



Federal Ministry  
for Economic Affairs  
and Energy



Federal Ministry  
of Education  
and Research



Australian Government

Department of the Environment and Energy



Australian Government

Department of Foreign Affairs and Trade



Welcome to the

# Australian-German Energy Symposium

18-19 September 2019



Deutsch-Australische  
Industrie- und Handelskammer  
German-Australian Chamber  
of Industry and Commerce



#AU\_DE\_Energy2019

# Flexibility Options

**Moderator: Dr. Wolf-Peter Schill**

Deputy Head, Department Energy, Transportation, Environment, German Institute for Economic Research (DIW)

**Paul-Georg Garmer**

Senior Manager Public Affairs, TenneT (German Transmission System Operator)

**Vince Duffy**

Executive Director Energy and Technical Regulation, South Australia Department for Energy and Mining

**Benedikt Deuchert**

Project Manager Central & Western Europe, entelios

**Dr. Jemma Green** *(no slides)*

Cofounder and Chair, Power Ledger

**Nathan Dunn** *(no slides)*

CEO, sonnen Asia Pacific

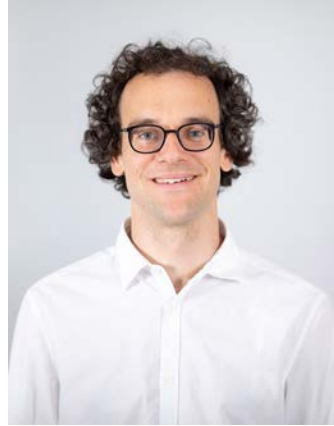




# Flexibility options: a brief introduction



# Speaker



## Wolf-Peter Schill

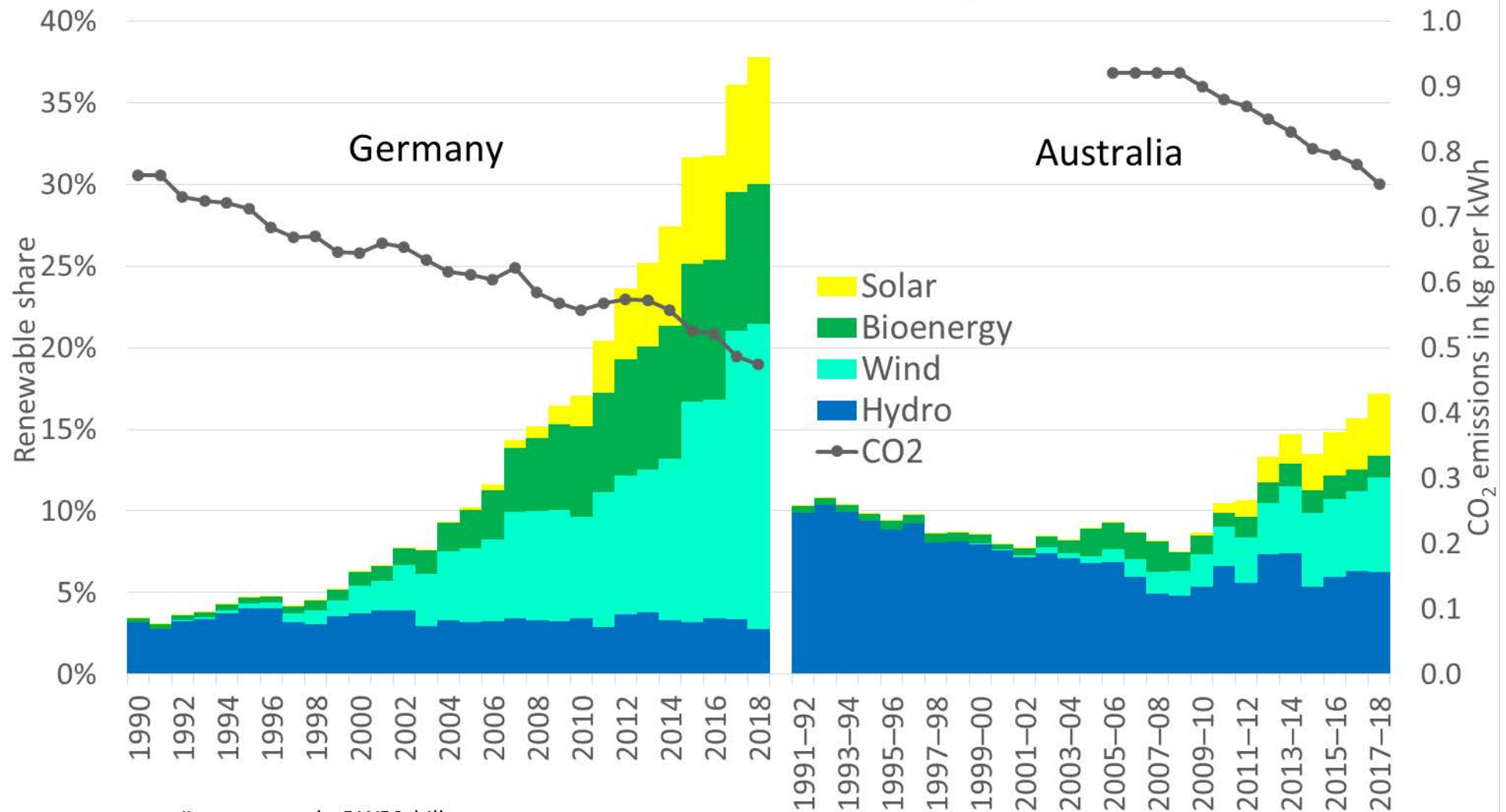
Deputy Head of Department  
"Energy, Transportation, Environment"

German Institute for Economic Research (DIW Berlin)

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# Renewable shares in electricity and CO<sub>2</sub> emission factors



#energy\_graph @WPSchill

Own calculations based on BMWi, Umweltbundesamt, Department of the Environment and Energy, Clean Energy Regulator

GER: share in gross electr. consumption, avg. emissions of generation; AUS: share in electr. generation, scope 2 emissions factors

→ Discussion about flexibility options in Germany for several years

# Why?

## Properties of variable renewable energy sources

Temporal

- Time- and weather-dependent availability
- Short-term deviations from forecasts

