Increasing Hosting Capacity: Near-Term Opportunities

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Outline of Presentation

- Introduction to Smarter Grid Solutions
- Hosting Capacity
- Increasing Hosting Capacity – Learning from Europe
- Active Network Management (ANM)
- Increased Hosting Capacity – Online Portal Example
- Conclusions

Smarter Grid Solutions

- Established in 2008
- Spun-out of the University of Strathclyde
- 60 employees
- Launched US business in 2014

European activities:

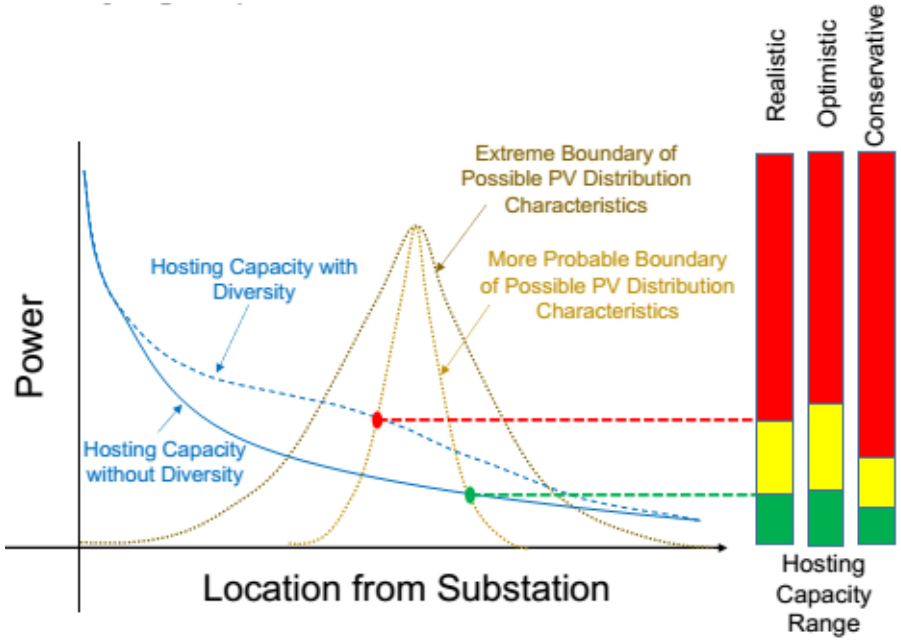
- Deploying ANM platform technology to increase distribution grid hosting capacity with 4 of the 6 distribution utilities in the UK.
- Participating in Regulatory change and UK Govt/Regulator Chaired working groups and forums.
- Web Portals for online capacity assessment of new wind and solar interconnections.

North American activities:

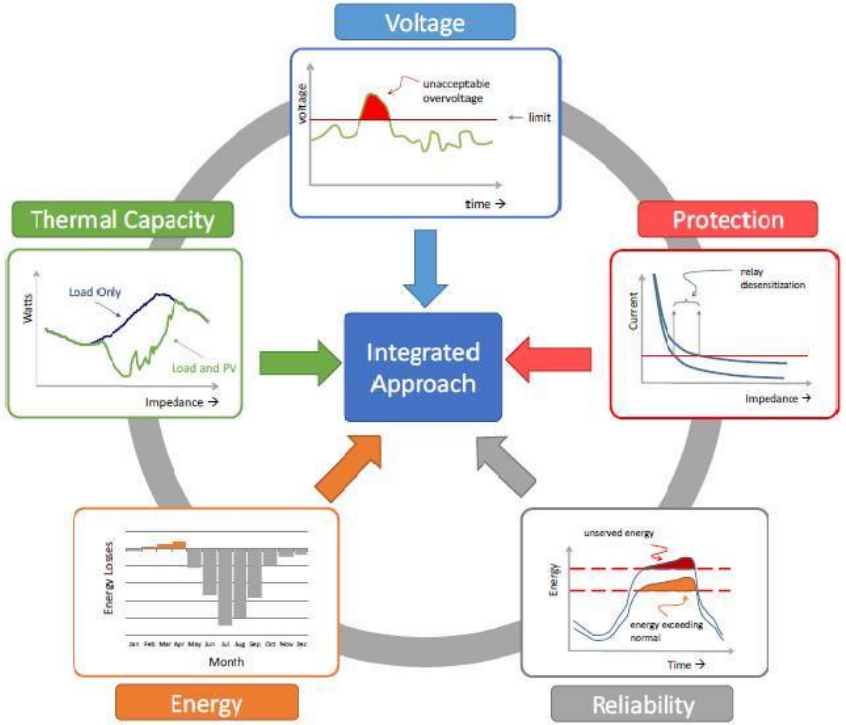
- Con Edison and Southern Company - Microgrids and Distributed Energy Resource integration
- PowerStream (Ontario) - non-wires alternatives
- NREL Demonstration Project
- REV Demo Project with Avangrid in New York
- REV, SGIP, IEEE 1547 and IEEE 2030.7 Working Groups

