Customer export curtailment value methodology

Stakeholder workshop
23 February 2022

aer.gov.au

Housekeeping

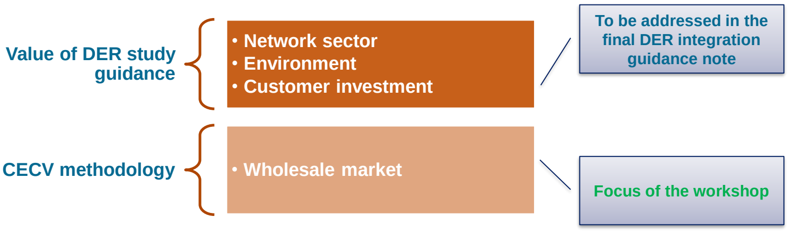
- Questions may be raised at any time in the chat box.
- Please remain on mute unless speaking.
- Use the ‘raise hand’ function to ask a question during the discussions.
- Note that views expressed by AER staff are not to be attributed to the AER.

aer.gov.au

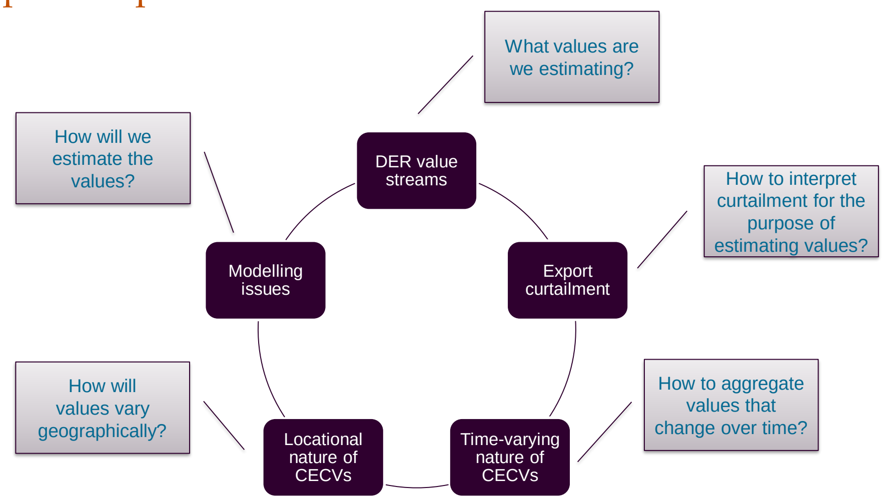
Agenda

AER	***Introduction***	15 mins
Oakley Greenwood	***Overview of approach to CECV methodology***	15 mins
	Wholesale market modelling	30 mins
	DNSP model	30 mins
All	***Q & A***	30 mins