Spatial

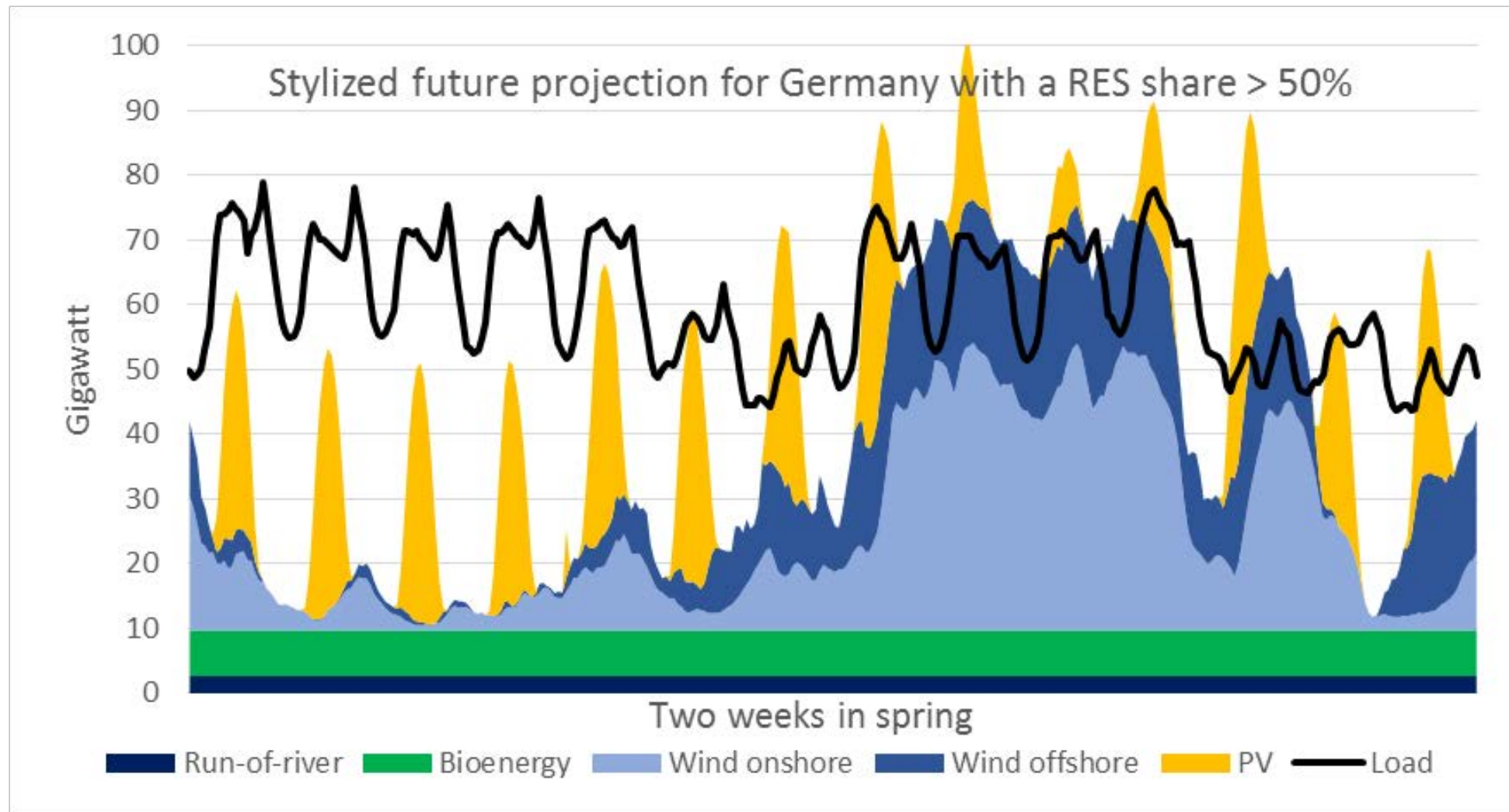
- Geographic distribution not corresponding to historic grid layout

# What?

## Dimensions of flexibility

- Residual load smoothing, “energy arbitrage”
- Real-time balancing and other ancillary services
- Spatial balancing

# Variable renewables vs. electric load





# Overview of flexibility options

Category	Example
Power storage	<ul style="list-style-type: none"><li>• Mechanical, electrochemical, chemical storage</li><li>• Short-, medium-, and long-term storage</li></ul>
Generation-side options	<ul style="list-style-type: none"><li>• Indirect water storage (reservoirs)</li><li>• Flexibilisation of CHP and biomass</li><li>• Dispatchable conventional power plants</li><li>• Adjusted feed-in of variable renewables</li></ul>
Demand-side options	<ul style="list-style-type: none"><li>• Load shifting</li><li>• Load curtailment</li></ul>
New flexible loads	<ul style="list-style-type: none"><li>• Power-to-Heat</li><li>• Power-to-Gas</li><li>• Power-to-Mobility</li></ul>
Grid options	<ul style="list-style-type: none"><li>• Grid expansion and optimisation</li><li>• Power electronics</li></ul>

„Power-to-power“

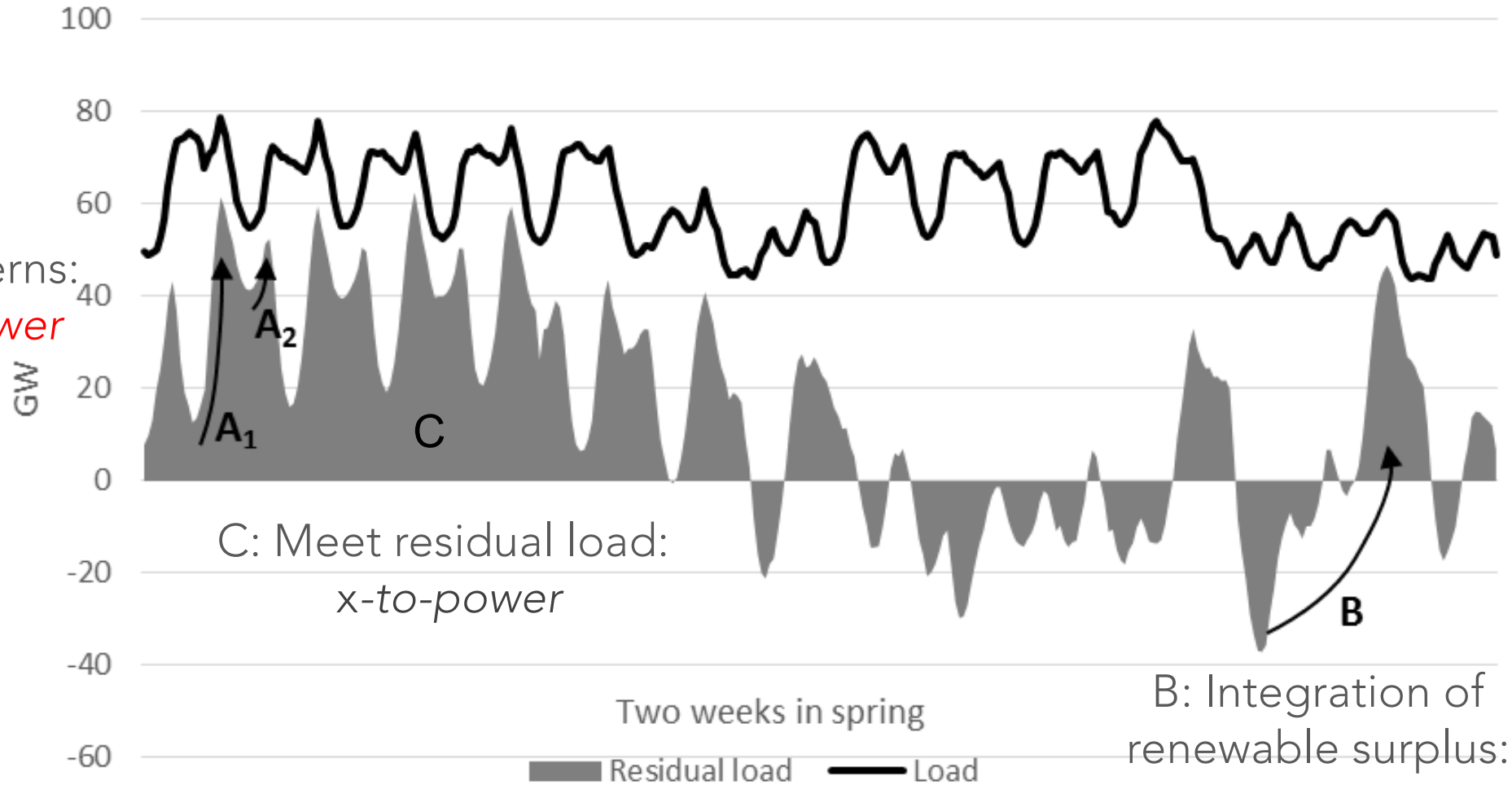
„X-to-power“

„Power-to-X“

# Example: Residual load and flexibility

options

A: "Daily"  
flexibility patterns:  
*power-to-power*



B: Integration of  
renewable surplus:  
*power-to-power*,  
or *power-to-x*

## Spotlight: distributed flexibility options

Many examples, e.g.:

- Charging (and potentially discharging) of electric vehicle batteries
- Load shifting in commercial and residential applications
- PV-battery systems

→ But: often no possibility / no incentive to be operated in a system-oriented way

“

*There is no shortage of potential flexibility options – but there are barriers to their implementation.*

”



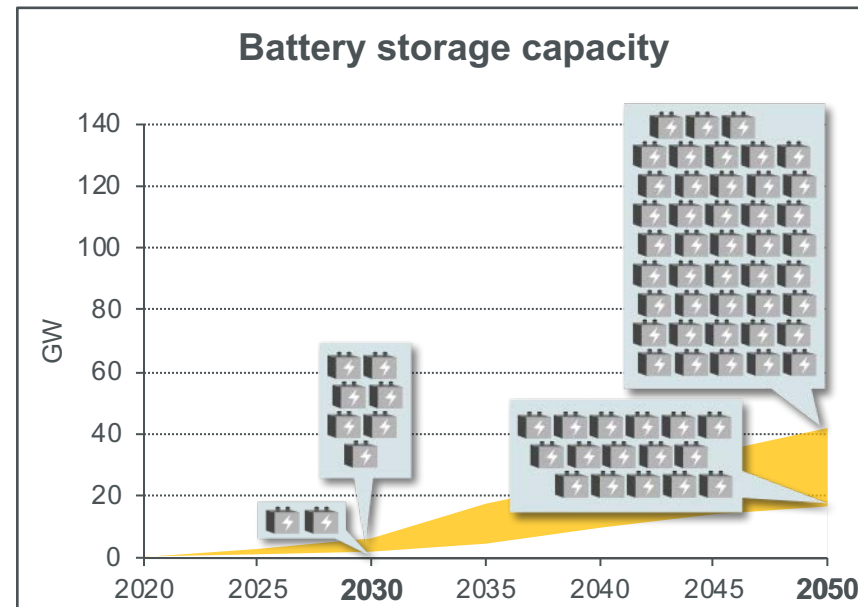
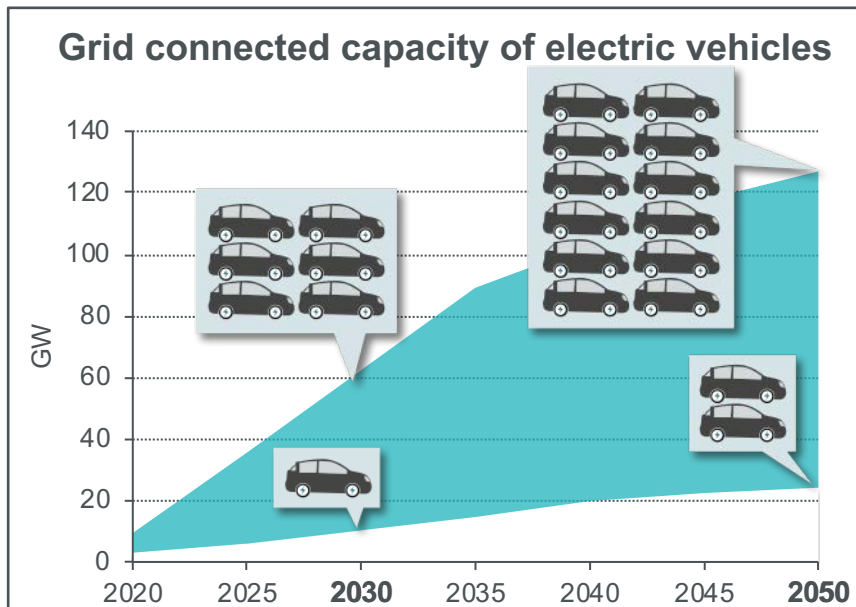
# Flexibility options – a TSO perspective

Melbourne, 09/18/2019

Paul-Georg Garmer

# Distributed Flexibility

Germany: EVs, charging stations and PV-battery storage systems provide the largest potential for distributed flexibility



- Germany: Large bandwidth of possible development due to uncertainty of market penetration.
- Even if at the lower bound, some 3-5 million single flexibility sources would need to be managed.

\*ource: Agora Energiewende (2014), "Stromspeicher in der Energiewende"



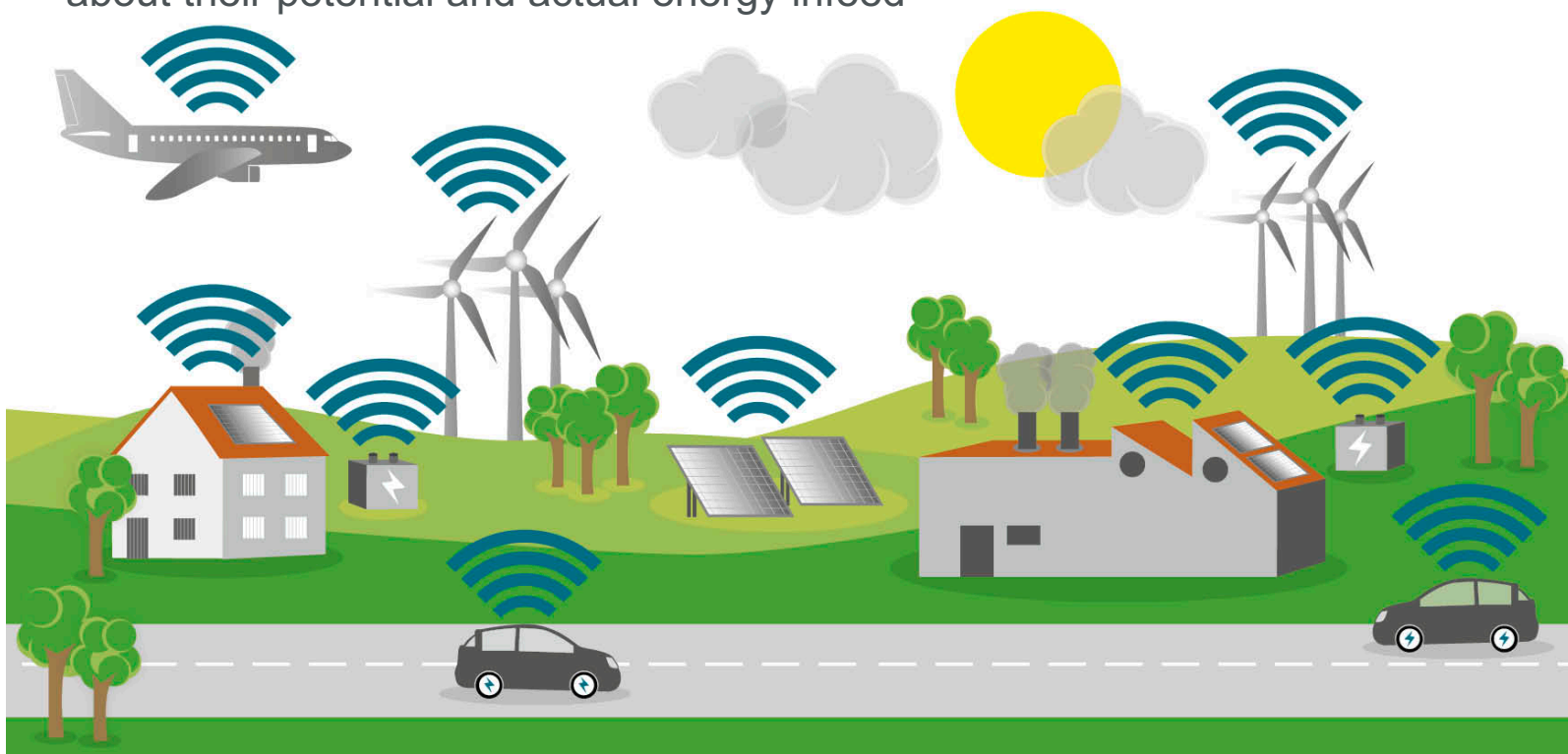


# Sensors for Energy Forecasting

Sensors provide live data about the energy system and the environment

- cars and mobile sensors provide local, real-time weather information  
→ pilot project with Volkswagen Group research department to improve forecasts
- smart meters provide live information on demand and production
- production, storage, and energy consuming assets provide information about their potential and actual energy infeed

**VOLKSWAGEN**  
AKTIENGESELLSCHAFT



# TenneT and blockchain technology



In two pilot projects with Sonnen and Vandebron, TenneT is using a private blockchain to balance the grid.