Hosting Capacity

- EPRI: “Defining a Roadmap for Successful Implementation of a Hosting Capacity Method for New York State”, June 2016
- NREL/Sandia: “On the Path to SunShot: Emerging Issues and Challenges in Integrating Solar with the Distribution System”, May 2016



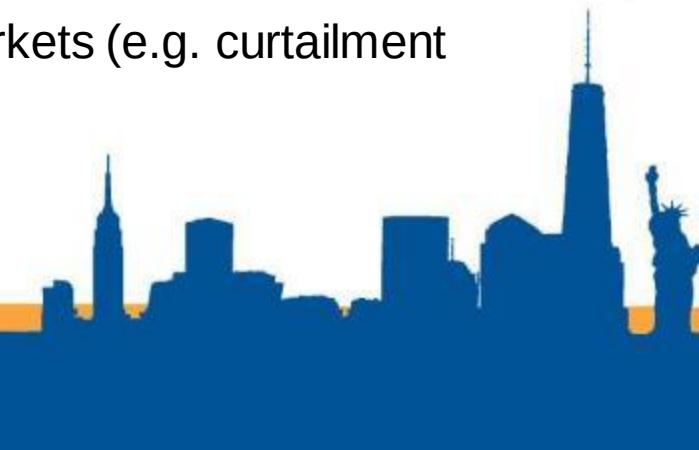
Source: Rylander et al, EPRI, CIRED Conference 2015



Source: EPRI

Increasing Hosting Capacity

- Traditional reinforcement is becoming cost prohibitive for increasing hosting capacity
- How to get better value out of existing grid?
  - Use customer DER and software/controls solutions to gradually transition from static to dynamic hosting capacity
  - Need more data on DER, better power system models, need to reflect offers made, in process, etc., address security and confidentiality concerns
- Recent Implementation Plan for Demo A by Southern California Edison is an excellent description of next steps
  - Including more advanced analysis, hourly integrated capacity analysis results and considering options (e.g. backfeeding or not)
  - This is an exciting development that could foster innovation and new markets (e.g. curtailment mitigation through storage)



Increasing Hosting Capacity

- Although not focused on the Avangrid FICS REV Demo, the distributed control & flexible interconnection approach described in these slides is what underlies our partnering with Avangrid (NYSEG/RGE) for their Flexible Interconnection Capacity Solution REV demonstration project.
- This project covers the full lifecycle of DG development, from planning and the interconnection process to live management and control of new and additional DER beyond traditional limits.
- This approach is directly relevant to wind, solar and other DER today.

Curtailment is a Dirty Word?

"Limited ***curtailment may be more cost effective than upgrading grid infrastructure****. Curtailment of distributed generation (or "DG shedding") has the potential to considerably increase the connection capacity and therefore accelerate the deployment of wind and solar power. According to a study from the German distribution company,* ***EWE Netz, the dynamic curtailment of 5% of the energy generated from solar PV increases the grid connection capacity by around 225% without new grid investment*** *(EWE Netz, 2015). While this might sound surprising for project developers, curtailment can lower the overall cost and accelerate the deployment of wind and solar PV."*

Source: IEA, 2016. Re-powering Markets: Market design and regulation during the transition to low-carbon power systems

Curtailment is a Dirty Word?

*"**Curtailment of the annual feed-in from these renewable energy installations by 1% is sufficient to reduce the network expansion requirement by around 30%.** Regulation of 3% of the annual energy would be enough to make a saving of more than 40% of network expansion. **The effectiveness, i.e. the ratio of potential network expansion saving to regulated energy, reduces significantly from an annual regulated energy level of about 3%.** The progression of effectiveness is independent of the renewable energy expansion scenarios investigated and also broadly independent of whether PV or wind power installations are regulated. Effectiveness can be increased further with selective regulation of renewable energy installations. Taking into account curtailment in network planning means annual supplementary costs for integrating renewable energy installations into distribution networks can be reduced by at least 15%."*

Source: http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/Studien/verteilernetzstudie-englisch,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

Orkney – Making Curtailment Work

SSEPD seeking cost effective alternative to grid upgrades to provide connections for renewable generators: network already at 'full capacity'. Technical challenge is multiple thermal overloads on various overhead and subsea cables.

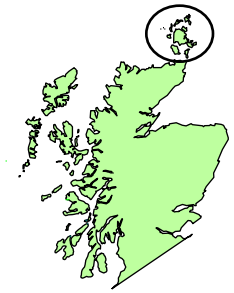
Solution

Non-firm actively managed grid connections for distributed generation using ANM 100 with an energy storage control module.

Delivered Benefits

- Operational since November 2009
- **Generation now over 200% of peak demand**
- 103% of electricity demand met by renewables in 2013
- **Estimated saving of at least £30million**

The Orkney Isles are located off the north cost of Scotland and interconnected to the main UK transmission system.

