



**‘When the sun is shining and the wind is blowing’
Ideas for regulating abundance**

Dr Gabrielle Kuiper
2017 Churchill Fellow

Rewarding Australians Striving for Excellence

Four ideas for an abundant solar future



1. Valuing abundance by time and location
2. Beneficial Electrification
3. 'Non-wires alternatives'
4. Systems engineering revolution?

Rewarding Australians Striving for Excellence

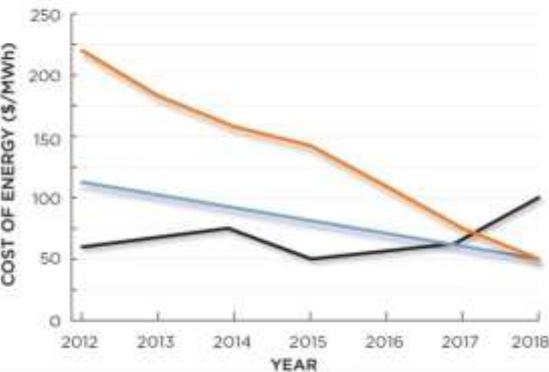
Abundance



- 📍 Solar will be the dominant source of future generation
- 📍 NYC: 160MW of rooftop PV from 1MW in 2006
- 📍 Norway's 'solar boom'
- 📍 Massive curtailment of large-scale solar in California already



COST OF RENEWABLE ENERGY IN AUSTRALIA



Norwegian solar market grew by 59% in 2017

The country's cumulative installed PV capacity reached 45 MW at the end of last December. Newly installed PV systems for 2017 totaled around 18 MW, which was the largest annual growth ever registered in the Norwegian PV market.

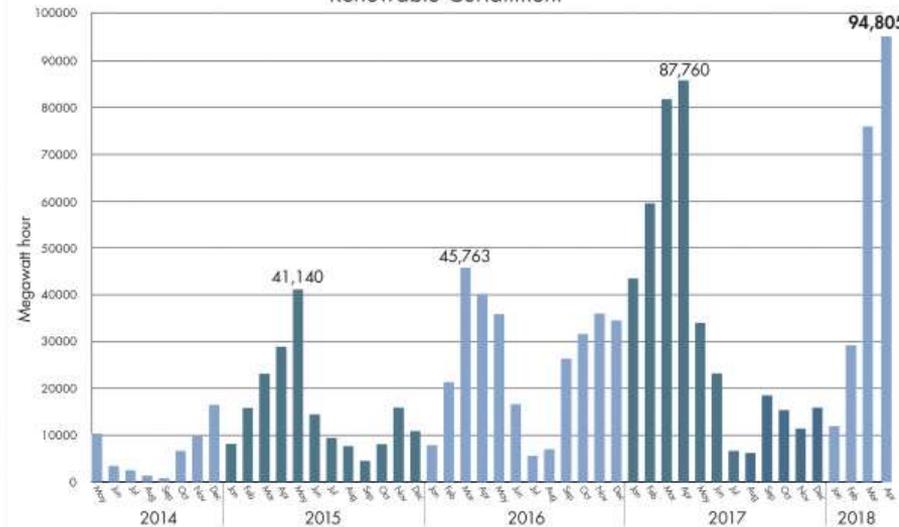
MARCH 16, 2018 EMILIANO BELLINI

HEADLINES MARKETS ENERGY



Norway has currently an installed PV power of around 50 MW. Image: Flickr/Solrune42

