
3. **Measured Value reaches release threshold**
4. **Some flexible DER are released & safe margin is maintained.**



Architecture

ID	Communication Type	Medium
1	ICCP over Dedicated Operational Telecom Network (Phase 1)	Dedicated Operational Telecom Network
2	ICCP	LAN
3	ICCP	LAN
4	Web service API (Phase 2)	Dedicated MPLS
5	Existing SCADA infrastructure	Depending on DNO
6	Existing Balancing Mechanism communications	Depending on provider



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Trial Demonstration Outcomes

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Delivery Architect
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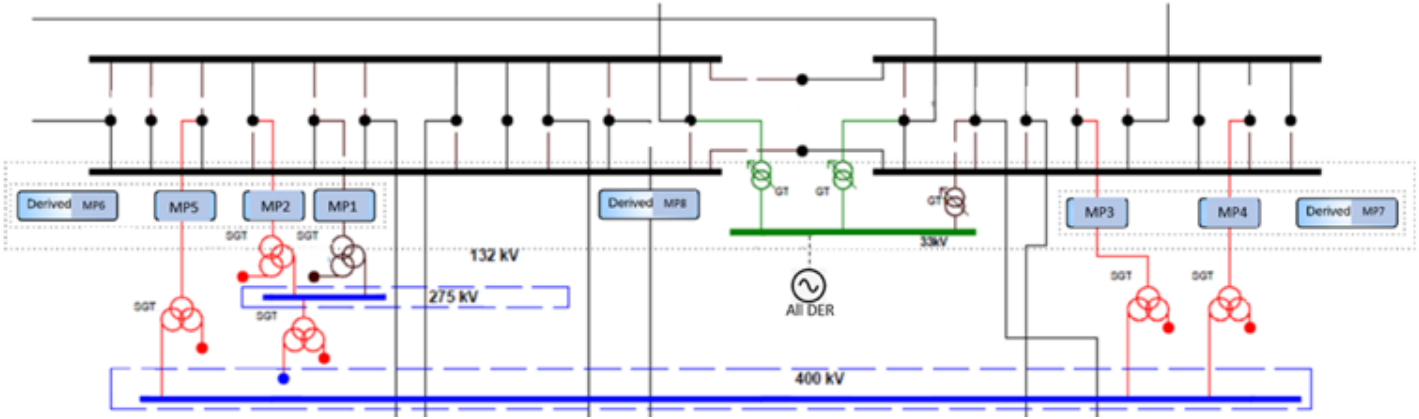
Test Network Overview

Based on ANM System controlling NGED network.

Generator Name	Max. MW	Type	ANM Y/N
Generator 1	8	Wind	Y
Generator 2	3.68	PV	Y
Generator 3	7.84	PV	Y
Generator 4	1.9	Hydro	Y
Generator 5	4.12	PV	Y
Generator 18	10	Battery	N
Generator 19	10	Battery	N



Measurement Point	Transducer Measurements	Description
MP1	Thermal (A) Directional 132 kV	Thermal constraint at transmission / distribution boundary
MP2	Thermal (A) Directional 132 kV	Thermal constraint at transmission / distribution boundary
MP3	Thermal (A) Directional 132 kV	Thermal constraint at transmission / distribution boundary
MP4	Thermal (A) Directional 132 kV	Thermal constraint at transmission / distribution boundary
MP5	Thermal (A) Directional 132 kV	Thermal constraint at transmission / distribution boundary
MP6	Thermal (A) Directional 132 kV	Virtual MP controlled overall current through MP1, MP2, and MP5.

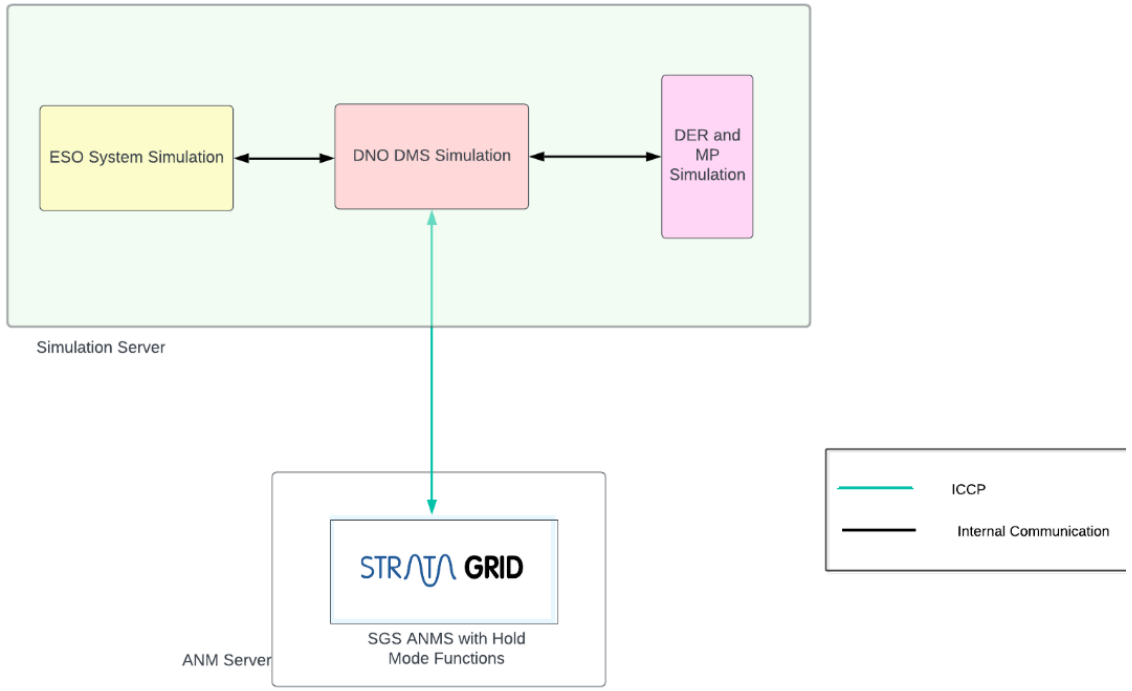
Measurement Point	Transducer Measurements	Description
MP7	Thermal (A) Directional 132 kV	Virtual MP controlled overall current through MP4 & MP5
MP8	Thermal (A) Directional 132 kV	Virtual MP controlled overall current through MP1, MP2, MP3, MP4 & MP5
MP9	Voltage (V)	Voltage constraint in distribution network
MP10	Thermal (A) Directional 33 kV	Thermal constraint in distribution network
MP11	Thermal (A) Directional 33 kV	Thermal constraint in distribution network

Trial Architecture

Instance of Strata Grid deployed with Hold Mode functionality.

Simulation server providing following functions:

1. **ESO System:**
   - Issuing data about BM requests
2. **DNO System:**
   - Consuming & parsing BM requests
   - Pass through of DER & Network Data to ANM System
3. **Network Simulation:**
   - Simulating DER response
   - Simulating network response



Scenario Overview

Scenario driven trials

- Input based on historical data
- Simulation of DER export – changes in response to ANM & BM requests.
- Network measurements change in relation to input data & DER simulation

20 scenarios were tested under the following categories:

1.Service Conflicts: Demonstrating conflict of services where the ANM degrades the ESO request.

2.ESO Decrementing Service Requests: Demonstrating successful resolution of conflict

3.Management of Boundary Export: Demonstrating management of conflict & continued management of conflict during the duration of ESO service requests.

4.Constraint Management: Demonstrating successful resolution of conflict under when different constraints are active.