- Sonnen pools household batteries to provide redispatch services.
- Vandebron provides automated secondary control reserve from a pool of charging stations for electric vehicles.
- The flexibility is managed by TenneT via an IBM blockchain solution and used to balance the grid.
- Once the concept has been proven, the use of the blockchain solution will be made available to further flexibility providers.
- The potential of battery storage for Germany lies between 15-60 GW by 2030.



# Use of electric vehicles for redispatch



## Starting point

- Grid congestions due to production surplus of electricity in the north and insufficient production in the industrial load centers in the south
- Congestions limit the purposeful transport of electricity from north to south
- TSOs are responsible for the "copper plate" and grid security in Germany (inter alia through redispatch measures)

## Goal

- Demonstration of the technical and commercially desirable feasibility of the regular use of batteries from electric vehicles as storage units in the context of redispatch measures
- Simulation of injection into and withdrawal from the grid via the bidirectional charging capacity of Nissan vehicles
- Deduction of recommendations for the design to use V2G concepts

[www.tennet.eu](http://www.tennet.eu)

TenneT is a leading European electricity transmission system operator (TSO) with its main activities in the Netherlands and Germany. With approximately 22,000 kilometres of high-voltage connections we ensure a secure supply of electricity to 41 million end-users.

**Taking power further**



# Australian-German Energy Symposium

**Vince Duffy**

**Executive Director, Energy and Technical  
Regulation**

**Department for Energy and Mining**



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# SA's Energy Transition Snapshot

- One of the world's highest penetrations of renewable energy.
- 48% renewable energy generation in 2017/18.
  - 39% large scale wind (19 wind farms)
  - 9% rooftop solar PV (1 in 3 households)
- Up from less than 1% in the early 2000s
- Deployment accelerating – AEMO project 66% renewable energy generation in 2020/21
- A pipeline of large scale wind, solar and energy storage projects > 14GW / \$21B
- Continuing growth in rooftop solar
  - One of the most distributed grids globally