Quantification of DER value streams



Issues paper recap



CECV Methodology Development

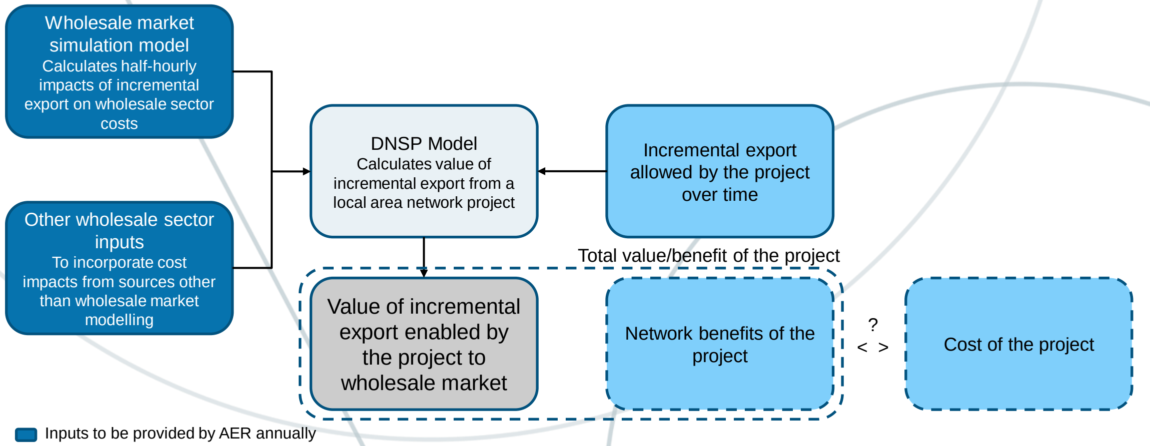
Stakeholder Workshop
23 February 2022

Oakley Greenwood

Overview of project team structure and roles

AER	• Project client and maintainer and primary user (along with relevant stakeholders)of the CECV and DNSP models
Oakley Greenwood	• Overall project direction • Inputs to wholesale market modelling • Primary responsibility for development of the DNSP model
Endgame Economics	• Wholesale market modelling of CECVs
Cadency Consulting	• Technical input on the network investment projects to enable additional DER export • Input on the integration of the CECV modelling capabilities and outputs with the regulatory process

Overview of project outputs and integration with regulatory process

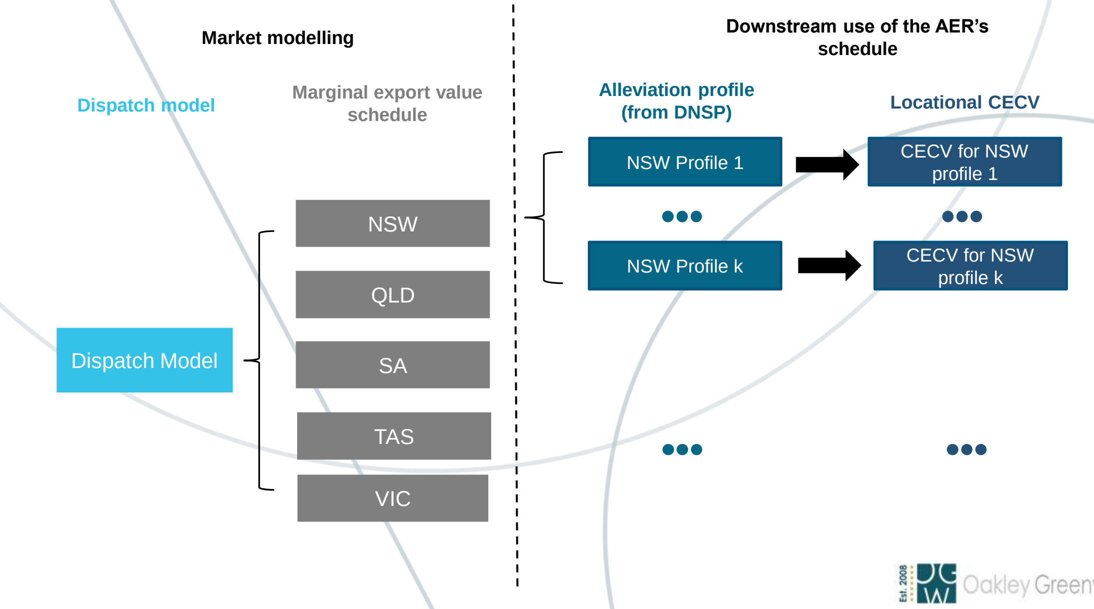


- Inputs to be provided by AER annually
- Model to be developed, maintained and possibly upgraded by AER
- Inputs to be provided by the DNSP for each project four use in the DNSP model
- Inputs to be provided by the DNSP outside the DNSP model but needed for final assessment of the economic efficiency of the proposed capex project
- Primary output of the model for decisions regarding proposed projects

