# Calculating the value of small scale generation to networks

## *Future Proofing in Australia's Electricity Distribution Industry*

18th August 2015

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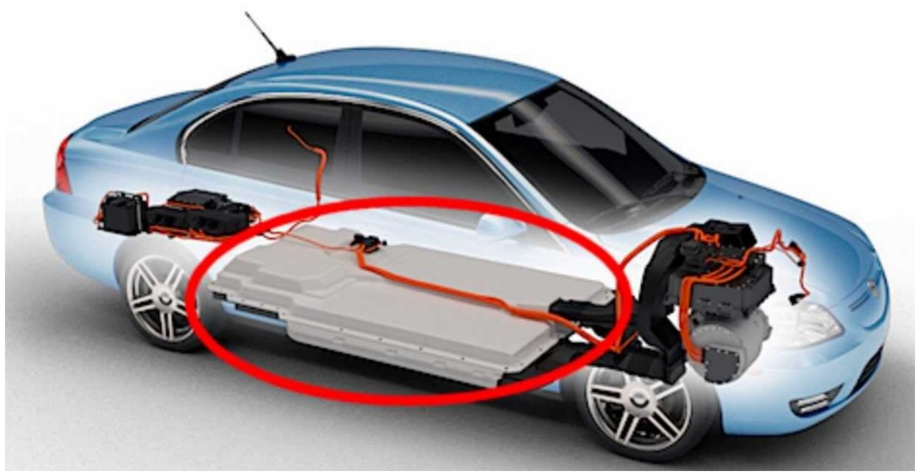
Building a better working world

# Defining DERs

- Distributed Energy Resources (DERs) are:
  - Any **small** electricity generator that may be installed at multiple locations within a distribution network
  - Examples include rooftop solar PV, micro-turbines, battery storage, Electric Vehicles (EVs)


Source: www.teslamotors.com



# What is this all about?


- The financial structure of the electricity system was established without consideration of consumers generating their own electricity
- DERs bring both costs and benefits to the electricity system, which raises the questions:
  - What are the costs and benefits?
  - Who is responsible for them?
  - How do we put them together in a consistent manner?
  - How to quantify each cost and benefit?
  - How to distribute these costs and benefits amongst stakeholders?
- Benefits of answering these questions
  - Encourage efficient and appropriate network and DER development
  - Help DNSPs to evaluate DER-based network solutions

We addressed these questions for distribution network service providers (DNSPs)



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# What we did

- Developed a nationally applicable framework to assist DNSPs to evaluate the relevant costs and benefits of DERs for their network business
- A comprehensive literature review and international benchmarking
  - Assessing other methods and frameworks in use or proposed
- Obtained a case study from industry for demonstrative purposes
- Assessed technical, economic and regulatory barriers to taking up the framework
- Made recommendations for next steps
- Everything done with industry consultation via the project steering committee

# Why do this?

- Inform efforts to distribute the costs and benefits of DERs in an equitable way amongst the relevant stakeholders, including reducing cross-subsidies
- Provide a means of consistently quantifying costs and benefits of DERs to help address barriers to DER uptake:
  - Technical
  - Regulatory
  - Economic
- Help encourage efficient and appropriate developments of future DER installations
  - Providing the right cost signals to DER proponents and DNSPs
- Help DNSPs make the costs and benefits of DERs more obvious
  - Facilitate DNSPs in evaluating transparent DER-based network solutions to compare with traditional network augmentation or replacement approaches

# Developing the framework – identifying the costs and benefits of DERs

- What are all of the costs and benefits in the electricity supply chain that are impacted by DERs?
- Which costs and benefits specifically impact the distribution network?