Renewable Curtailment



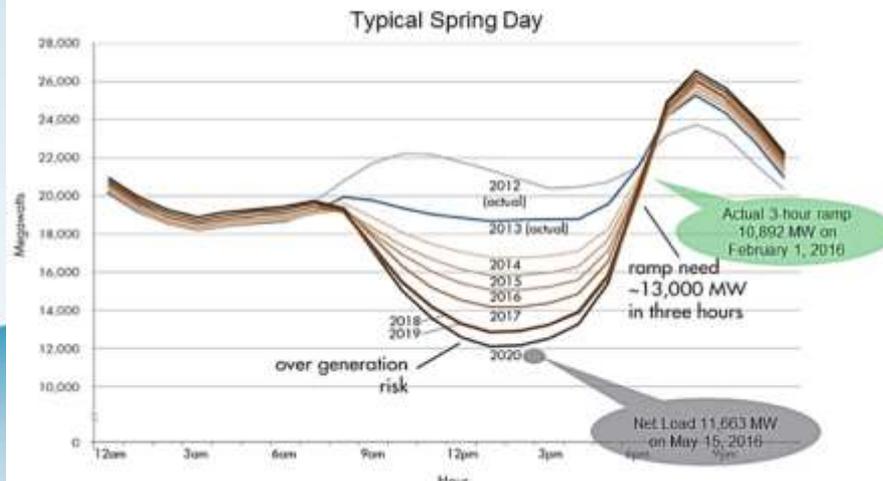
Time and location matter



- 📍 The importance of action being evaluated on a time-of-day basis
 - ▶ Also with wind at night in some locations
 - ▶ A steepening duck curve in most locations
- 📍 **#emiciency** aka emissions efficiency: a metric for proportional emissions reduction:
 - ▶ GHGs saved (not just kWh saved)

Figure 2: The duck curve shows steep ramping needs and overgeneration risk

Source: CAISO



Excellence

So value time and location



 **VDER:** Value of Distributed Energy Resources by time and location - at the distribution level

▶ California value stack currently includes avoided:

- GHG,
- T&D (transmission and distribution costs),
- generation,
- energy,
- ancillary services,
- public safety costs, etc

for every Distribution Planning Area

▶ In NY - VDER complexity and lack of certainty has made the ROI less clear to solar developers ([Solar Value Stack Calculator](#))

Infrastructure for abundance



📍 post-WWII investment in Transmission in the UK

ec.europa.eu/energy/infrastructure/transparency_platform/map-viewer/main.html

ENERGY
Projects of common interest – Interactive map

Legend Network

Project Status:
Completed Ongoing All

- Electricity
 - Electricity storage
 - Substation
 - Phase-shift transformer
 - High-voltage line
 - Electricity synchronisation
- Existing power grid
- Natural Gas
- Oil
- Smart Grids
- CO2

European Commission - DG ENER - PLATTS - 2017 | Earthstar Geographics

#Beneficial Electrification



- 📍 The Beneficial Electrification League defines beneficial electrification as:
- ▶ ‘the application of electricity to end-uses that would otherwise consume fossil fuels (e.g. natural gas, propane, oil, gasoline) where doing so satisfies at least one of the three following conditions, without adversely affecting the other two:
 - benefit the environment and reduce greenhouse gas emissions;
 - save consumers money over time;
 - foster a more robust and resilient grid.’



<http://www.beneficialelectrification.com/>

ans Striving for Excellence

Electrifying heat, fuels



- 📍 **#gasexit** - NL at the forefront
- 📍 **'Power to X'** - the potential for synthetic fuels, such as hydrogen and methane, generated from renewable electricity
- 📍 Long term storage needed for **'Dunkelflaute'**



Electrifying vehicles

- 📍 **'supercomputers on wheels'** (when autonomous)
 - ▶ In China it is two-wheelers (principally electric bicycles) and buses 'driving' electricity demand growth.
 - ▶ New electric planes, trains and helicopters
 - ▶ Electrified non-road equipment developed or under development: snow blowers, lawn mowers and forklifts



DER as 'non-wires alternatives'



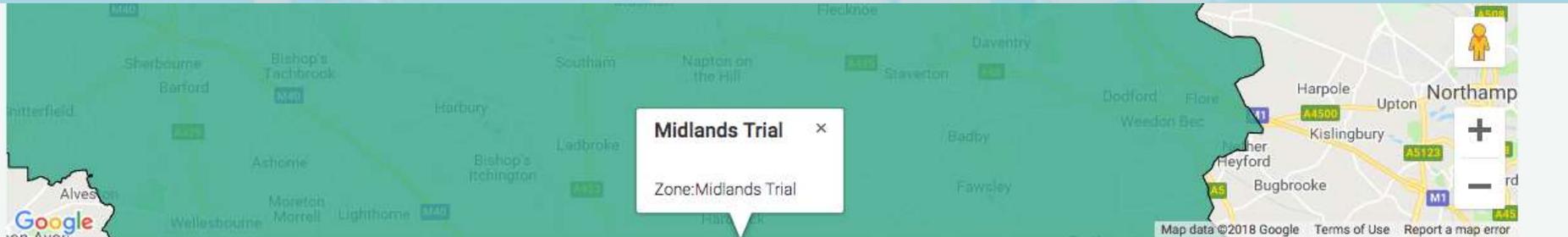
- 📍 explicit consideration of non-wires alternatives
 - ▶ transparency vital in regulation
- 📍 California:
 - ▶ 8-9 non-wires projects underway, 40-50 at RFP stage
 - ▶ 3-5 years ahead is the 'goldilocks zone' for DER to provide grid services
- 📍 NYC:
 - ▶ Brooklyn-Queens Demand Management project \$US250m was spent to defer a \$US1.2b substation
 - ▶ Balvinder Deonarine's view is that they are at the second stage in evolution of non-wires alternatives