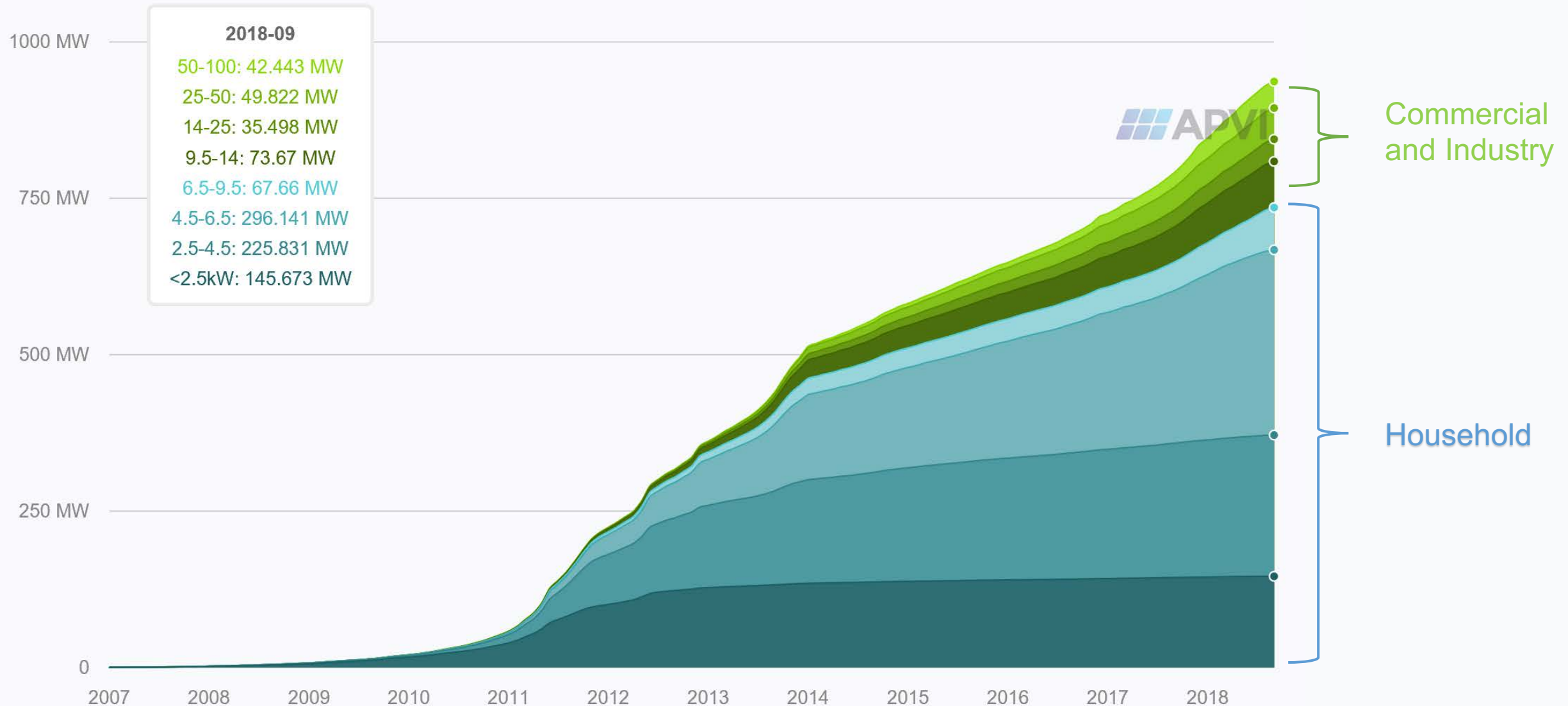




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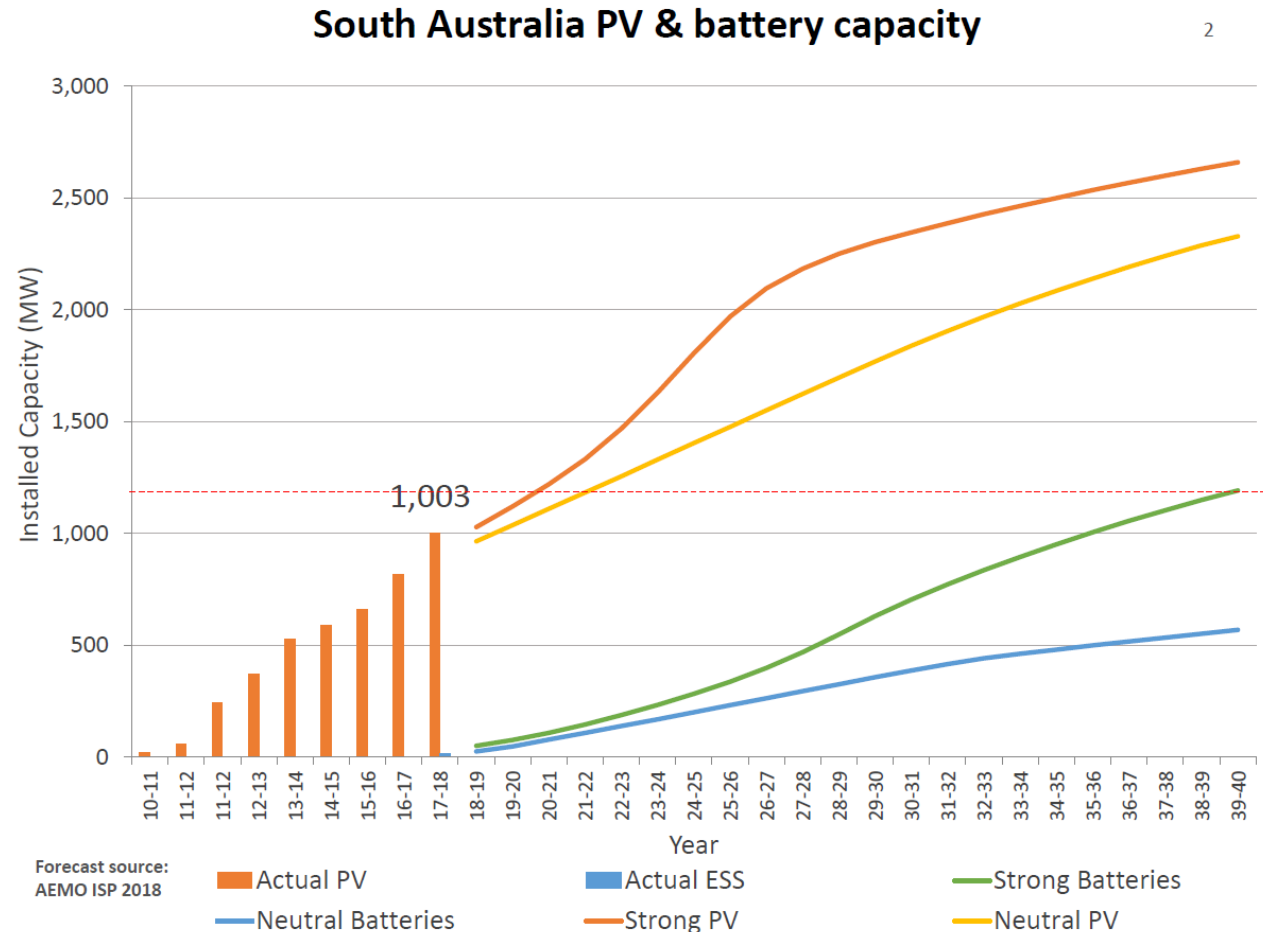
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# SA rooftop solar PV: 0 to 1000MW in a decade



# SA – SOLAR PV GENERATION

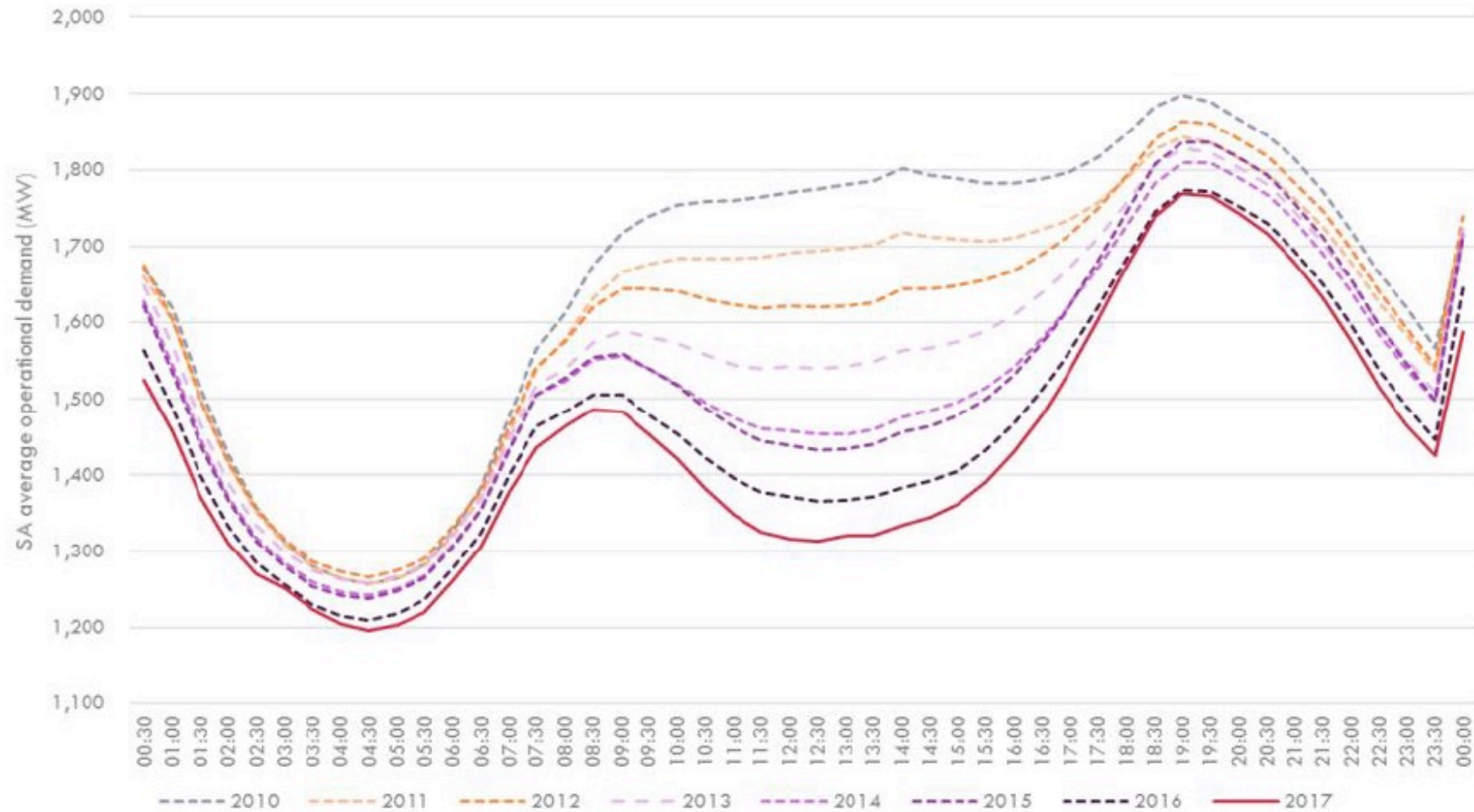
- Since 2009, SA's total installed rooftop solar PV capacity has grown strongly.
- More than 30% of dwellings in SA now have rooftop solar PV systems installed.
- High Solar PV penetration may require changes to managing distribution systems in SA.