*We undertook a significant technical and literature review to answer these two key questions*



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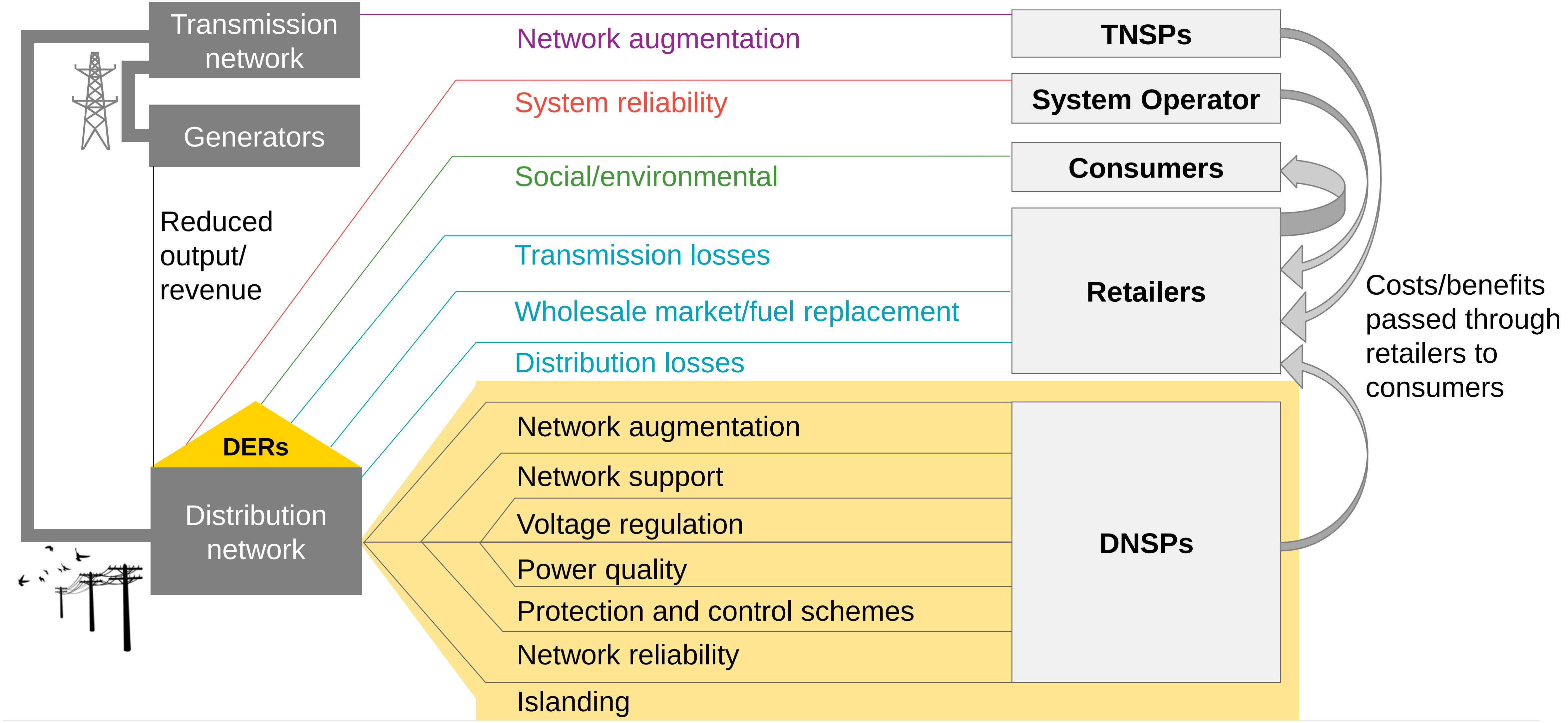
# Conclusions of literature review

1. There is broad agreement about which cost and benefits may reasonably be attributed to DERs
2. There is reasonable agreement about which are associated with the distribution network, and which are associated with other parts of the supply chain
3. The cost and benefit categories identified are present in any distribution network and are independent of network design and organisational structures
4. There is little agreement as to the best way to *quantify* costs and benefits attributable to the distribution grid
5. There is widespread acknowledgement that quantification requires high analytical granularity, and that the task is challenging