UK: Flexibility platforms



<https://www.flexiblepower.co.uk/> - for half hourly metered businesses and aggregators to offer dynamic (fault response), restore (black/brown start) and secure (demand response) power by postcode.

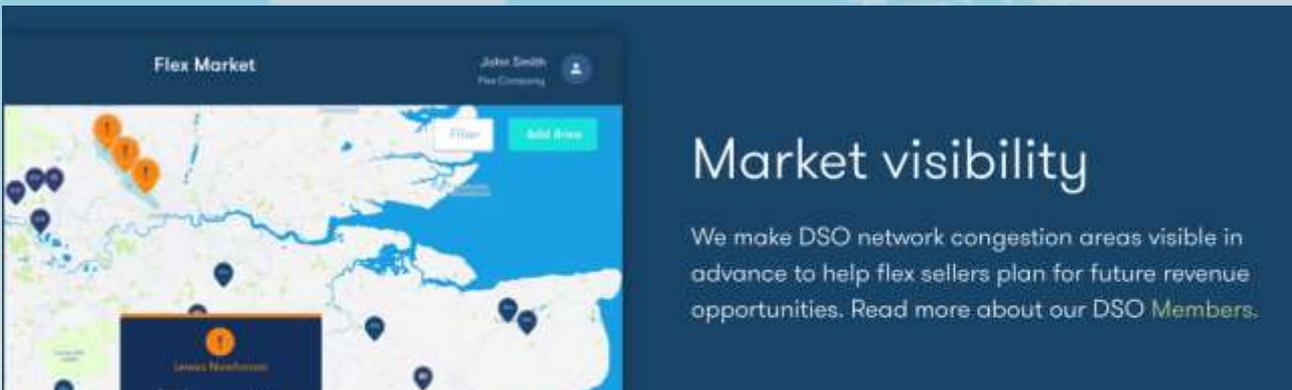


Colour	Name	Services	Arming Fee (£/MW/h)	Availability Fee (£/MW/h)	Utilisation Fee (£/MWh)	Restore Fee (£/MWh)
Blue	Exeter City	Dynamic & Restore	N/A	5	300	600
Purple	South Hams & Plymouth	Dynamic & Restore	N/A	5	300	600
Yellow	Rugeley	Secure & Restore	75	N/A	150	600
Green	Existing Midlands Trial Area	All	N/A	N/A	N/A	N/A



Flexibility platforms

 <https://piclo.energy/> makes DSO network congestion areas visible - and then suppliers can offer supply at the strike (spot market) price in those areas.