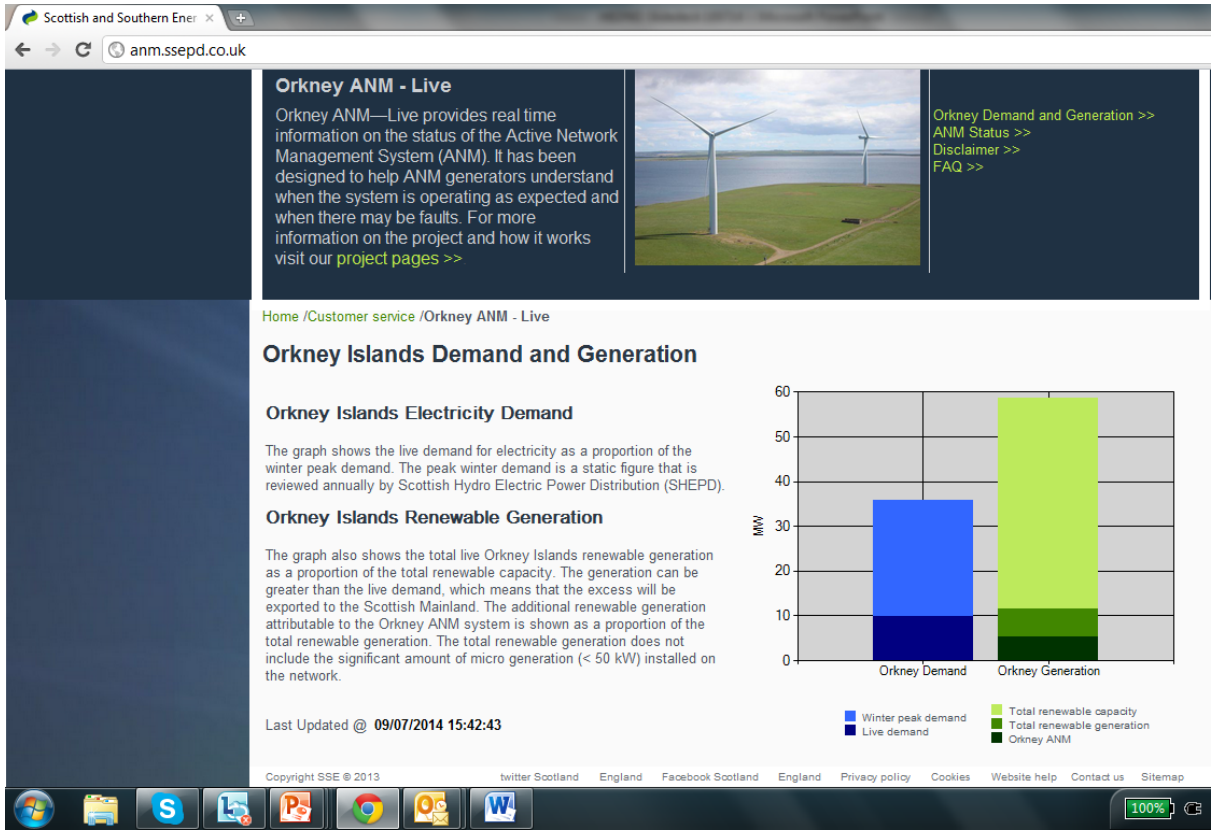


Orkney Isles Background Information

- 70 islands with 20 inhabited
- ~1000 sq km and 21,000 inhabitants
- Winter peak demand of 31 MW
- Summer peak demand of 6 MW
- Annual average temperature 8^0C
- Industry mainly agricultural, fishing and tourism