MARKET MODELLING TO DETERMINE CECV

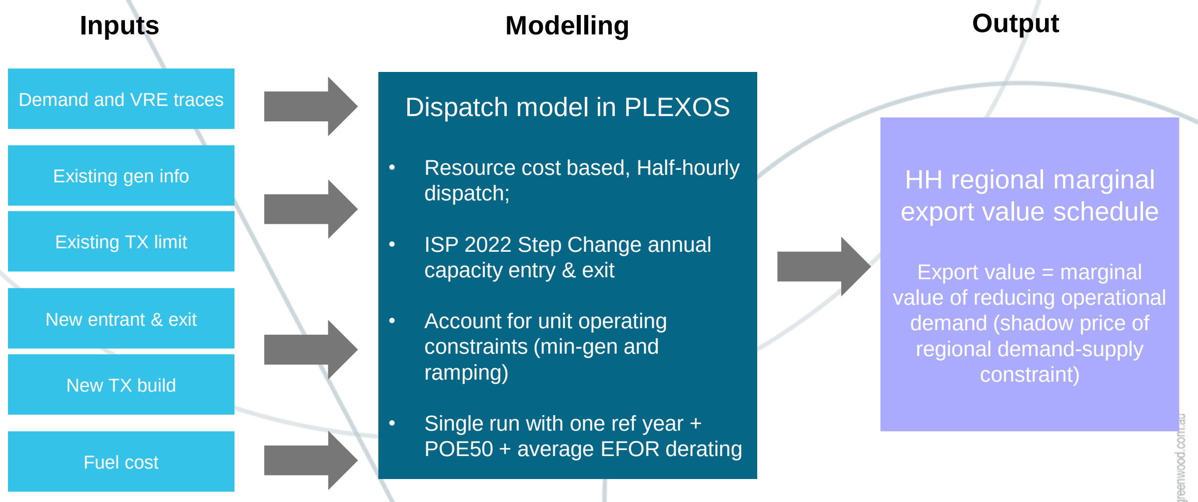
8

Market modelling process overview



9

Dispatch model design



Market modelling inputs

Input	Source
Existing & committed unit capacity	Draft ISP 2022 assumptions (2021 IASR)
Gen operating characteristics	Draft ISP 2022 Step Change (2021 IASR)
New GX and TX entrant capacity	Draft ISP 2022 Step Change modelling output including the Optimal Development Path for TX expansion
Demand traces	Draft ISP 2022 Step Change (2021 IASR)
Fuel Prices	Draft ISP 2022 Step Change (2021 IASR)
VRE traces (same ref. year as demand)	ESOO and ISP traces

What is and is not captured in the current modelling

Component	Reason/notes
Energy related dispatch cost	• Plant dispatch directly impacted by additional DER export on day-to-day basis
Resource cost related to ESS provision	• FCAS services modelled as a headroom and a footroom requirement. • Marginal export value captures FCAS-related resource cost impact by DER export.
Investment cost	• Note that the direction of additional DER export capacity on costs is unclear, and may result in an increase or decrease in total system costs • Not consistent with the marginal assessment approach, and would require a with/without approach and an assumption about the alleviation

Potential future improvement

Component	Future improvement
Investment cost	• Extend the current methodology to explicitly model generation investment. The export values would then include the investment benefit from DER export. • Including TX investment would likely be computationally resource intensive and add little improved accuracy.
Resource cost related to ESS provision	• Continue to monitor the development of DER participation in FCAS including ○ Impact of new ESS (FFR and potentially Inertia) ○ Regulatory and technological barriers for DER participation ○ Impact of DER export on the demand for ESS

THE DNSP MODEL – INITIAL DESIGN IDEAS

Oakley Greenwood Est. 2008

www.oakleygreenwood.com.au

What types of investment cases will the DNSP model have to cater for?