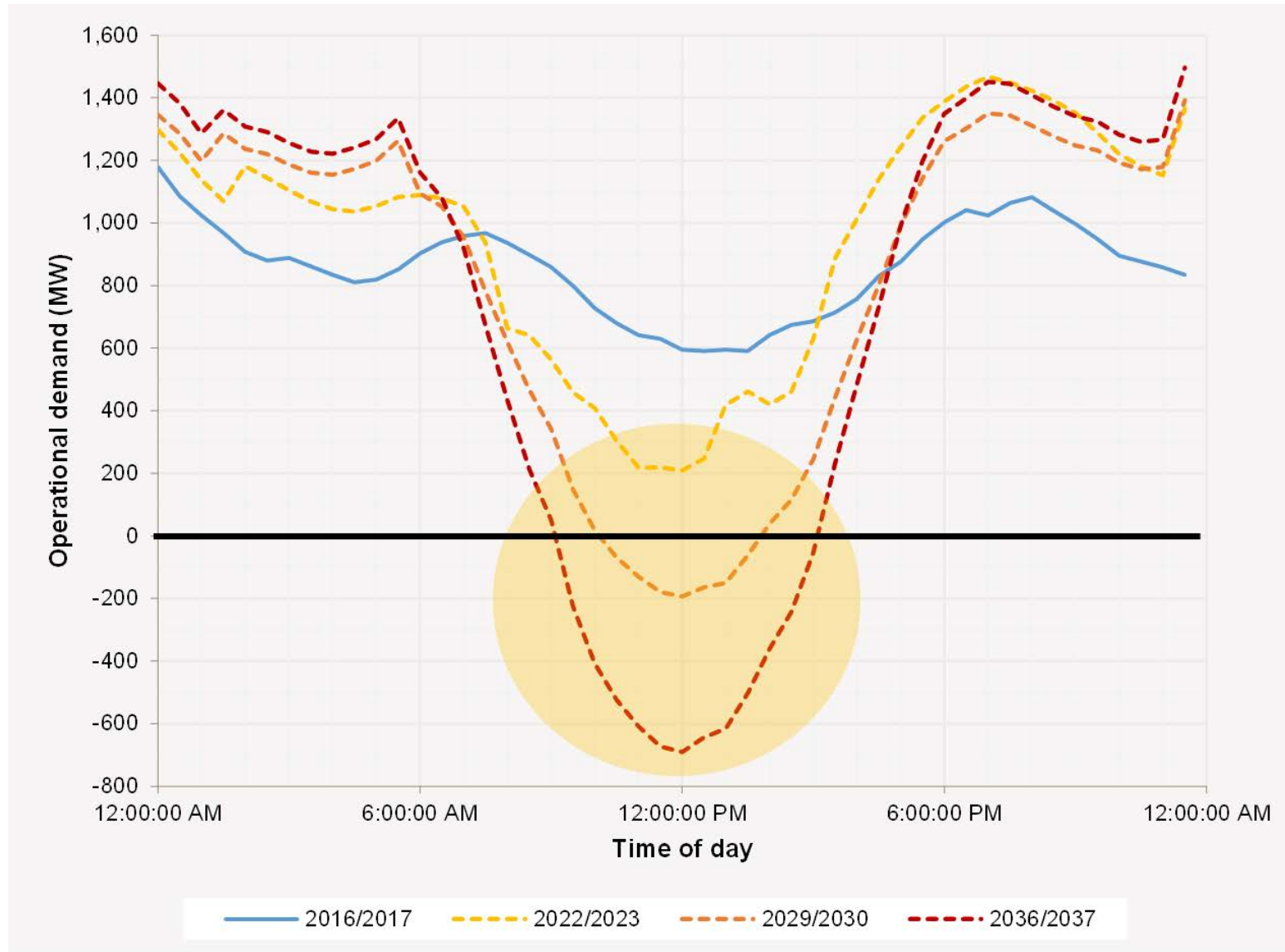


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### Figure 5 Effect of growing rooftop solar



# Swan Curve?





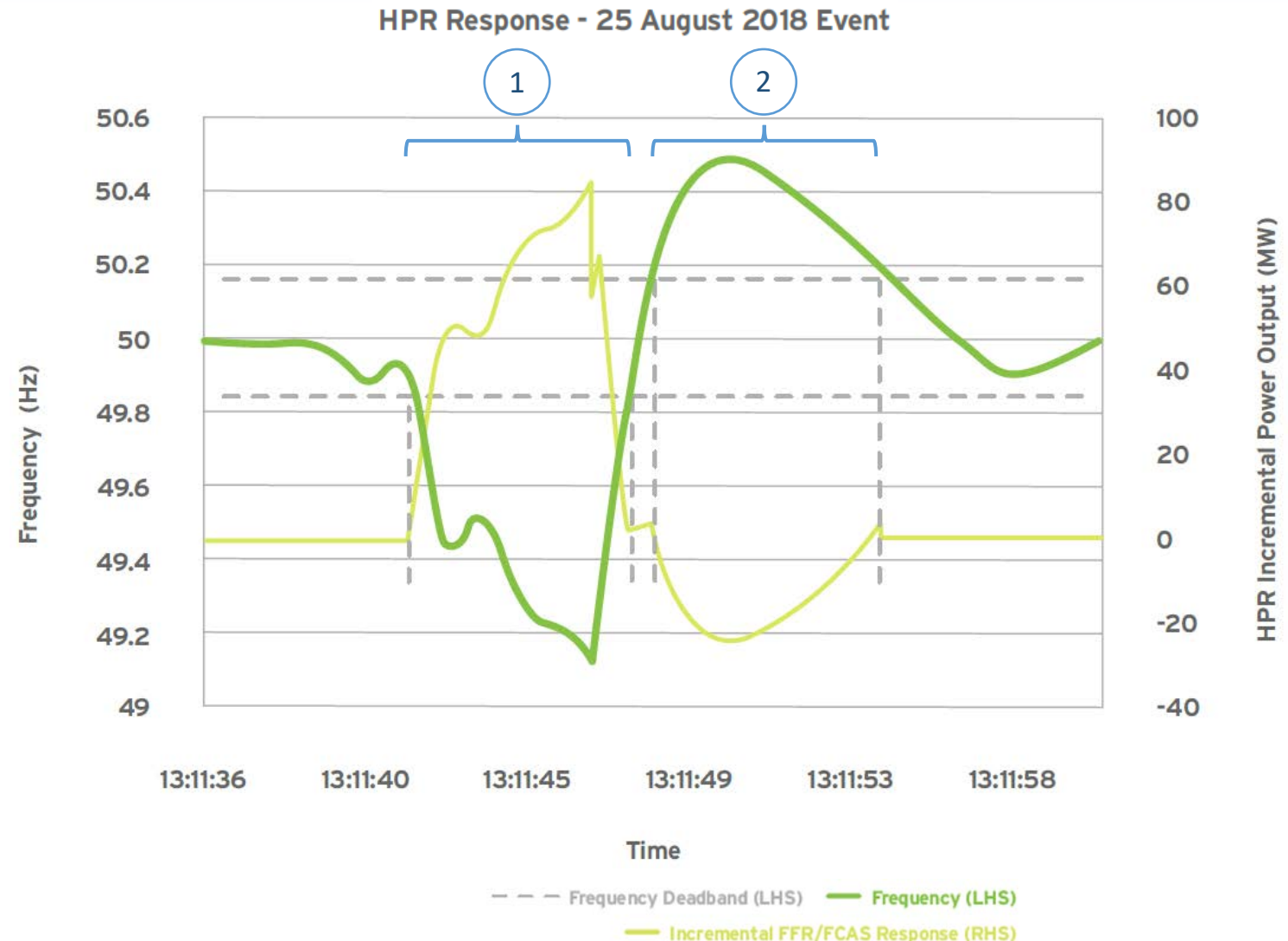
# Benefits of storage technology

## Fast Frequency Response

- First of its kind on the NEM
- Fast dispatch of active power in response to frequency disturbances (~ 100 ms)
- Slows RoCoF during contingency event and supports return to normal frequency band

### 25 August 2018 case study

1. Hornsdale Power Reserve (HPR) provides low frequency support to all connected mainland NEM regions
2. HPR provides high frequency support to the separated SA region



# Distributed Energy Resource (DER) Integration



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- AEMO analysis of major system events, including August 25, highlights the need to improve technical standards for DER.
  - Fault ride through
  - Grid support
  - Coordination and communication
  - Cyber security
- Issues with compliance with standards also highlighted
- Working with Standards Australia and stakeholders on updating AS 4777



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Technical Integration of  
Distributed Energy Resources