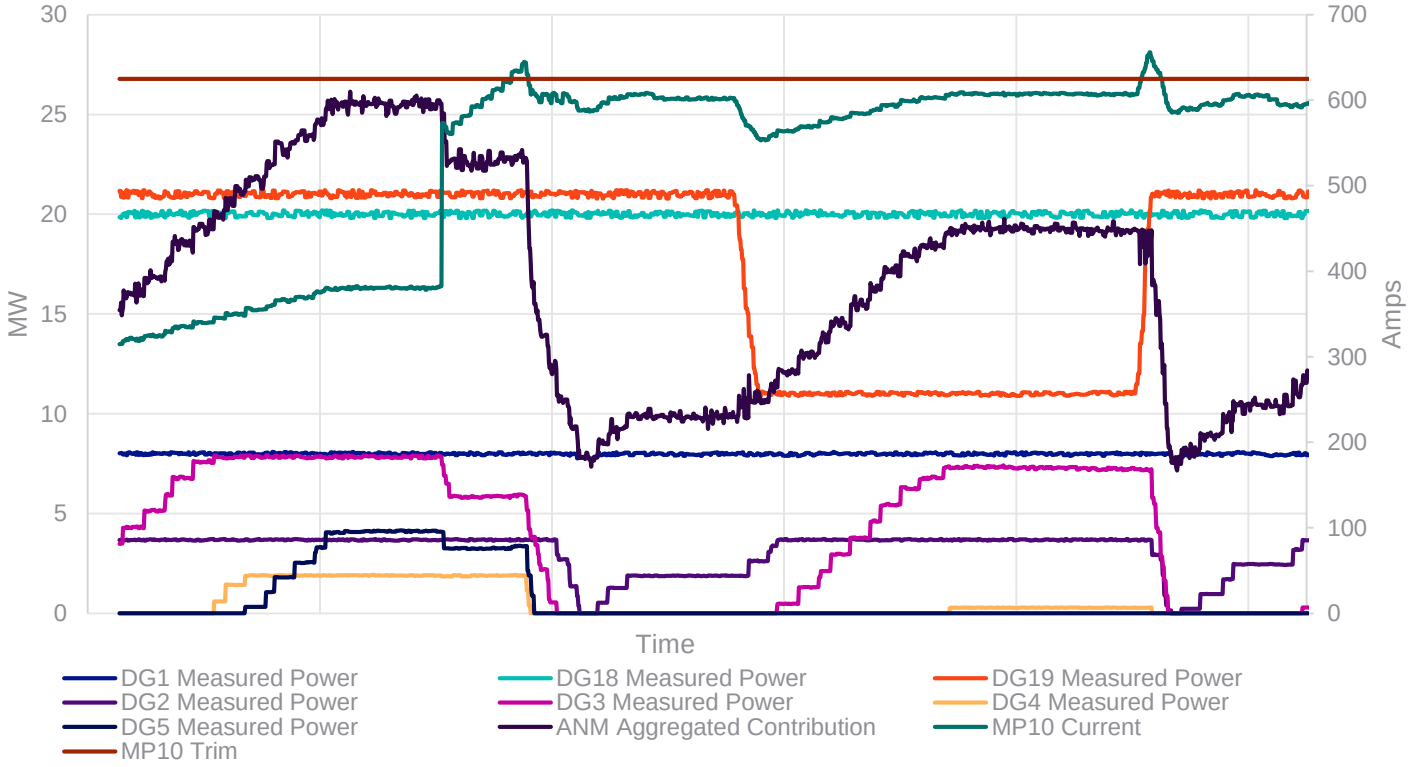
5.Response to Failures: Demonstration resolution of conflict under different failure scenarios

6.Principle of Access: Demonstrating resolution of conflict under different ANM principles of access.

Scenario 1: Demonstrating Conflict

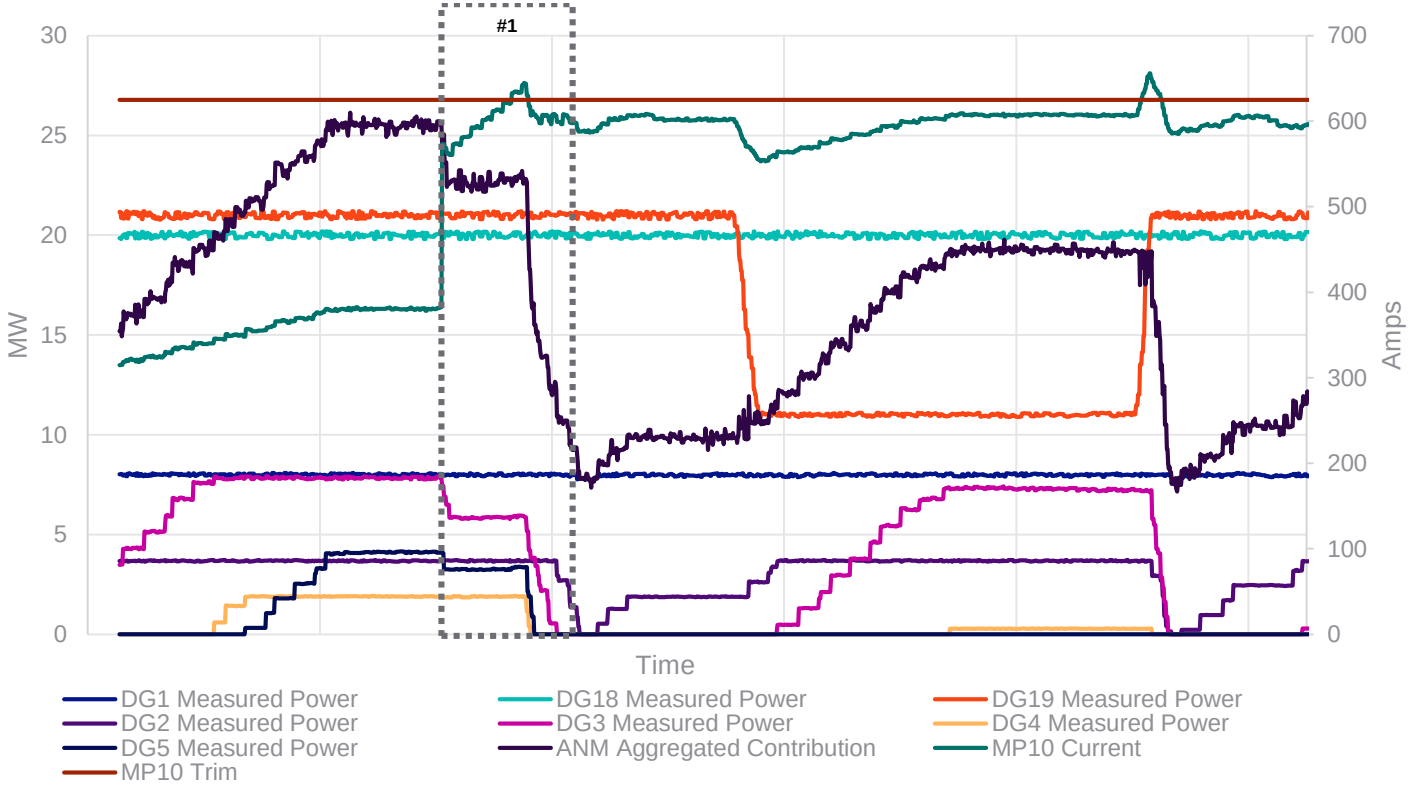
Highlights:

1. **ESO service is eroded**
2. **ESO service ending causes additional curtailment event**