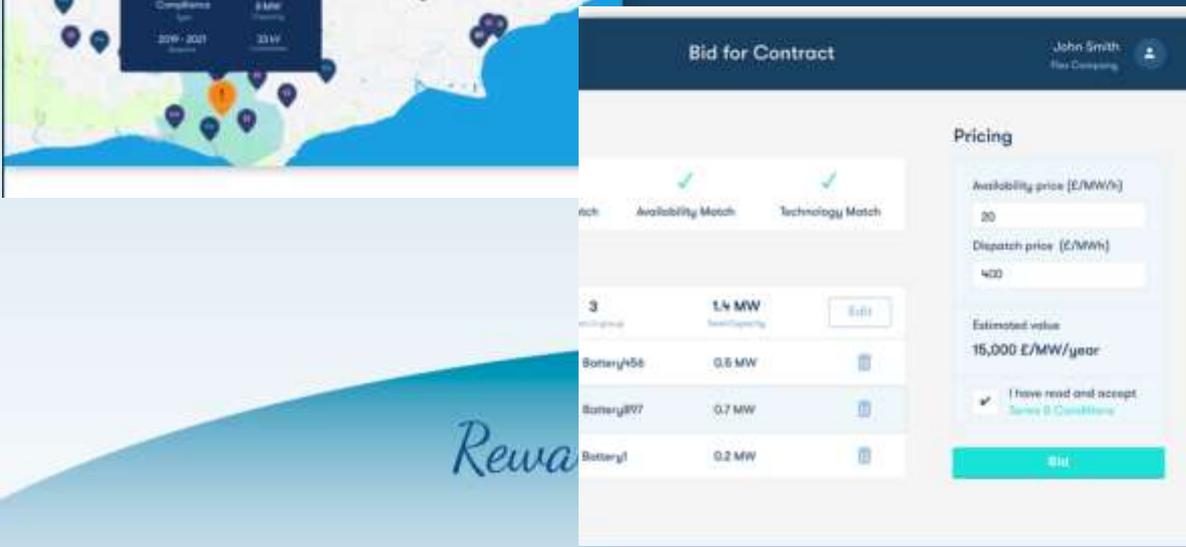


Flex Market | John Smith, Flex Company

Market visibility

We make DSO network congestion areas visible in advance to help flex sellers plan for future revenue opportunities. Read more about our DSO Members.

The screenshot shows a map of the UK with several orange location pins indicating congestion areas. A pop-up window for 'Lewes Powerstation' displays details: Compliance type: 2019-2021, 33 MW, and 33 MW.



Bid for Contract | John Smith, Flex Company

Availability Match Technology Match

Bid ID	Capacity	Technology	Action
3	1.4 MW	Battery	Edit
Battery456	0.6 MW	Battery	Delete
Battery807	0.7 MW	Battery	Delete
Battery1	0.2 MW	Battery	Delete

Pricing

Availability price (€/MWh): 20
Dispatch price (€/MWh): 400
Estimated value: 15,000 €/MWh/year

I have read and accept Terms & Conditions

Bid

Rewa

Online auctions

Flex providers can access all flexibility tenders on a single platform. We are streamlining the procurement, auction, contracting and settlement processes.

Do we need a systems engineering revolution?



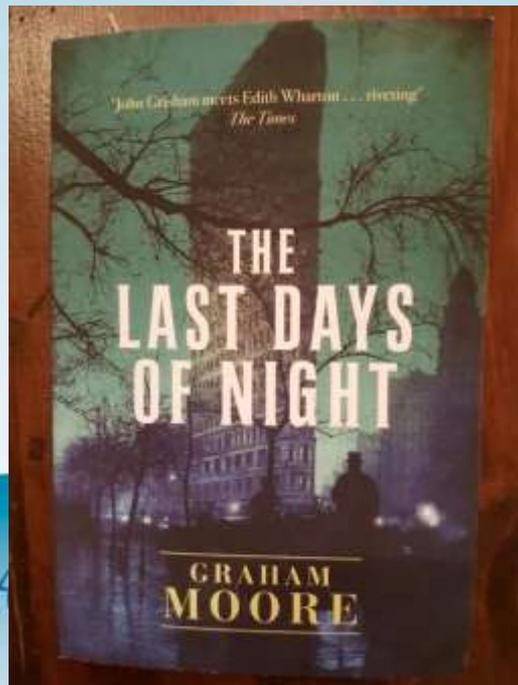
- 📍 If you had the chance to design networks and electrical systems for the digital age, how would you do it?
 - Would you move from four voltage levels to two?
 - Would you design for floating frequency?
- 📍 How quickly will we have next generation electro-technical devices that can dispatch in both directions and hold electricity when needed?
- 📍 Will we manage the supply-demand balance at household level with IoT - then at the street, neighbourhood and zone substation level?

Disruption/Transition/Conflict



'Edison had taken Broadway. So Westinghouse would take Broad Street, Ohio.

The lines were drawn. Everyone would have to choose a side. Everyone would join a network. Networks of light. Networks of people. Networks of power. Networks of money.'



Rewarding A

Excellence



No one know how this story will end ...

- 📍 Solar is becoming abundant
- 📍 Regulatory change is slow
- 📍 Electrification is challenging, time consuming - and expensive

- 📍 High stakes:
 - ▶ emissions reduction
 - ▶ billions of dollars in network infrastructure
 - ▶ (potential) billions in DER/non-network alternatives

- 📍 Can we make the most of solar abundance in time?