# Attributing costs and benefits of DERs in Australia





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# Included Costs and Benefits

| Category | Financial impact on network, if applicable | Cost/ Benefit/ Either | Description |
|---|---|---|---|
| **Network augmentation or replacement** | High | Either | Changes in expenditure on any network augmentation associated with the DERs, including replacements or upgrades of cables or transformers. This also includes entirely new developments, for example, where a brand new feeder or similar is to be developed. |
| **Network support** | High | Either | Benefits or costs associated with DER(s) offsetting generation from contracted distribution network support facilities or avoiding the need to obtain such contracts. |
| **Voltage regulation** | Moderate | Either | Costs from adjusting taps on transformers, or installing/upgrading transformers to maintain acceptable voltage levels for customers. |
| **Power quality** | Moderate | Either | Any associated value from grid support that the DER might provide/require. These are managing harmonics, DC injection and flicker. |
| **Reassessment of protection and control schemes** | Low | Cost | Fault current settings may need to be changed and retested, depending on the designed operation of the DERs during a fault. |
| **Network reliability** | Currently low, but potentially significant | Either | As part of operating and maintaining a distribution network, DNSPs have reliability standards to meet, with associated penalties if they don't. These penalties are intended to be related to the Value of Customer Reliability (VCR). This category refers specifically to these penalties. |
| **Islanding capability** | Currently not applicable, but potentially significant | Benefit | Any benefit to customer reliability through being able to use the DERs to create a stable island network during a fault. This value would be set to zero if the DERs are configured to automatically disconnect during a fault. EY notes that islanding is not currently desirable in networks due their present design characteristics. |