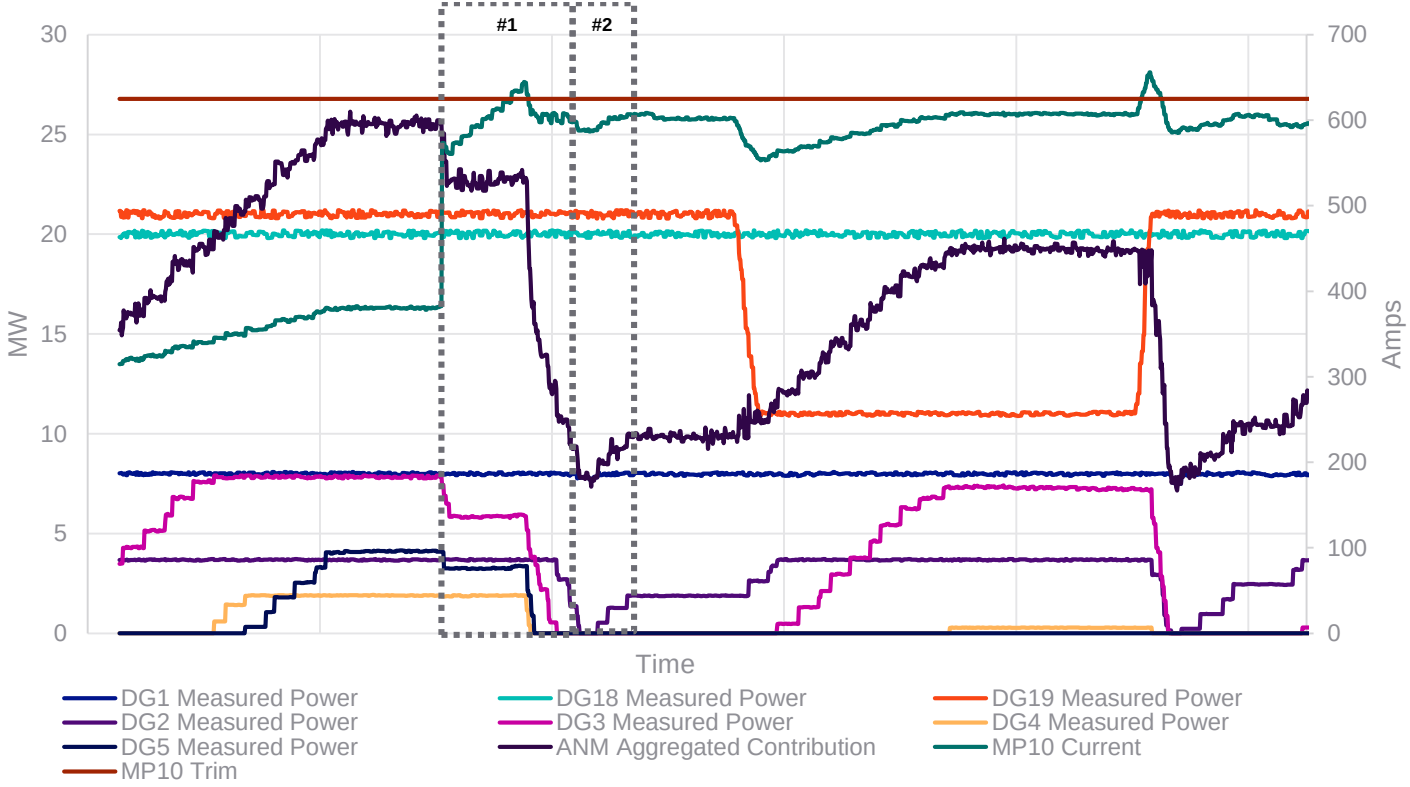
Scenario 1: Demonstrating Conflict

1. **Thermal constraint Trim & DG curtailed**



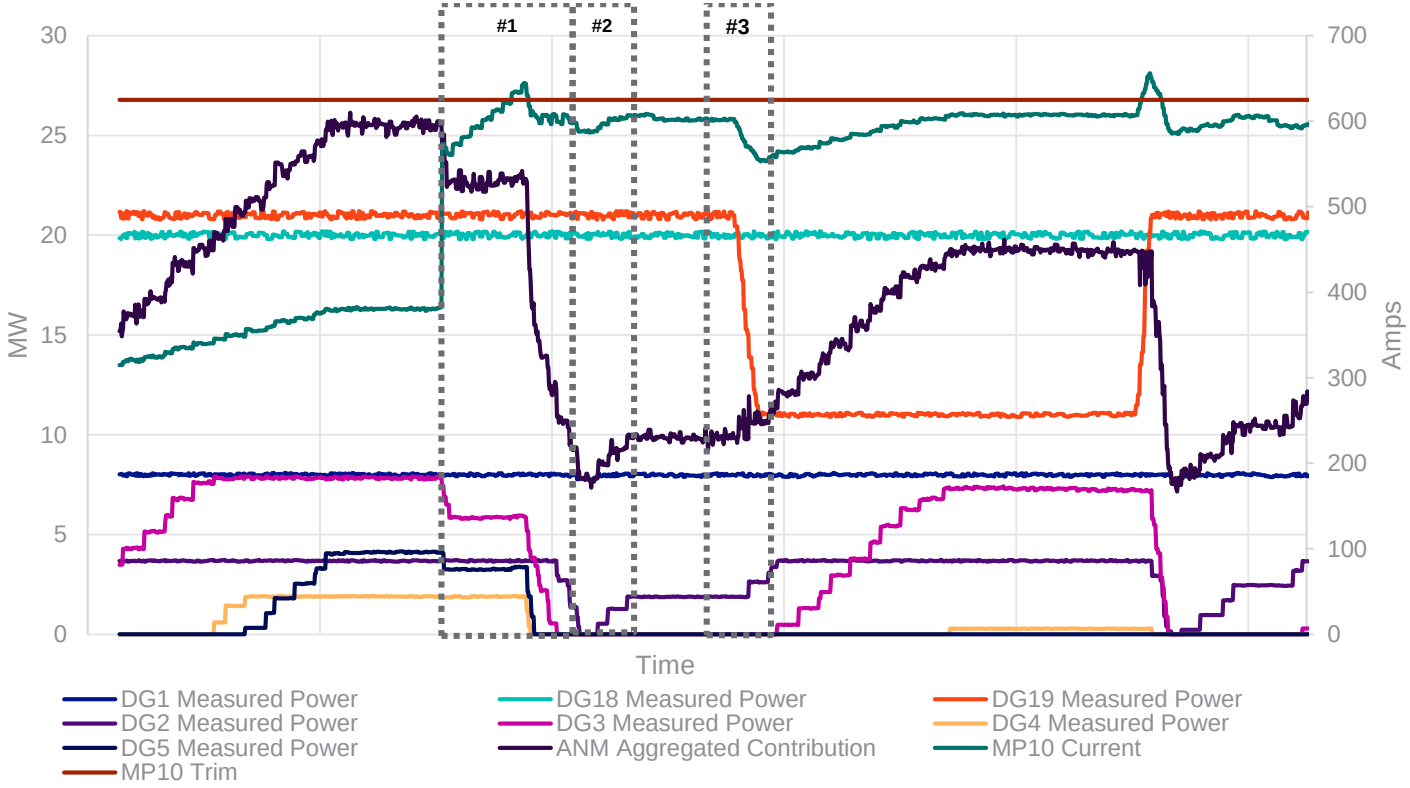
Scenario 1: Demonstrating Conflict

1. **Thermal constraint Trim & DG curtailed**
2. **Capacity released**



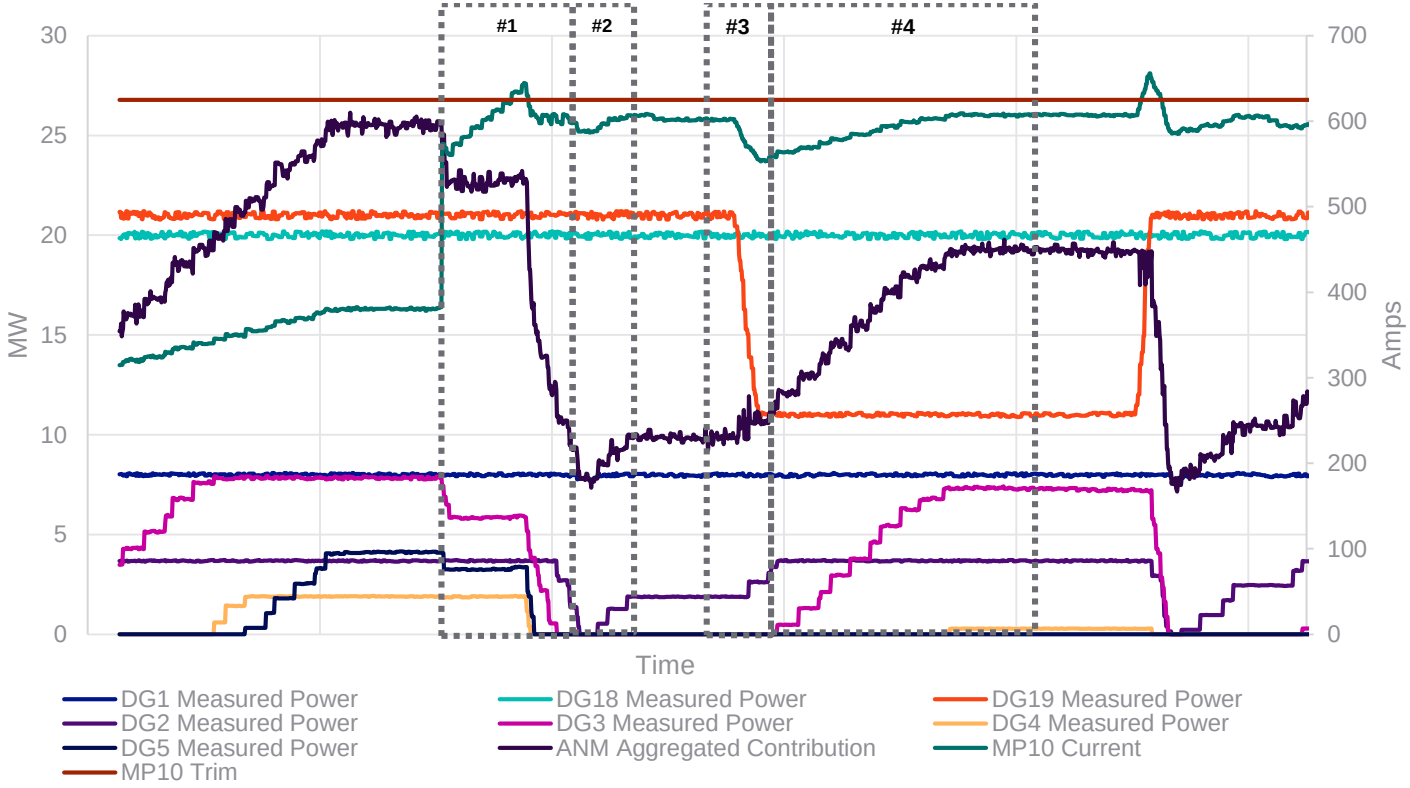
Scenario 1: Demonstrating Conflict