Scottish and Southern Energy Power Distribution

Orkney – The Customer Experience



Customer website to see live status of ANM system

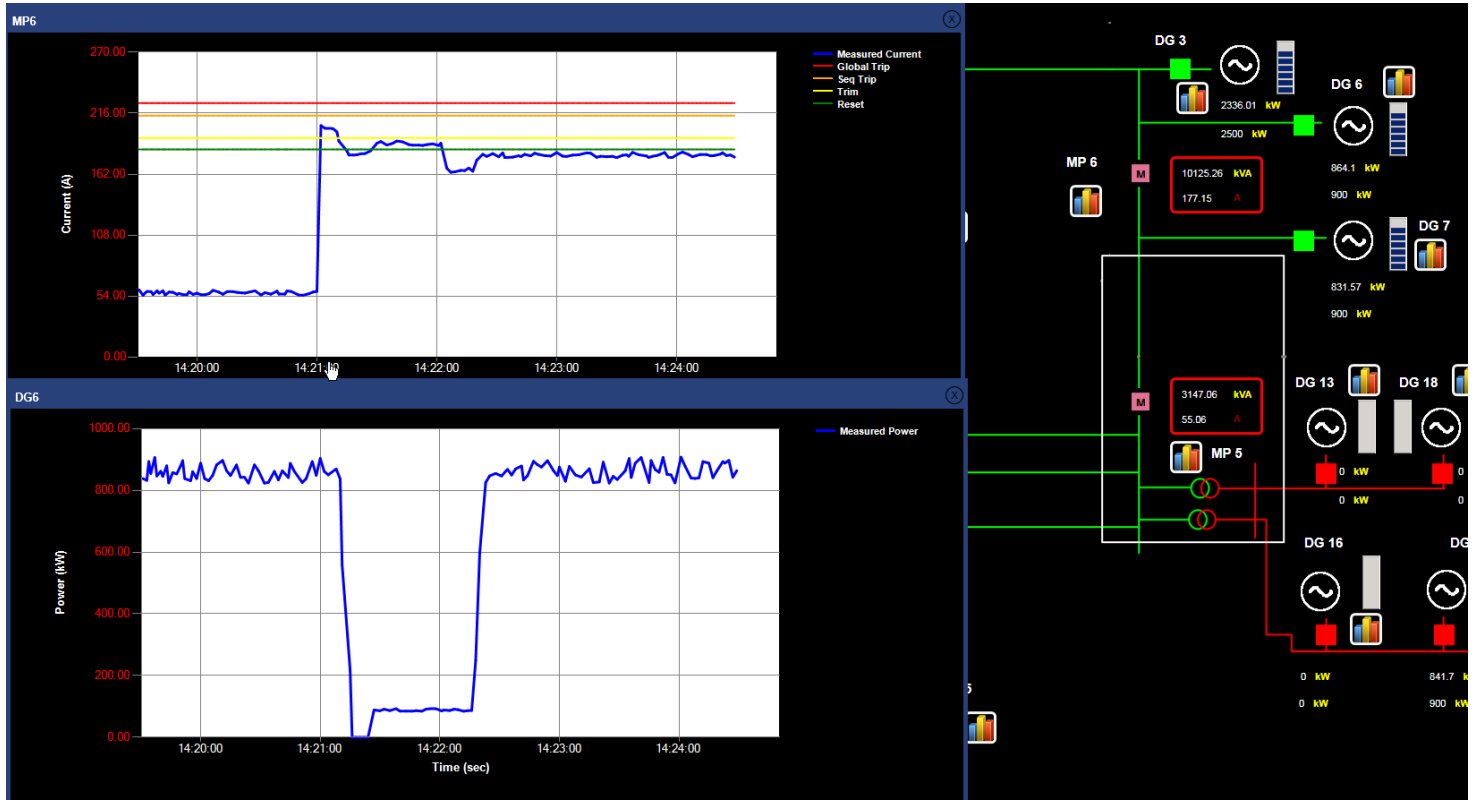
http://anm.ssepd.co.uk/

Generator ID	Size (MW)	Capacity Factor after Curtailment
1	0.9	37.06%
2	2.3	47.70%
4	4.5	45.35%
5	0.9	37.22%
6	0.9	40.08%
7	0.9	40.77%
9	0.9	31.76%
10	0.9	34.03%

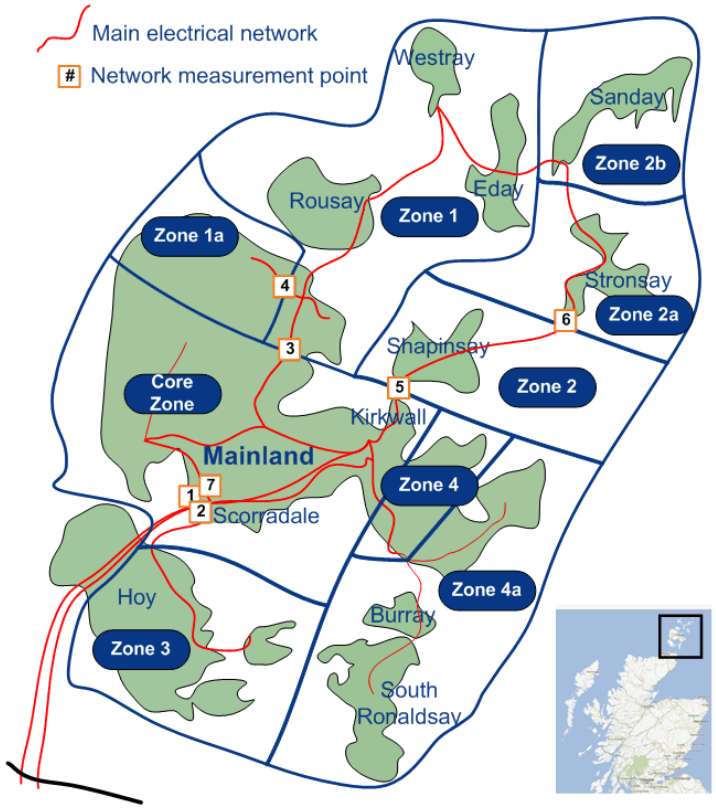
ANM generation export after curtailment

Orkney – The Operator Experience

Scottish and Southern Energy
Power Distribution



Autonomous curtailment event showing Measurement Point reading and corresponding wind generator output