# Excluded Costs and Benefits

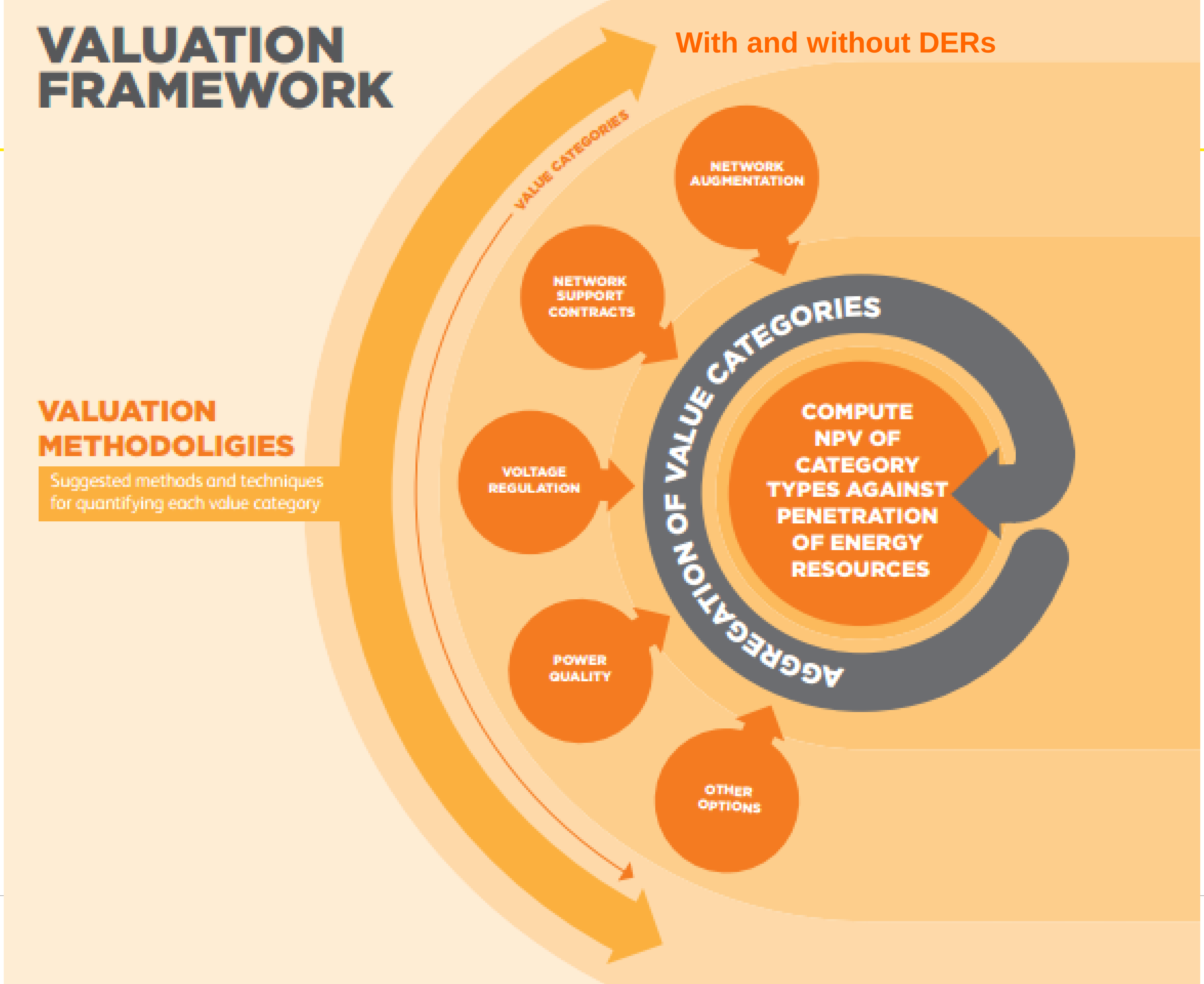
| Category | Description | Reason for exclusion |
|---|---|---|
| **DUOS** | Distribution Use of System (DUOS) charges are levied by the DNSP for use of their distribution network. | DERs affect DUOS charges applicable in the area where they are located through influencing losses in the network. DUOS charges are passed through to customers, and are not borne by the DNSP. |
| **TUOS** | Transmission Use of System charges (TUOS)are applied by TNSPs for use of their transmission network. | TUOS charges are a cost passed through directly to consumers thus not borne by the DNSP. Avoided TUOS is an important contribution attributable to DERs, but should be captured as a benefit to the transmission networks. |
| **Fuel replacement** | Cost savings from  DER generation offsetting generation from more expensive fuels. | Fuel costs (or savings) are not borne by DNSPs but by retailers. |
| **Wholesale market value** | Value obtained via control of DERs to allow arbitrage in the wholesale electricity market, or influencing market prices through merit order effects. | Any wholesale market value from operating DERs is external to the distribution network. |
| **Network control ancillary services** | Value from DERs providing Network Control Ancillary Services (NCAS) to provide voltage and transient support to the network. | NCAS applies to support of the transmission grid, not the distribution grid. Therefore DERs providing NCAS would benefit the transmission network, not the distribution network. Equivalent services in the distribution network are included in the ‘Network support’ category. |
| **Network losses** | Cost of changes to electrical losses in the distribution network (and in the transmission network). | Distribution losses are affected by DERs but are borne by the retailer (and recovered from customers). Impacts of altered distribution losses are reflected in other value categories. |
| **Safety issues** | Costs associated with delivering network services at expected safety levels | Costs associated with maintaining safety standards may by impacted by DERs but should be reflected in calculations of included categories. |

# The proposed framework

1. **Define** scenario boundaries
2. **Assess** applicability of each value category
3. **Determine** a valuation methodology for each value category
4. **Quantify** each value category with and without DERs
   - Starting at current DER penetration level
5. **Total up** values and determine Net Present Value