1. **Thermal constraint Trim & DG curtailed**
2. **Capacity released**
3. **BMU ramps down**



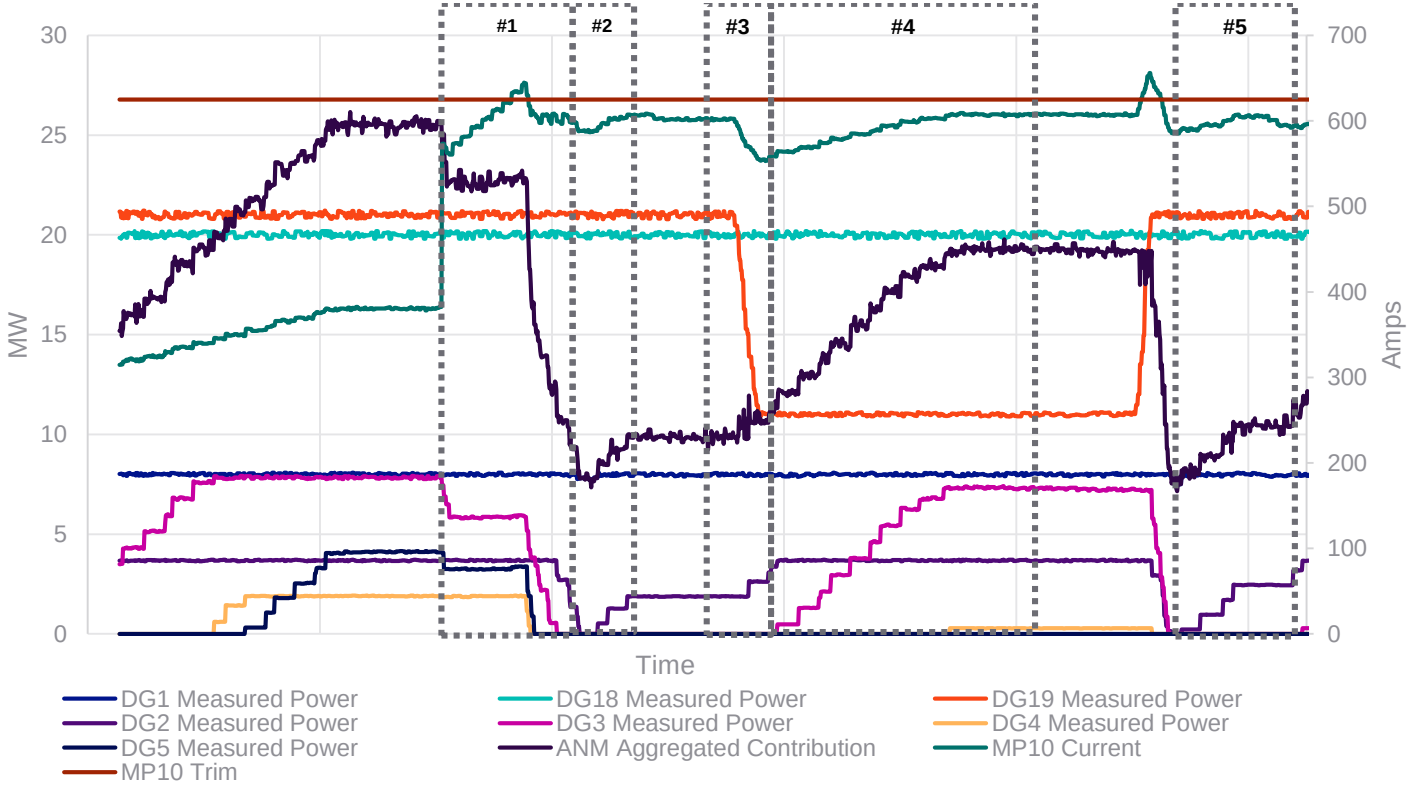
Scenario 1: Demonstrating Conflict

1. **Thermal constraint Trim & DG curtailed**
2. **Capacity released**
3. **BMU ramps down**
4. **Hold mode is not activated ANM DG are ramped up due to available headroom**