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April 2019

Improving DER capabilities to benefit consumers  
and the power system

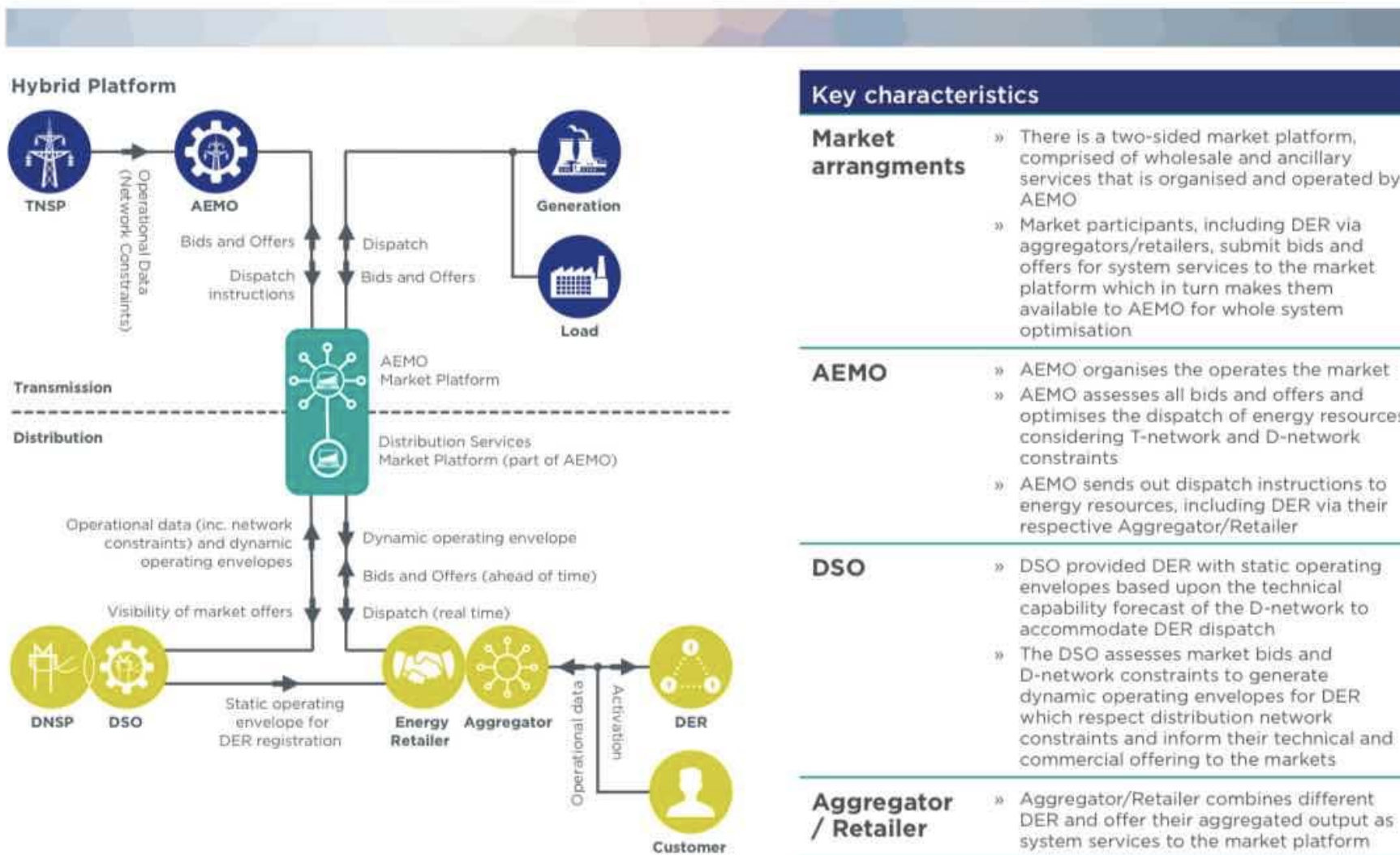
A report and consultation paper

# AEMO/ENA Open Energy Networks



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- Cost Reflective Pricing
  - Tariff Structure Statement includes 'solar sponge' Time of Use charging
- Low Voltage Management proposal
  - Essential enabler for integration, consistent with Open Energy TSO
- ARENA funded Advanced VPP Grid Integration project
  - LV constraints to DER via API



# National Electricity Market

- Ancillary Services Unbundling – July 2017
- 5 minute settlement – rewards fast response technology, commencing July 2021
- Wholesale Demand Response Mechanism – recent Draft Determination proposing July 2022
- Energy Security Board Post 2025 Market Design for the NEM

# Disclaimer

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# Providing flexibility through distributed demand response in Germany

Australian – German Energy Symposium 2019  
Sep 18th, 2019  
Benedikt Deuchert  
Project Manager, Entelios AG  
[benedikt.deuchert@entelios.com](mailto:benedikt.deuchert@entelios.com)

s not too late



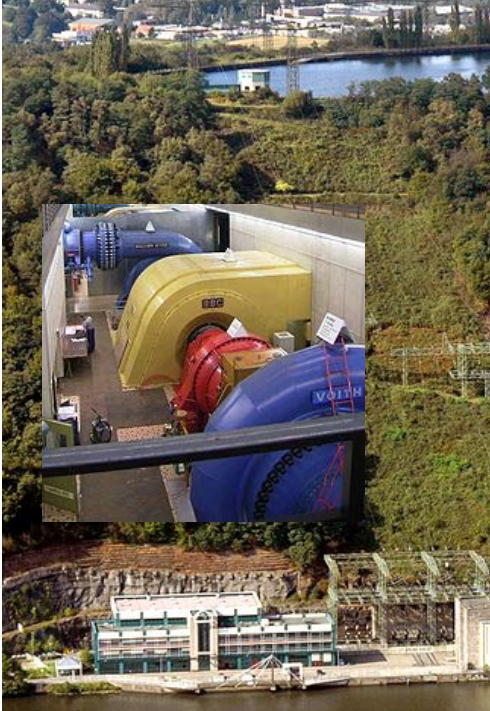
A part of Agder Energi



# Great flexibility potential can be unlocked by demand response



**Flexibility potential: 590 MWh**



Conventional source of flex  
Koepchenwerk/ Herdecke

**DR flexibility potential: 200 MWh**



Wood storage in paper factory  
of wood grinders + wood/ p

**DR flexibility potential: 7.920 MWh**



Aluminum production: Thermal mass of hot aluminum +  
aluminum oxide/ raw aluminum storage



# Large industry is a particularly valuable DR resource...



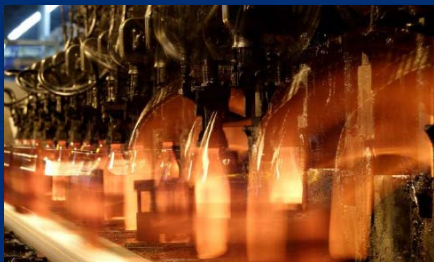
Metal/ steel



Chemistry



Paper & pulp



Glass



Aluminum



Cement



Industrial gas



Aerospace

Others...

## Technical assets

- Electrolysis
- Smelters
- Refiners, grinders
- Cement mills
- On-site generation (CHPs)
- Heating/ air conditioning
- Ventilators / dryers
- Pumps, compressors
- Stirrers
- (...)