The DNSP model must be fit-for-purpose, therefore, it is important that when designing the model (and formulating its inputs), we identify the types of investment cases the DNSP model is likely to be used to support

Investment Case	OGW Comment
Investment(s) to remove / reduce static export limits on Solar. Examples include: ▪ Dynamic Operating Envelopes (DoE) ▪ Dynamic voltage management ▪ Network hosting/visibility improvements	Static export limits potentially affect the level of curtailment all year round. Key drivers of the probability of occurrence include: • Current static limit (e.g., 5kW) being applied, or that would be applied absent the investment • Probability of a customer's net export (PV generation *minus* underlying demand) exceeding that static limit
Investment(s) to reduce curtailment that is driven by voltage issues. Examples include: • Tap changes • Phase balancing • Load transfers/circuit balancing	Excess PV export may lead to excessive voltages, necessitating curtailment, generally at times of high PV production / low underlying demand (e.g., mild spring day). Key drivers of the probability of occurrence include: • Level of local network demand • Level of local PV production
Investments to cater for new sources of BTM energy (e.g., VPPs / EVs) that may be dispatched and exported back into the grid*. Examples include: • Any of the above options • A combination of the above options • Tariff reforms in combination with the above options	Thermal and voltage constraints may limit that amount of energy that can be exported back into the grid from BTM resources. Key drivers of the probability of occurrence include: • High wholesale energy prices and • High FCAS prices (on the assumption that export volumes from dispatchable resources are likely to be highest when the prices are high).

*It is assumed that DNSP's investments would not be driven by BTM resources that are purely used to offset grid consumption (i.e., resources that are not in fact, exporting to the grid).

Oakley Greenwood Est. 2008

www.oakleygreenwood.com.au

How the DNSP Model could package wholesale market values for use – Option 1

We are considering **three broad approaches** for packaging wholesale market values into a model that the DNSPs (and the AER) can use to calculate the value of incremental export from a local area network project:

1. **A string of half-hourly values for each year in the analysis period for each region**:
   - [A] ½ hourly wholesale market values [directly from wholesale modelling]
   - [B] Level (kWh) of curtailment relief provided by investment in that year, by half hour period [inputted by DNSP]
   - [A]*[B] = [C] Total wholesale benefit ascribed to a hosting capacity project

•The advantages and disadvantages of this option are that:

- **Advantages:**
  - It provides DNSPs with the flexibility to develop their own alleviation profile.
  - Requires no material post-processing of wholesale outputs required
- **Disadvantages:**
  - Does not provide DNSPs with the factors that drove wholesale market values (some of which may also drive PV curtailment – e.g., assumed PV production), hence potential for misalignment between alleviation profile and market values
  - Labour intensive for DNSP to develop detailed alleviation profile by ½ hour for analysis horizon.
  - Labour intensive for AER to review robustness of alleviation profile inputted by DNSP (given amount of data inputted, and significant flexibility ascribed to DNSPs)

How the DNSP Model could package wholesale market values for use – Option 2

2. **Wholesale values are developed for a set of "characteristic day" types**:
   - [A] Create a matrix of 'characteristic days' when curtailment is likely to be relieved by an investment (e.g., low demand, high PV output, in spring)
   - [B] Align wholesale outputs (from PLEXOS modelling) to those characteristic days:
     - [B1] Marginal generation costs averaged across those characteristic days during times when curtailment is likely to occur (e.g., 12pm to 3.30pm), for each year
     - Number of those characteristic days in each year.
   - [C] DNSP inputs the total additional energy exported pa (kWh) they are forecasting to occur as a result of their network expenditure, by each characteristic day type
   - [D] = [C]*[B1] = Value of curtailment relief stemming from a network investment

The advantages and disadvantages of this option are that:

- **Advantages:**
  - Easier than Option 1 for DNSPs to populate model;
  - Easier than Option 1 for the AER to review/audit the data that has been inputted into the model
  - Better alignment between market values and alleviation volumes
- **Disadvantages:**
  - Still requires DNSP to allocate total amount of curtailment relieved across characteristic days
  - AER has to have a means of reviewing robustness of alleviation allocations inputted by DNSP