- ***Repeat*** *the process for different DER penetration levels*

With and without DERs





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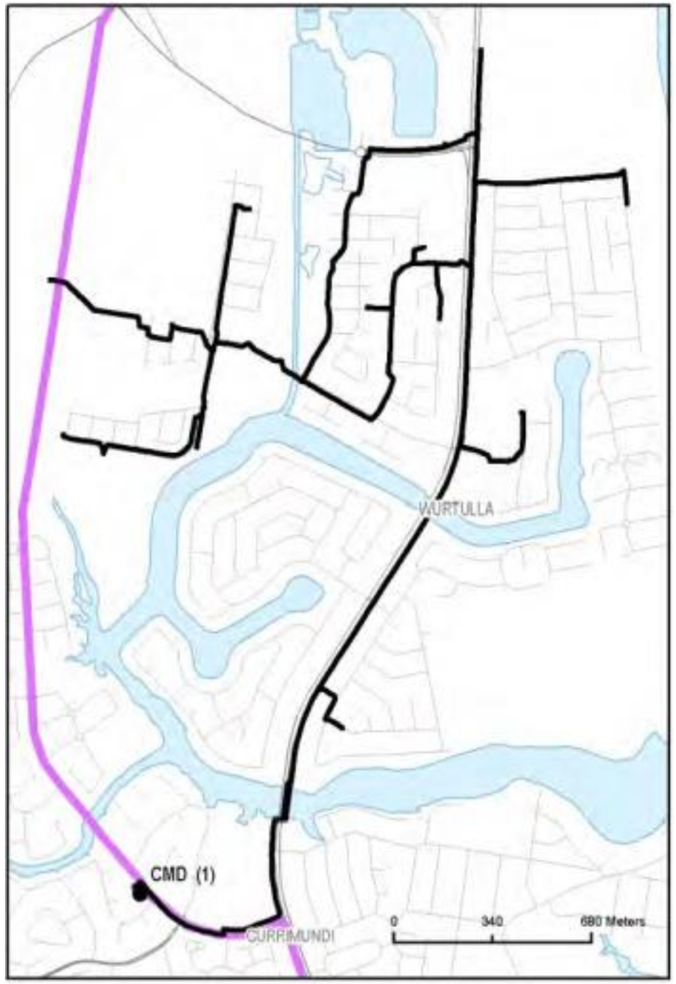
# Key aspects of framework

- Valuation boundaries must be defined that are:
  - large enough to realise the full extent of the impact the DERs have on a distribution network
  - small enough to preserve reasonable local detail
    - E.g. how the DERs impact peak loading on the main transformers
- A medium-voltage feeder level (e.g., 11 kV) is proposed as the most appropriate boundary to use
  - Alternative boundaries may still be suitable; boundaries should be selected on a case-by-case basis





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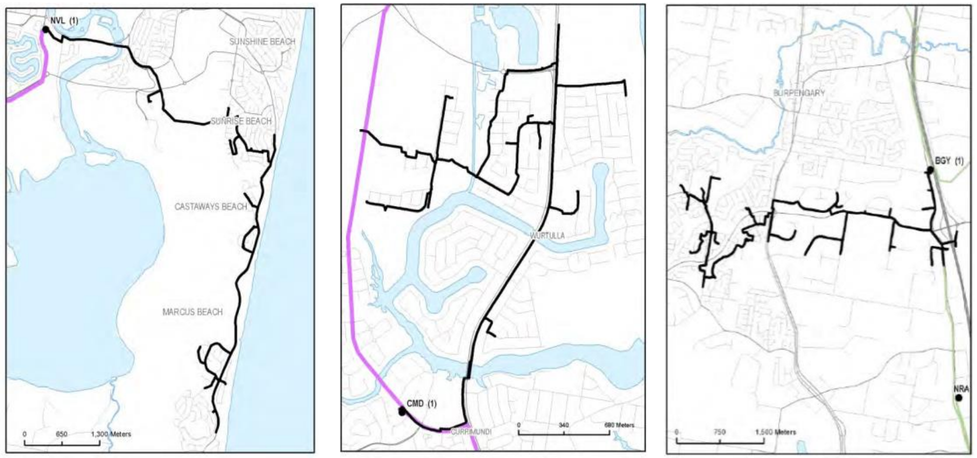
# Feeder classification

- Classification of feeders is desirable to:
  - Reduce computational burden
  - Communicate to the market in a timely fashion
  - Minimise duplication of effort across jurisdictions
- Requirements for feeder classification:
  - **DER type**
  - **Network type:** The interconnectivity of the network.