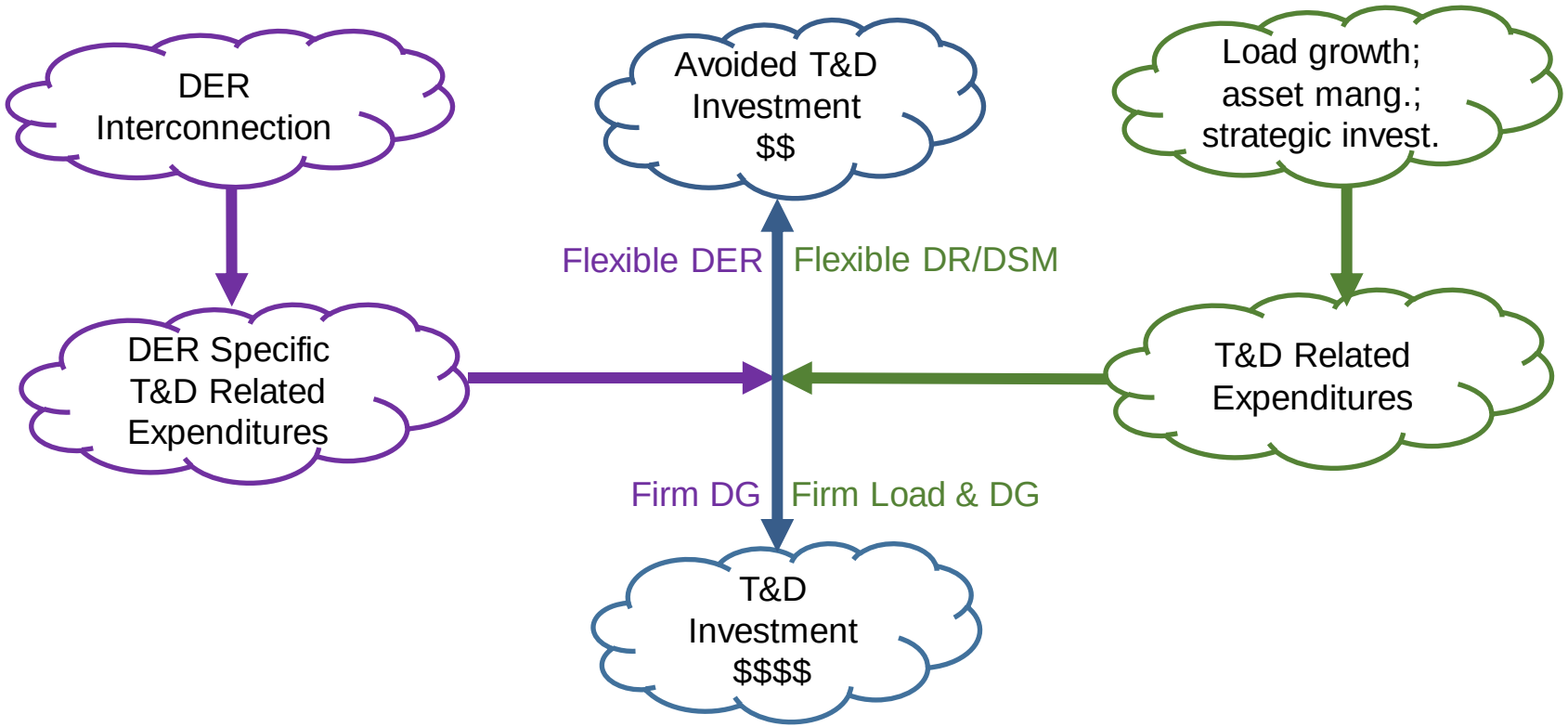
How can hosting capacity developments help with interconnection?

- Much focus is being applied to identifying and valuing the contribution of DER to the system
- This is a welcome and necessary activity, but does not address the developer project need for interconnection solutions – speed is not the only objective for developers
- It has been shown elsewhere that offering new interconnection solutions can provide significant and timely increases in hosting capacity that are aligned with developers' interests

Increasing Hosting Capacity

DER Developer led focus
Encourages DER based on developer need

Utility lead focus
Encourages load management based on utility need



Need to focus on system-wide policies and approaches (e.g. value of DER)