Scenario 1: Demonstrating Conflict

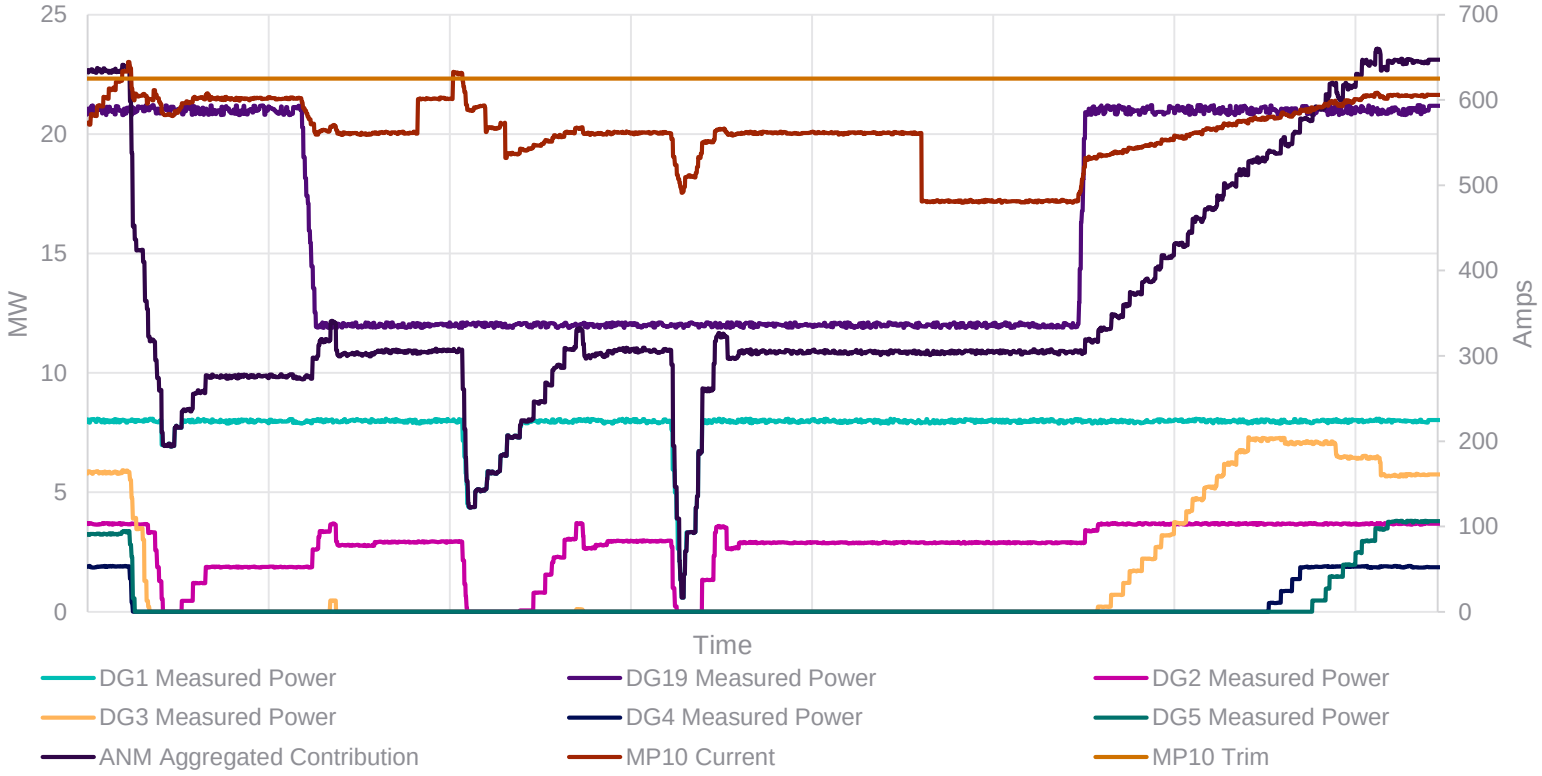
1. **Thermal constraint Trim & DG curtailed**
2. **Capacity released**
3. **BMU ramps down**
4. **Hold mode is not activated ANM DG are ramped up due to available headroom**
5. **BMU ramps up & causes Trim event DG are curtailed**



Scenario 11: Constraint Management during Hold Mode

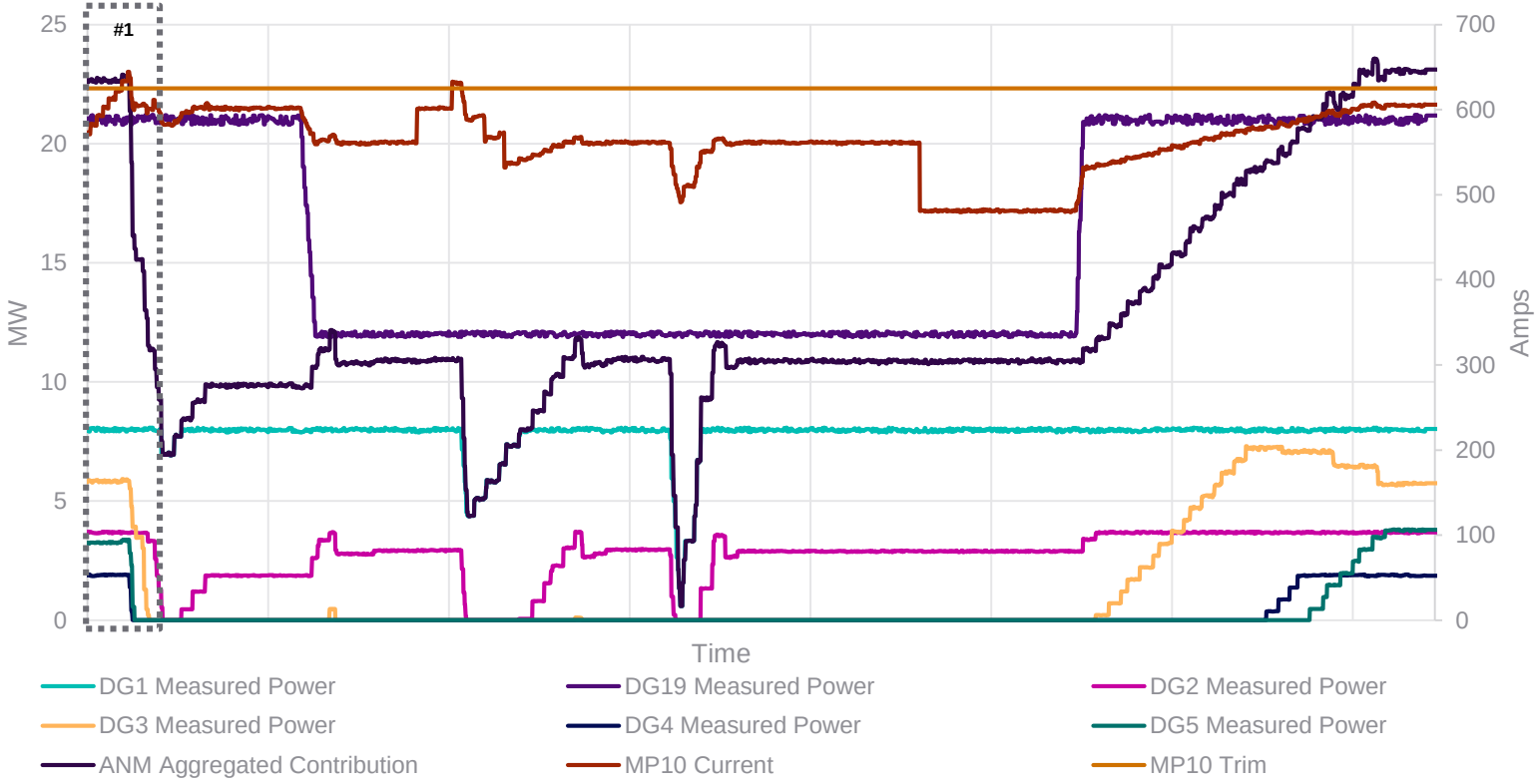
Highlights:

- **Hold Mode enabled**
- **Aggregated contribution held below limit**
- **Distribution constraints managed during Hold Mode**
- **DER released when possible**



Scenario 11: Constraint Management during Hold Mode

1. **Thermal constraint trim & DG curtailed**



Scenario 11: Constraint Management during Hold Mode

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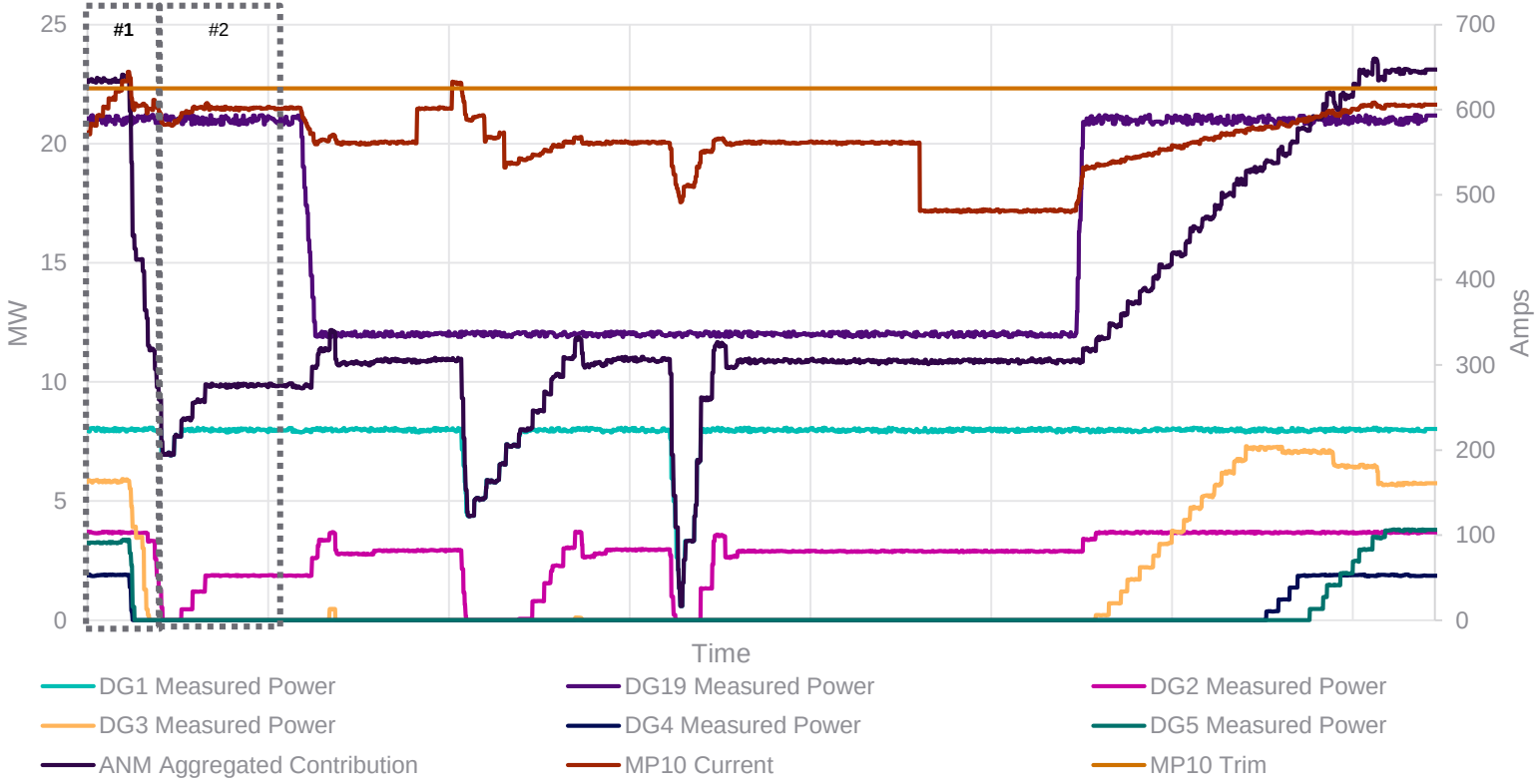