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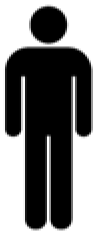

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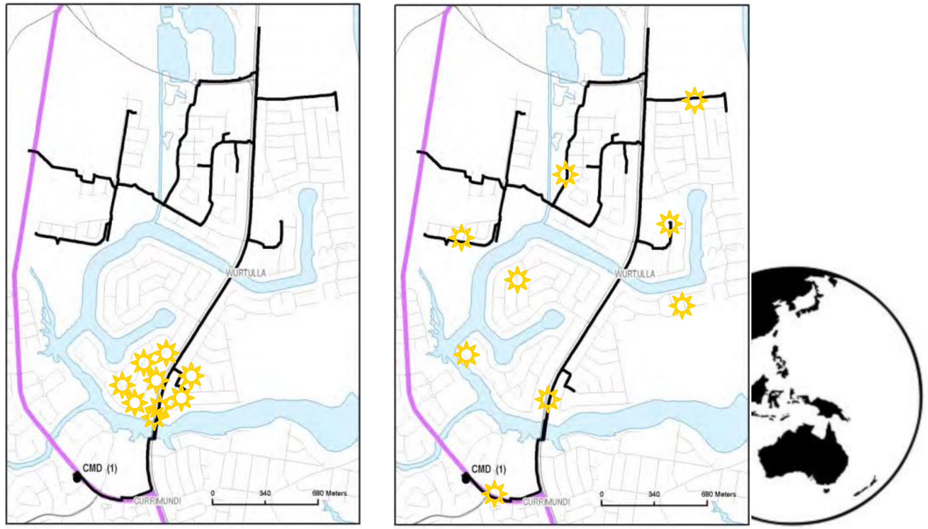
  - **Network type:** The interconnectivity of the network.
  - **Customer type**: customers in the network use electricity in different ways
  - **Geographical location**: The local demand and behaviour of DERs can vary significantly by location
  - **Network loading:** highly loaded networks may be able to have upgrades deferred due to the installation of DERs
  - **DER locations (within a network)**