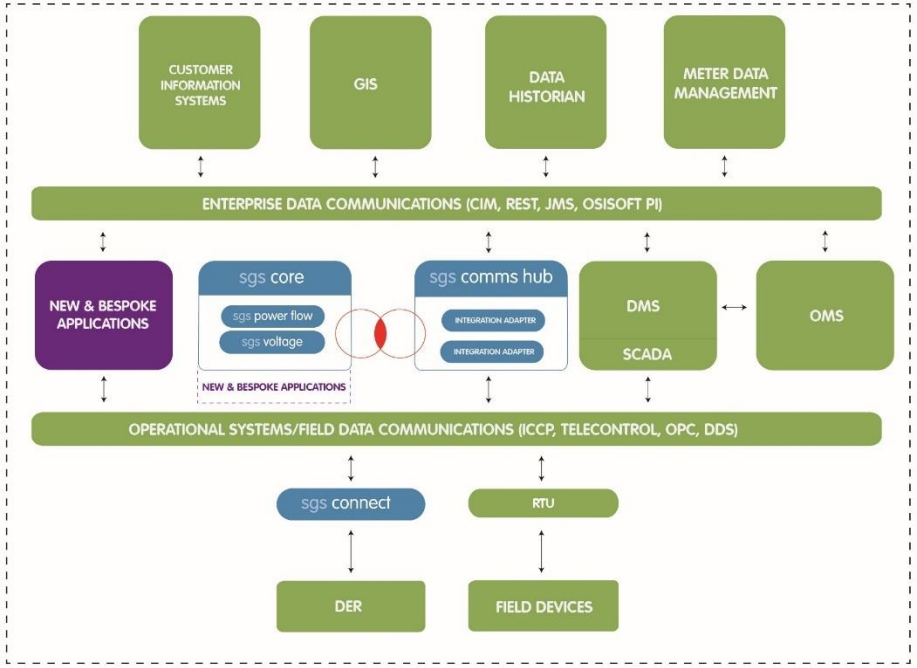
AND

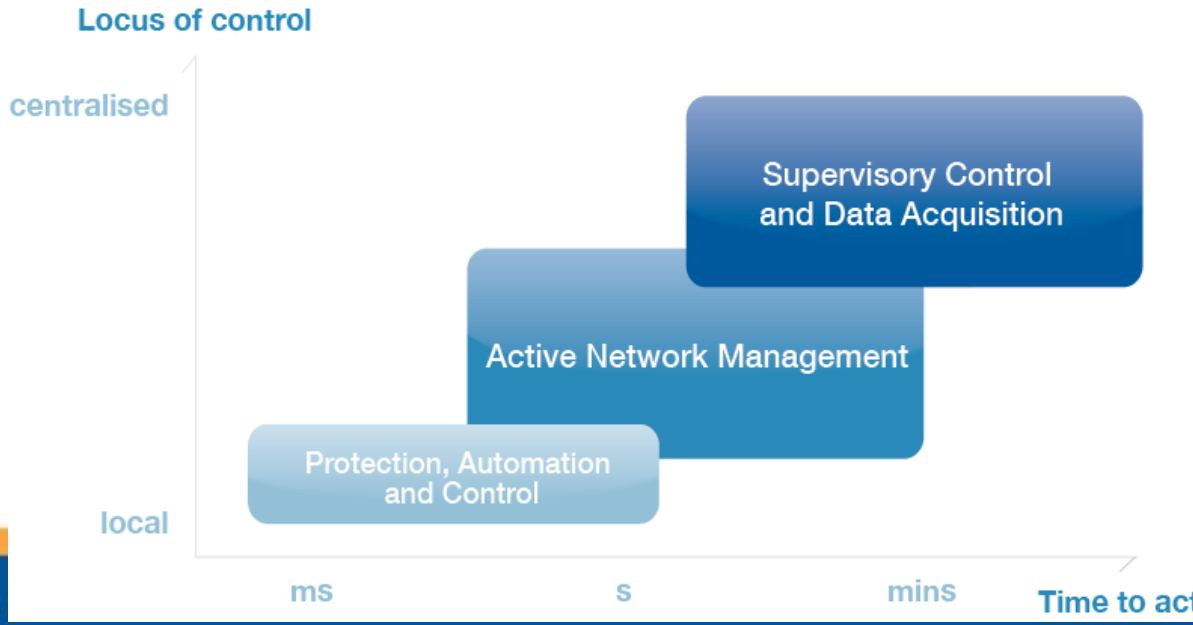
consider project solutions to overcome interconnection barriers

Active Network Management

ANM has delivered 100's MWs of DER interconnections to full or weak systems, increasing hosting capacity by up to 100%. The characteristics of ANM are:

- Autonomy
- Minimal Complexity
- Time-bounded Operation
- Predictability and Repeatability
- Scalability and Consistent Performance
- Open Integration
- Failover and Redundancy
- Fail-Safe Functionality
- Operate on Available Data