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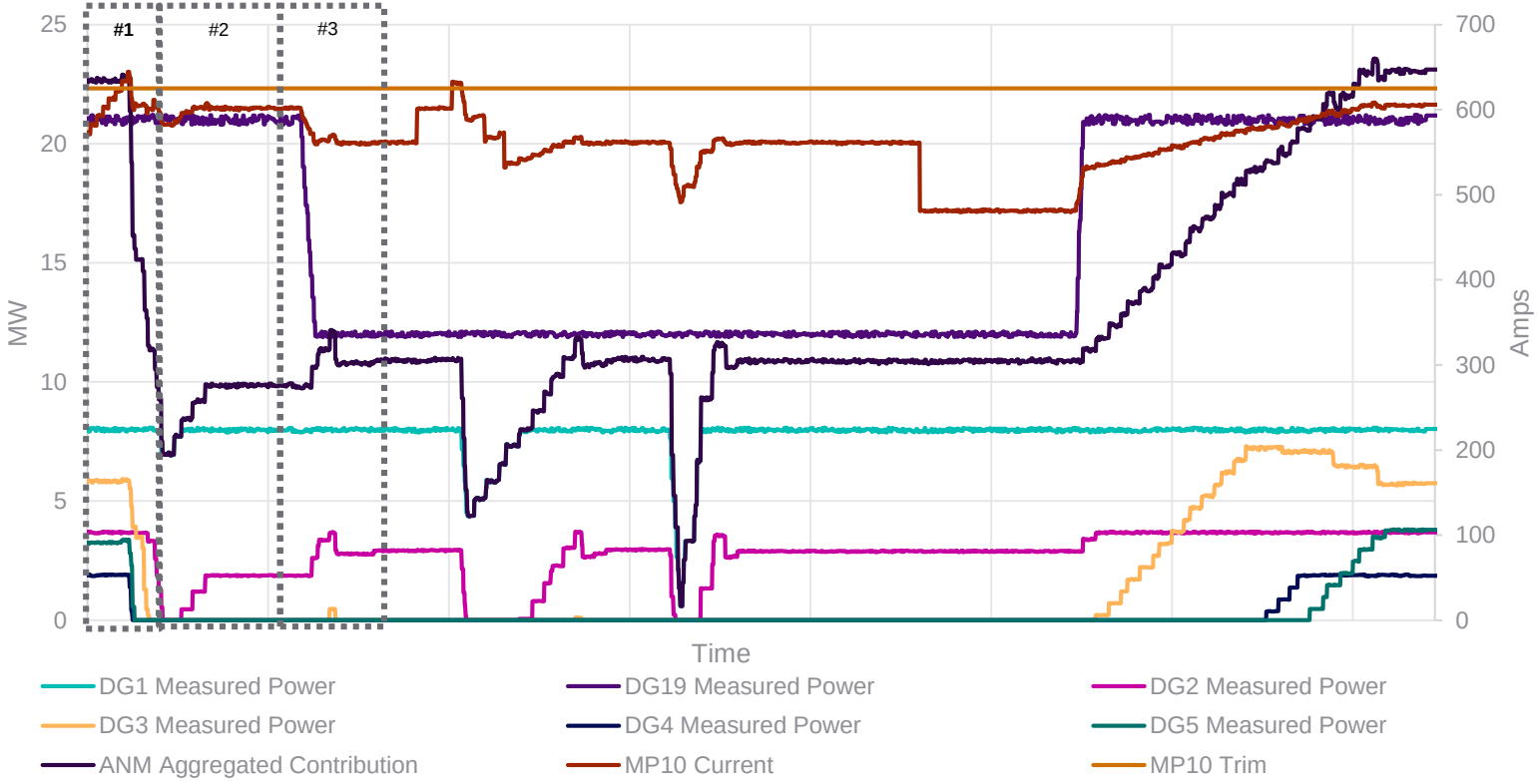
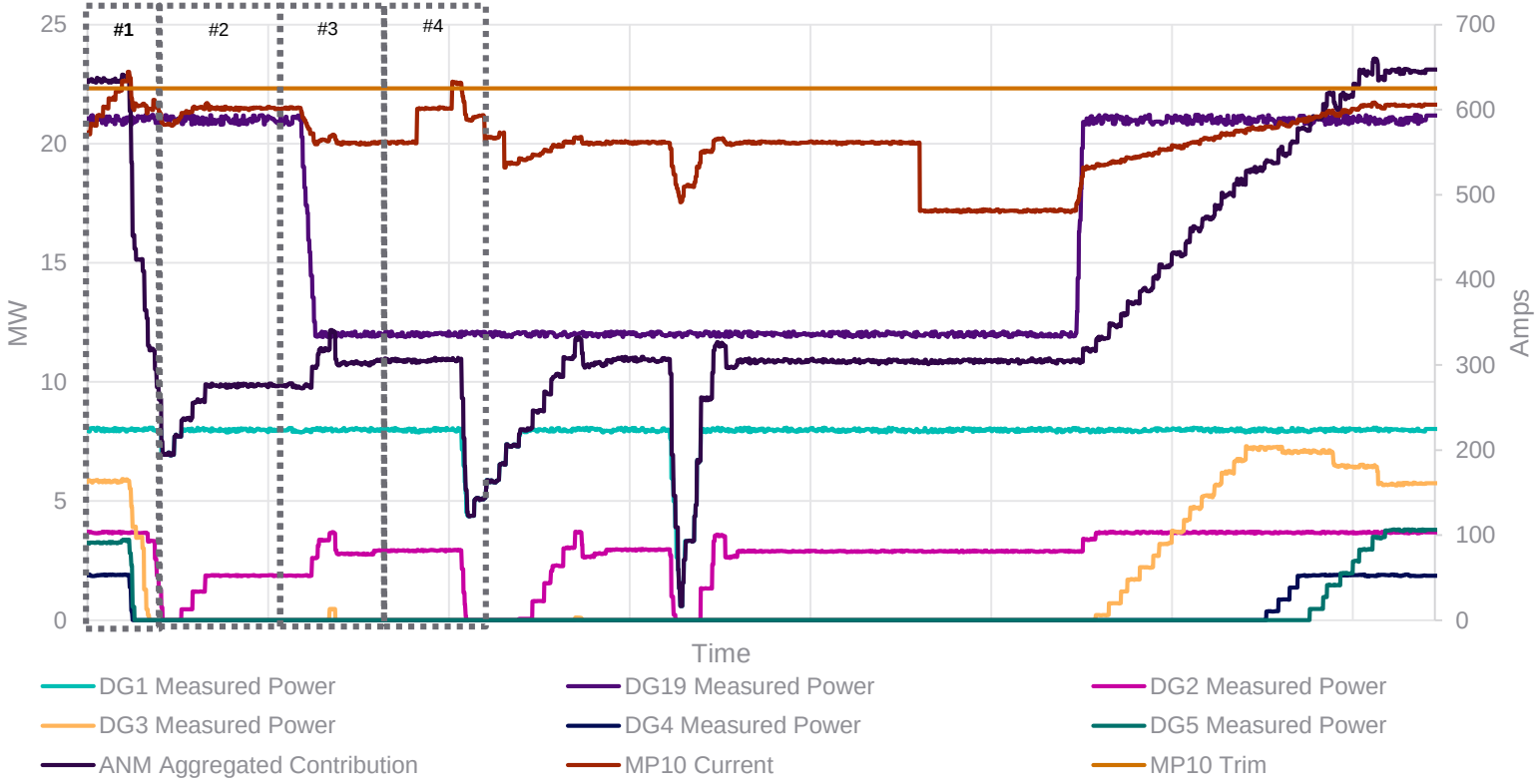


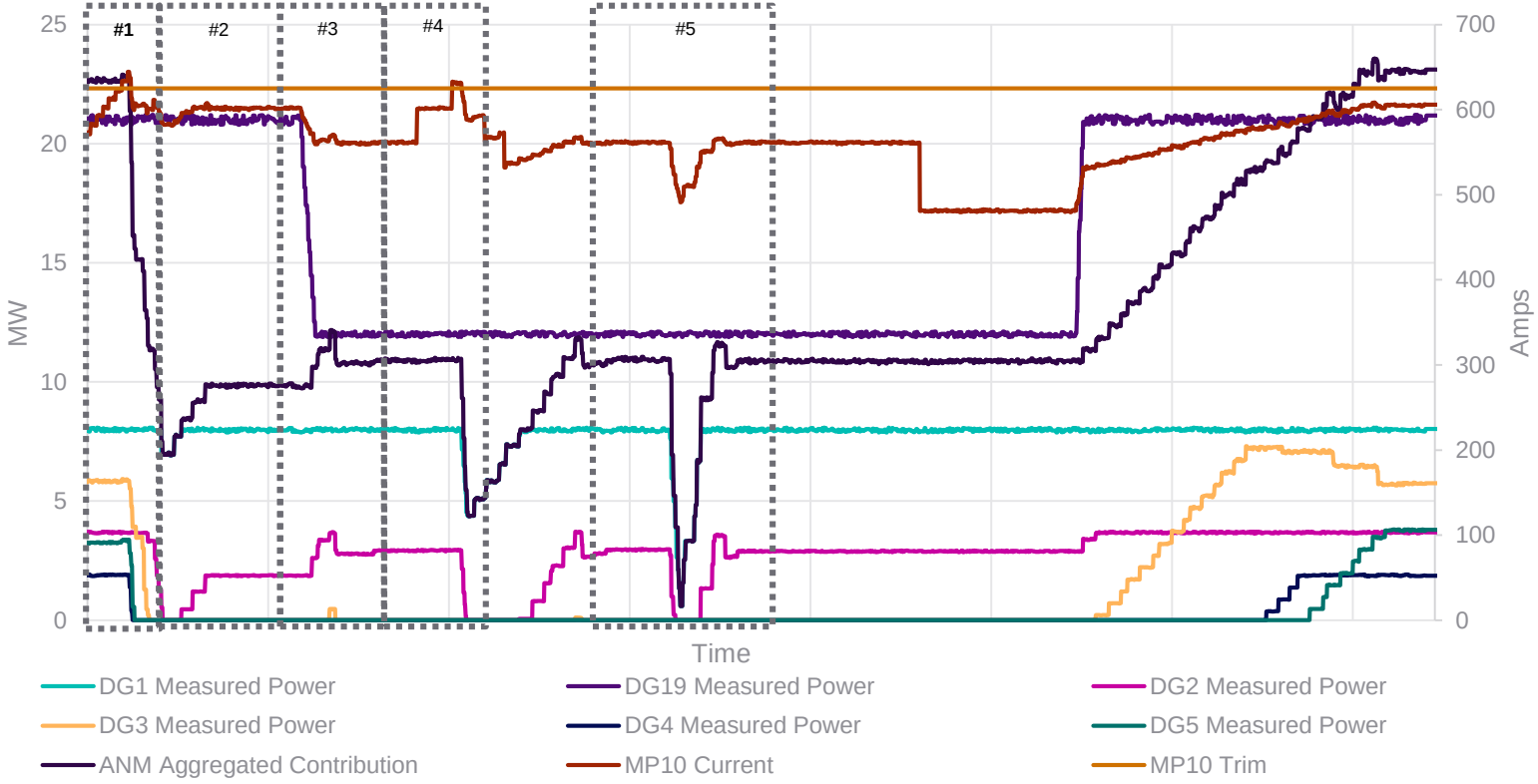
Scenario 11: Constraint Management during Hold Mode