Example of characteristic day concept

Characteristic Day	#days	Average marginal cost for alleviation periods
High Underlying Demand (POE10) / High Solar PV Generation (POE10)	X	X
High Underlying Demand (POE10) / Medium Solar PV Generation (POE50)	X	X
High Underlying Demand (POE10) / Low Solar PV Generation (POE90)		
Medium Underlying Demand (POE50) / High Solar PV Generation (POE10)		
Medium Underlying Demand (POE50) / Medium Solar PV Generation (POE50)		
Medium Underlying Demand (POE50) / Low Solar PV Generation (POE90)		
Low Underlying Demand (POE90) / High Solar PV Generation (POE10)		
Low Underlying Demand (POE90) / Medium Solar PV Generation (POE50)		
Low Underlying Demand (POE90) / Low Solar PV Generation (POE90)		

- PLEXOS outputs produced <u>for each NEM region, by season, by year</u>
- Results reported for different PV production thresholds
  - E.g., 5kW, 4kW, 3kW
  - All days where average BTM PV production <u>doesn't reach limit are excluded from analysis</u>
  - So 5kW results already exclude all days/results where MAX average PV production on day < 5kW
- POEs:
  - Aligned to threshold (so only reflect days above threshold)
  - POEs will be determined based on inputs into PLEXOS modelling - hence align with outputs
- This data potentially covers the following use cases:
  - Static limits applied to solar exports
  - Voltage constraints applied to solar exports
  - Examples provided on next slide
- Use cases not covered:
  - Export to grid from dispatchable BTM resources

Est. 2008 Oakley Greenwood

www.oakleygreenwood.com.au

Example of how to operationalise characteristic day concept

- Example use case: **Existing 5kW static limit on solar export removed**
- **DNSP:**
  - Selects wholesale values for 5kW static limit
    - This automatically excludes all days/wholesale values for days where average PV production never reached that limit - because removing the static limit will not affect export on those days
  - Inputs, for each year, their estimate of:
    - The <u>total</u> amount of additional energy released as a result of that investment
    - Additional energy released, <u>by each type of characteristic day</u> (e.g., low demand / high PV production spring day)
- Model:
  - Calculates the estimated value of that additional energy based on the kWh the DNSP has attributed to that characteristic day *multiplied by* the average wholesale value for that characteristic day (during ½ hour periods where curtailment is likely to happen)

Est. 2008 Oakley Greenwood

www.oakleygreenwood.com.au

How the DNSP Model could package wholesale market values for use – Option 3

A third approach, which is being considered, would build upon Option 2 by ranking days in order of when curtailment is likely to occur

3. Ranking characteristic days on the basis of when curtailment is likely to occur:

- As per OPTION 2, except, we would RANK each characteristic day in terms of the likelihood of curtailment occurring (absent the investment)
  - E.g., if curtailment is most likely to occur on low demand, high PV production days in SPRING, that type of day is Ranked 1
- DNSP then inputs:
  - The total additional export pa (kWh) they are forecasting to occur as a result of their network expenditure
  - The number of days pa that curtailment would have otherwise occurred had they not undertaken their hosting capacity project
- Model then automatically attributes those forecasted (kWh) of curtailment relief to the characteristic days based on:
  - Rank of day (1 through *n*) and
  - Number of those characteristic days in the PLEXOS modelling
- Value of curtailment relief stemming from a network investment = energy allocated to that characteristic day *multiplied by* average wholesale values for that day