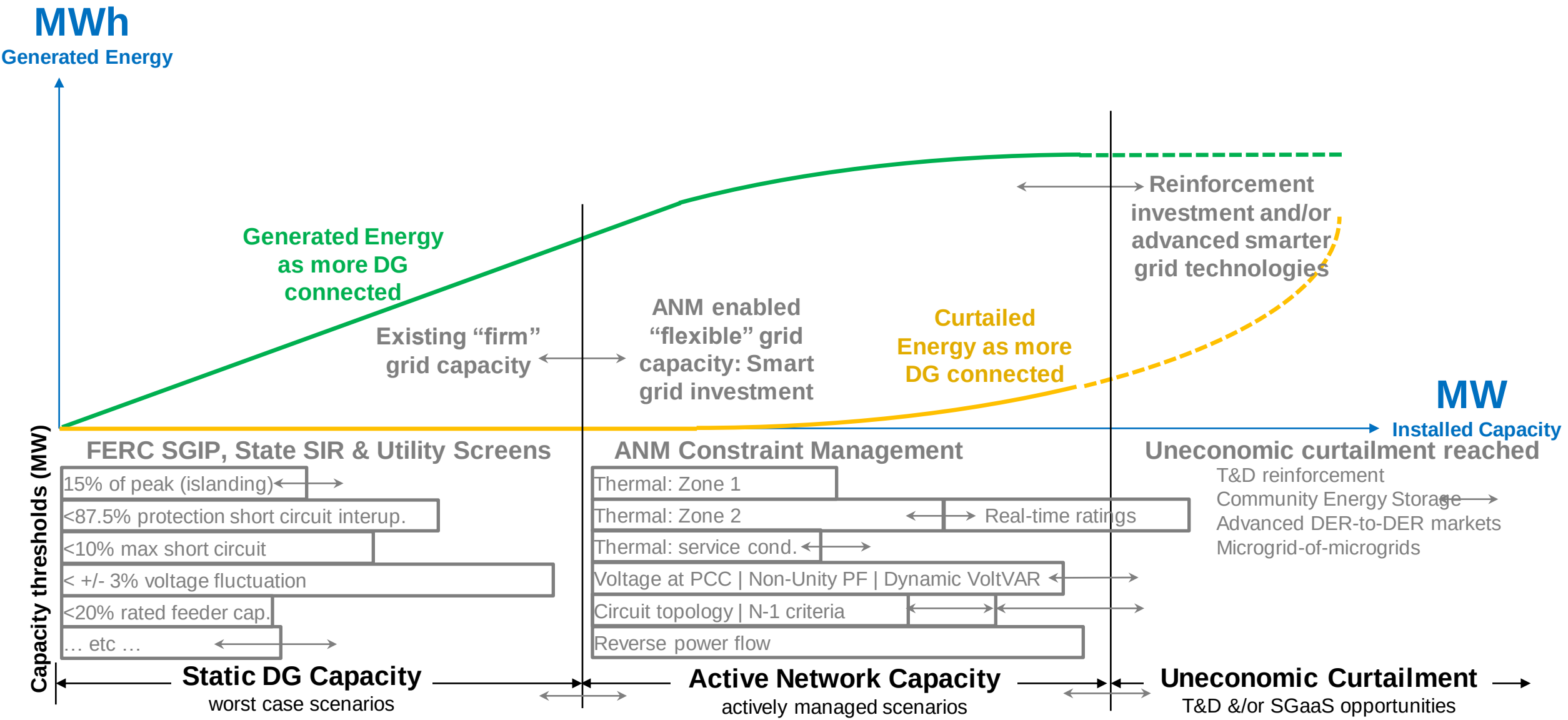




ANM Enabled Grid Hosting Capacity

- Real-time grid edge controls are cost-effective smart grid investments to “unlock” grid capacity/assets
- Hosting Capacity is **set by the market** (e.g. will next 5 MW DER accept 1% curtailment risk?)
- ANM monitors the constraints associated with hosting capacity and controls DER when constraints occur
- Constraints mostly all local: circuit by circuit, substation by substation
  - Many DER might be non-dispatchable resources, but the problems they cause coincide with when they are available to be controlled!
  - Voltage, power flow, backfeeding, etc., all managed automatically
- This presents energy storage and demand response with an additional revenue opportunity