1. **Thermal constraint trim & DG curtailed**
2. **BMU ramps down**
3. **Hold Mode enabled**
4. **Thermal constraint trim& DG curtailed**



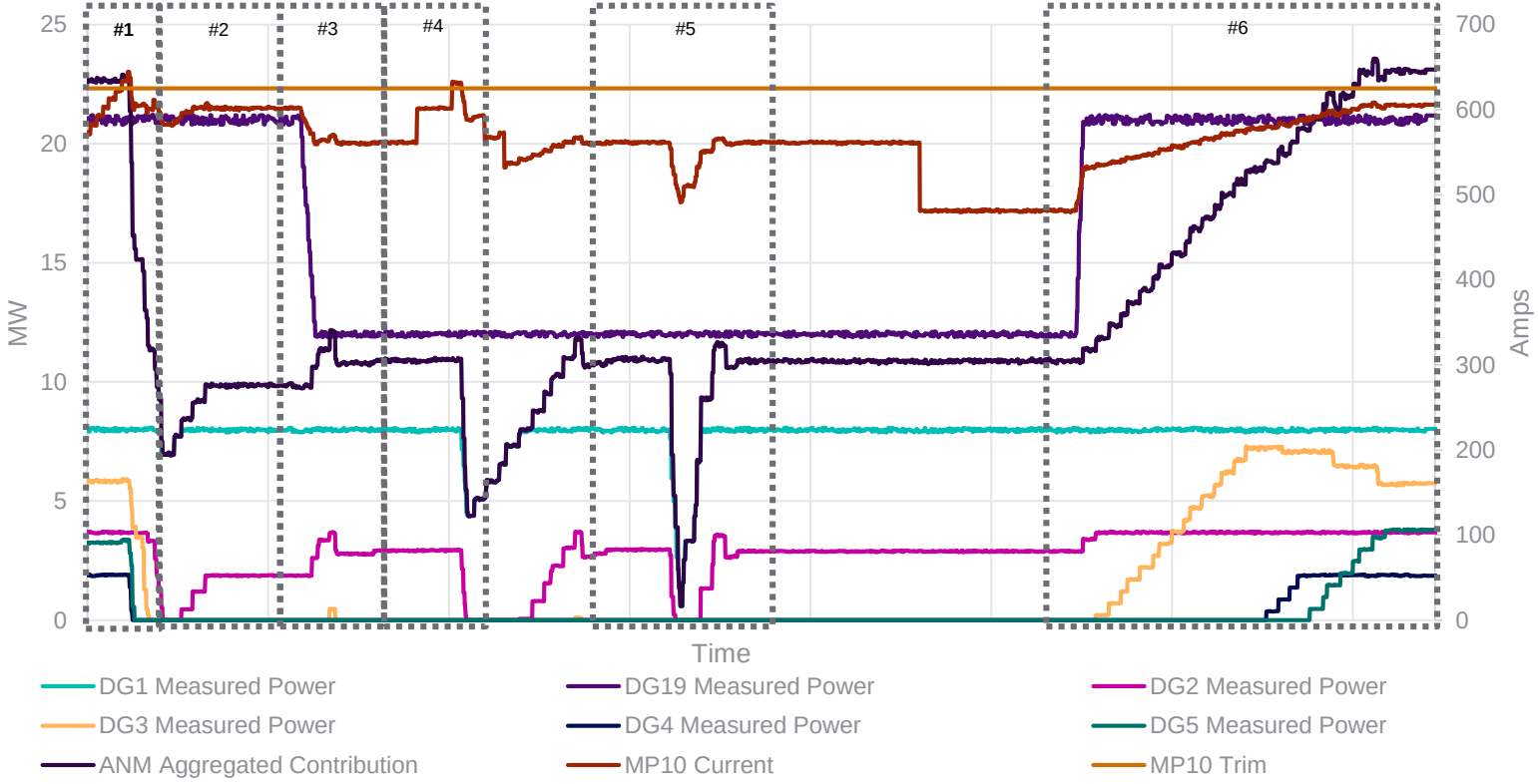
Scenario 11: Constraint Management during Hold Mode

1. **Thermal constraint trim & DG curtailed**
2. **BMU ramps down**
3. **Hold Mode enabled**
4. **Thermal constraint trim & DG curtailed**
5. **Voltage constraint trim & DG Curtailed**



Scenario 11: Constraint Management during Hold Mode

1. **Thermal constraint trim & DG curtailed**
2. **BMU ramps down**
3. **Hold Mode enabled**
4. **Thermal constraint trim & DG curtailed**
5. **Voltage constraint trim & DG Curtailed**
6. **Hold Mode disabled, BMU ramps up, ANM DER ramps up.**



Trial Learnings

Unavoidable Conflict

- When ANM controlled generators are used for BM and generators are managed in LIFO (Last In First Off) priority then high priority generators can sometimes be unaffected.
- However, when generators are managed in shared priority it's likely that at least some part of the ESO request will be degraded due to generators already being curtailed.

Complexity around data mapping

- Where the unique identifiers used by the ESO would likely differ from those used by the DNO.
- As such a mapping layer would need to be implemented somewhere on the system, initial designs discussed an independent "Data Platform" which could be a suitable place for this mapping to occur.

Complexity of signal exchange

- Difficulty around mechanism of communicating BOAi / PN between ESO & DSO – operational protocols such as ICCP make this type of data transfer difficult.

Small volume of service degradation due to BMU ramping

- Some degradation of ESO service due to BMU ramp down occurring before the hold mode ends. The system implementing the hold mode ideally should ideally initiate hold mode when the BMU starts ramp down, not at the BOA start time.

Reduction of curtailment events

- Hold mode can help reduce control actions on ANM controlled DG when an embedded BMU ramps up after providing a BM service

Commercial Evaluation and Learnings

Objectives

Financial and commercial evaluation necessary to understand the implication considering Access SCR.

Approach

- Review Access and Forward-Looking Significant Code Review (Access SCR)
- Engage with subject matter experts
- Identify data requirements for evaluation

Learnings & Challenges

Potential loss of revenue by a generator

DNO/ESO could incur to maintain balancing service headroom

Lack of Data

- It became apparent that the companies don't currently collect some of the information needed to carry out the assessment.
- In some cases, it would be unknown (e.g., the DNO doesn't know what a generator would export, if it was not curtailed).

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Remarks from NGED and ESO, next steps

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NGED and NGESO

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ESO Context and Benefits

- **DNOs deploying more ANM systems.**
- **Growing need for NG ESO to procure from embedded DERs.**
  - E.g., significant solar generation in southeast region.
  - Currently connected under Visibility & Control terms.
  - May sign onto MW Dispatch but BM is an option.
- **This system could apply primacy rules.**
- **Better co-ordinate NG ESO dispatch – mitigate operational conflict.**
- **Minimise overall energy system costs by supporting efficient system operation**

Conclusions and Next Steps

1. **Share Findings**
   - Open Networks , Primacy Rules Group
   - ANM system developers
2. **Publish project documents on NGED Innovation Portal**
   - Slides and recording from today
   - Closedown report
3. **BAU roll out CBA development**
   - Gather constraint data as post Access SCR implementation
   - Firm up roll-out costs and benefits
   - Compare to dispatch co-ordination alternative

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Q&A, wrap-up and close

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Any Questions?

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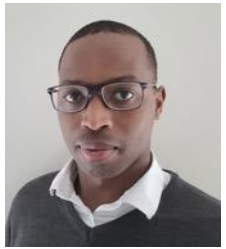

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