... and many of the players already participate successfully



Metal/ steel



Chemistry



Paper & pulp



Glass



Aluminum



Cement



Industrial gas



Aerospace



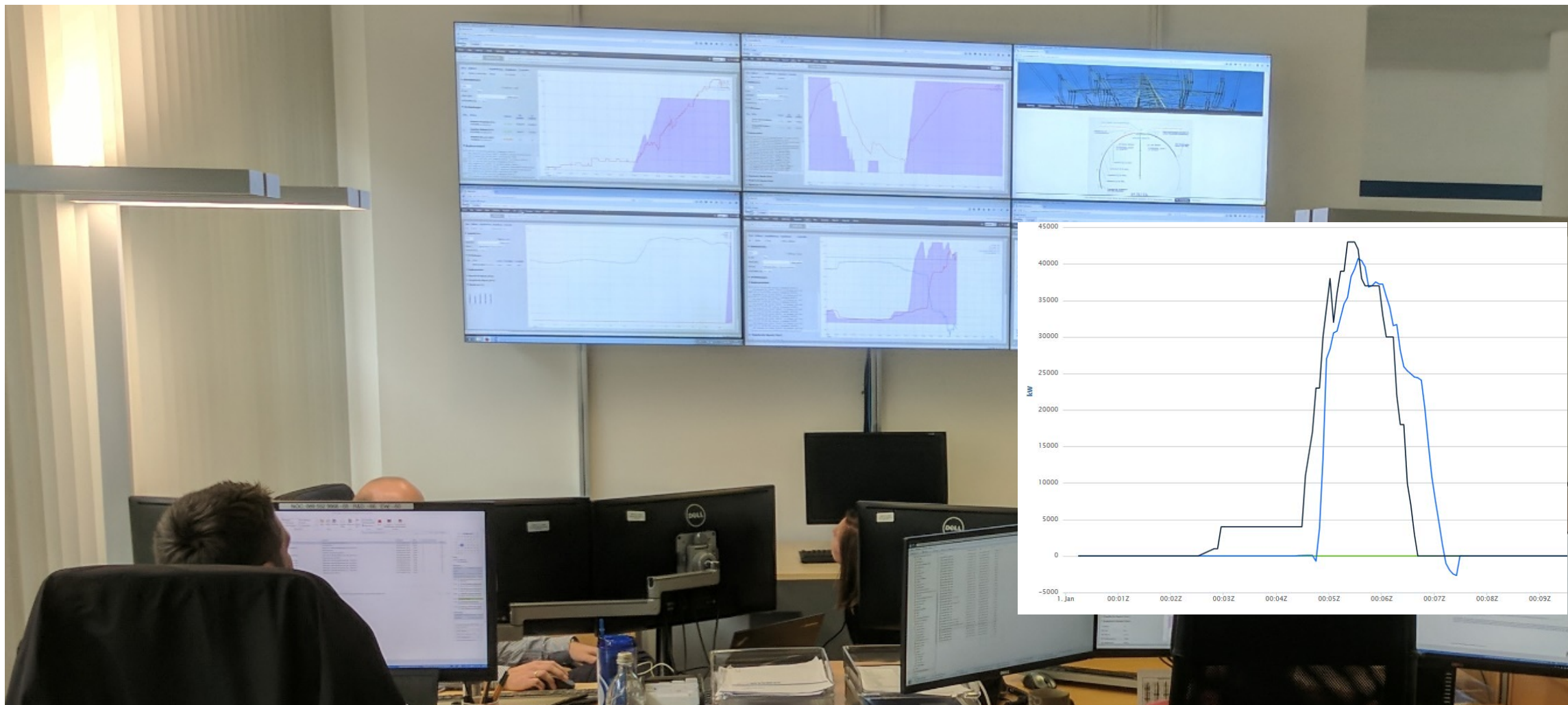
Others...

### Technical assets

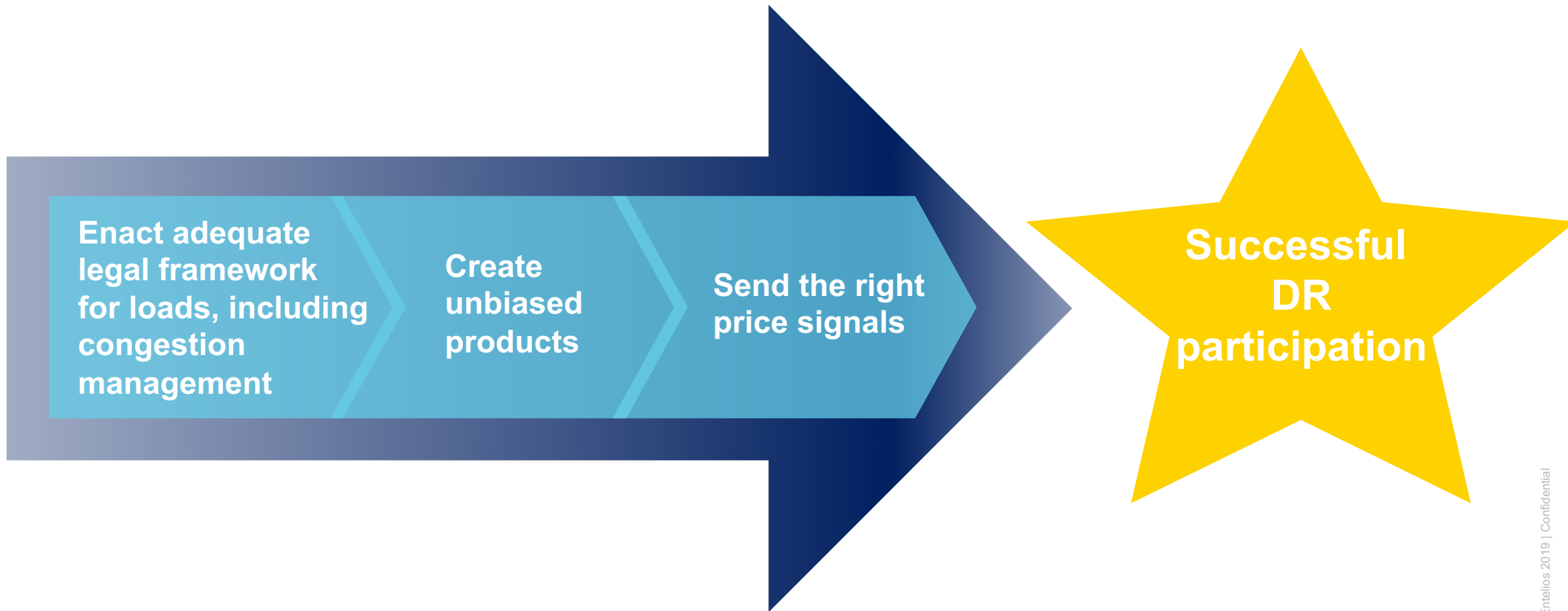
- Electrolysis
- Smelters
- Refiners, grinders
- Cement mills
- On-site generation (CHPs)
- Heating/ air conditioning
- Ventilators / dryers
- Pumps, compressors
- Stirrers
- (...)



# The Entelios Virtual Power Plant in live operation



# A level playing field for demand response is of the essence



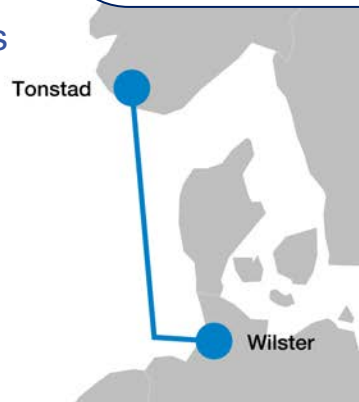




Entelios – a part of Agder Energi

## Power Supply

EEG-asset portfolio  
Market integration  
Hydro power (from 2021)  
Complete service incl. BKV management  
Supply of green power



## Environmental Markets

GO of wind and hydro power plants  
Agder Energi Vannkraft AS Green certificates  
CO2 and emission trading

**ENERGY  
ORIGINS  
.NET**



## Flexibility



Demand Response (Industry)  
System services  
Short-term trading (Algo-Trading)

Development of flexibility concepts  
„NODES“ – market place for local flexibility



## Portfolio management & 24/7 trading

Short-term trading  
Automated trading  
Management of fluctuating generation