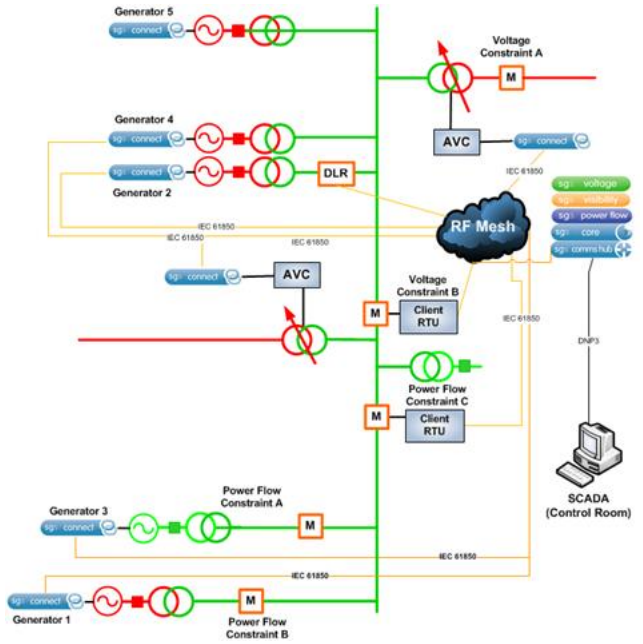
ANM Enabled Grid Hosting Capacity



ANM Benefit-Cost Example - UK

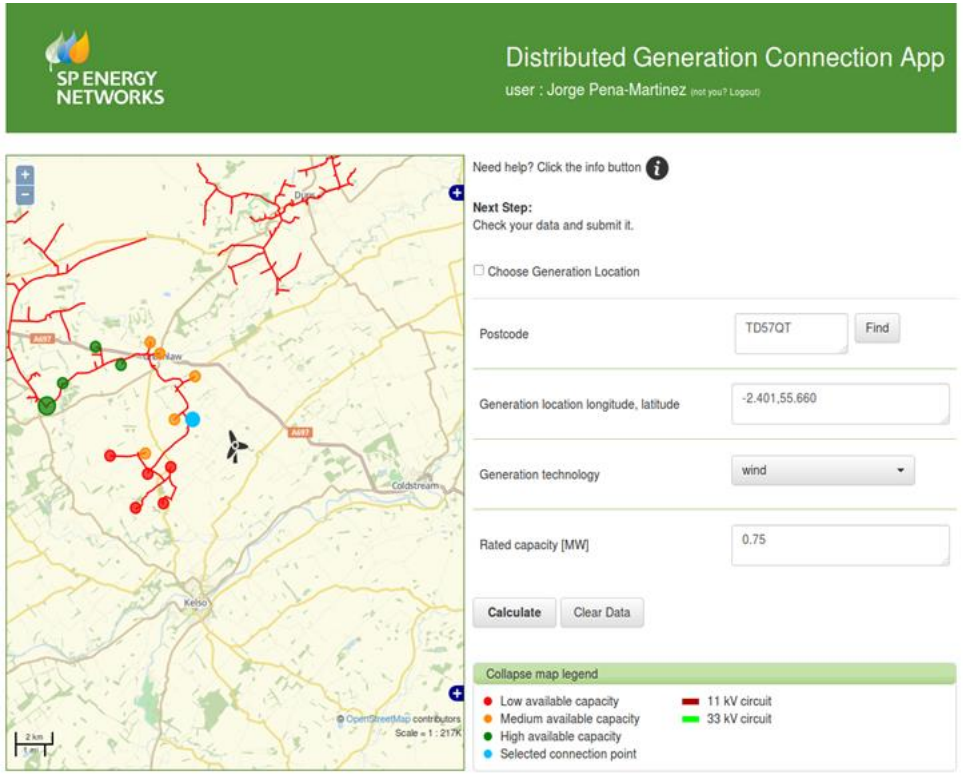
Connection Offers					Curtailment		
Capacity	Type	Firm BAU	Interruptible FPP	Saving	% Curtailment	MWh/yr	$/yr
8 MW	Wind	$5.3 m	$1,322 k	75%	2.7%	704	$48k/yr
10 MW	Wind	$7.2 m	$885 k	88%	5.33%	1,402	$95k/yr
0.5 MW	Wind	$1.2 m	$236 k	81%	5.33%	70	$20k/yr
0.5 MW	CHP	$3.8 m	$176 k	95%	1.73%	76	$20k/yr
6.6 MW	PV	$13.5 m	$2,601 k	81%	2.57%	166	$18k/yr
10.25 MW	Wind	$7.8 m	$2,376 k	70%	5.33%	1,437	$98k/yr
0.5 MW	Wind	$2.7 m	$351 k	88%	5.33%	70	$20k/yr
1.5 MW	Wind	$2.9 m	$236 k	92%	5.33%	210	$30k/yr
0.5 MW	Wind	$5.3 m	$1,322 k	75%	5.33%	70	$20k/yr

Connection costs and estimated curtailment levels for normal connection versus ANM connection



High level schematic of Cambridgeshire solution

Interconnection Online Analysis Tool



Online customer self-service planning tool

SP ENERGY NETWORKS

Results

	Firm Capacity	Non-Firm Capacity
Distance from generation location to connection point [km]	17.36	4.41
Estimated capacity factor [%]	32.1	28.4
Estimated annual output [MWh]	2108.97	1865.88
Indicative connection cost [£000's]	1318.0	220.5
Average connection time [Years]	5 to 7	1

Example results page from the customer self-service tool allowing DER develop an ANM connection

Currently supports PV, Wind and "always on" generation, could be developed to include energy storage – various policy issues need to be addressed.

Conclusions

- Hosting capacity limits reduce the size of projects or move projects to other locations
- This results in less interconnection and encourages the idea that there are no interconnection or constraint issues
- Limits can be breached by individual projects and are not a symptom of large-scale adoption, they just become more frequent at higher DER penetration levels
- Curtailment and other innovative solutions are already proven to provide economic solutions for developers that can significantly increase hosting capacity
- Such approaches augment the ongoing work on LMP+D+E