Est. 2008 OGW Oakley Greenwood www.oakleygreenwood.com.au

Example of how to operationalise ranking characteristic day concept

- Example use case: **Investment(s) to reduce curtailment due to voltage issues**
- DNSP:
  - Estimates daily maximum PV production level below which curtailment is unlikely to occur in a year, absent investment
    - E.g., curtailment is unlikely to occur if MAX PV production < 3kW
  - Selects wholesale values for that figure
    - i.e., >3kW inputs would be selected for use in the above example
    - Note this means that all days/wholesale values where MAX PV production never reached that limit are automatically excluded from consideration
  - Inputs, for each year, the:
    - Total estimated amount of additional energy released as a result of the investment (e.g., 100,000kWh)
    - Number of days when curtailment would have likely occurred (e.g., 25 days)
- Model inputs for rankings:
  - Rank 1: "Low Underlying Demand (POE90) / High Solar PV Generation (POE10)" = 10 occurrences in PLEXOS data
  - Rank 2: "Low Underlying Demand (POE90) / Medium Solar PV Generation (POE50)" = 15 occurrences in PLEXOS data
- Model outputs:
  - Model automatically allocates the 100,000kWh to days based on ranking (as opposed to the DNSP doing this under OPTION 2), and calculates wholesale market value :
    - Rank 1 day: 10 days/25 days *times* 100,000kWh * average wholesale value for that characteristic day
    - Rank 2 day: 15 days / 25 days *times* 100,000kWh * average wholesale value for that characteristic day

Est. 2008 OGW Oakley Greenwood www.oakleygreenwood.com.au

What about our third use case: Dispatchable BTM sources of energy exported to grid?

- Example use case: **Dispatch of BTM batteries (e.g., as part of a VPP) is curtailed due to thermal (or voltage) constraints**
- Issues for consideration:
  - As the energy source is dispatchable, the opportunity cost of not being able to dispatch at a certain time due to the network constraint <u>is not zero</u> (which is the case for curtailed solar)
    - The assumption here being that dispatchable DER will react to price signals in the wholesale energy and ESS markets
  - Rather, it is the value of the energy in the battery that was not dispatched due to the constraint, in its next best alternative
  - From an economic perspective, this is likely to be the value of that energy at another time <u>of that day</u> (assuming a daily charge/discharge cycle) - e.g., latter on that same day
- Calculating the value unlocked due to investment in this case would require (a completely different type of analysis):
  - Postulating the type of days when dispatchable technologies such as BTM batteries and EVs would be dispatched *en masse* (thus potentially causing constraints and the need for upgrading of network capacity)
    - These types of days would presumably be when there are either high wholesale prices, or high FCAS prices
  - Estimating the different values across the day, on those types of days, to estimate the opportunity cost (e.g., a price duration curve)

Est. 2008 OGW Oakley Greenwood

www.oakleygreenwood.com.au

Third use case: Dispatchable BTM sources of energy exported to grid? (cont'd)

- Issues/Considerations:
  - The likely (key) economic benefit of enabling more dispatchable BTM devices that would be expected to be dispatched *en masse* is likely to be the avoidance or deferral of future generation capital expenditure, which would require different wholesale market modelling (e.g., use of a game-theoretic LT model to capture bidding behavior and impact of DER on planting)
  - Near-term investment by DNSP to support this unlikely to be material
- Initial proposal:
  - Consider adding this functionality when investment cost impacts are addressed in the market modelling of CECVs

Est. 2008 OGW Oakley Greenwood

www.oakleygreenwood.com.au

For discussion

- Thoughts on DNSP model
- Thoughts on specific static limits to be catered for in the model
- Thoughts on the concept of characteristic days
- Thoughts on the possible ranking of those characteristic days
- If ranking were adopted, thoughts on the level of flexibility (if any) that should be built into model to allow DNSP / AER to overwrite ranking of characteristic days

Oakley Greenwood Pty Ltd
PO Box 125
Margate Beach QLD 4019
+61 7 3283 3249

lhoch@oakleygreenwood.com.au

Endgame Economics
Suite 118/165 Phillip St
Sydney NSW 2000
+61 2 8218 2174

oliver.nunn@endgame-economics.com

Cadency Consulting
PO Box 5043
Burnley VIC 3121
+61 4 1888 9890

anthony@cadency.com.au

Next steps

aer.gov.au