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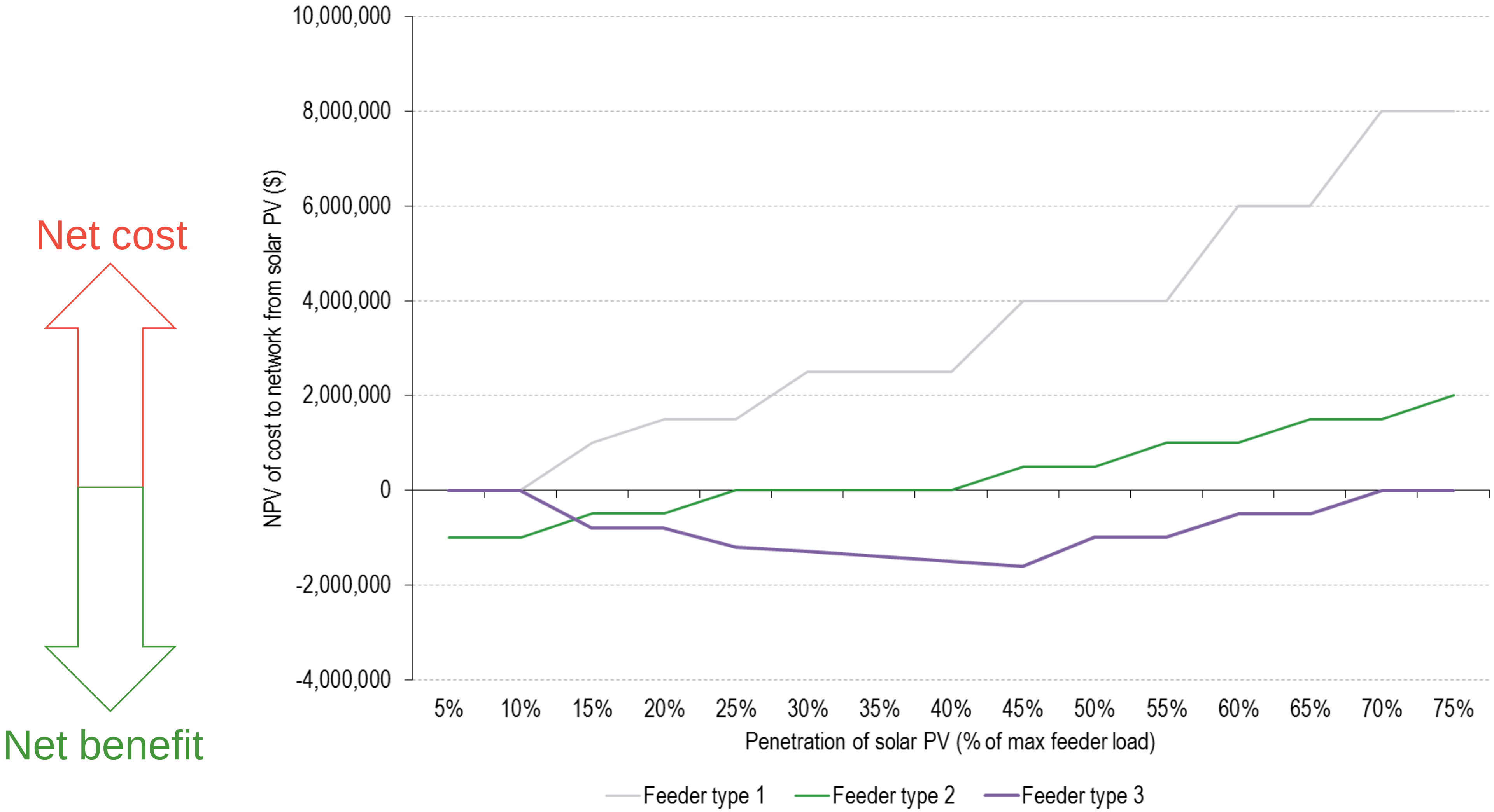
# The proposed framework – example outcomes for three different feeders



# A case study from Energex

- Scenario:
  - Radial 33 kV feeder in suburban south east Queensland was suffering power quality issues under extreme conditions
  - Feeder required network support to meet desired power ratings in summer
  - A major customer provided this network support through load curtailment but n-1 security standard dictate that feeder should withstand extreme conditions when load curtailment not available

- Energex first determined that the most economically viable solution was to rebuild the existing feeder and install a capacitor bank

# A case study from Energex

- DER evaluation:
  - 28% of residential customers on feeder have a solar PV system. At network peak loading, solar PV output was estimated at 0.42 MVA
  - Energex realized that increasing solar PV penetration within the feeder service area could defer the network augmentation.
- Using framework approach:
  - Without more DERs, the main network augmentation would be needed by 2015/16.
  - With a solar PV penetration of 60% would reduce peak loading by 0.5 MVA, sufficient to delay the network augmentation by 2 years
  - Some other costs not avoided, some costs (network support) higher under DER case
  - Equates to some $2.2m savings in NPV terms
  - Perhaps higher penetrations may have delayed network augmentation further

# A case study from Energex – the framework in action

| Value type: | Network capacity installations and upgrades | | Network support contracts | | Voltage regulation | | Power quality issues | | Reassessment of protection and control schemes | |
|---|---|---|---|---|---|---|---|---|---|---|
| **With DERs?** | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes |
| 2014-15 | - | - | 1,817 | 1,817 | - | - | - | - | - | - |
| 2015-16 | 26,553 | - | - | 1,835 | - | - | - | - | - | - |
| 2016-17 | - | - | - | 1,853 | - | - | - | - | - | - |
| 2017-18 | - | 26,553 | - | - | - | - | - | - | - | - |
| 2018-19 | 2,190 | 2,190 | - | - | - | - | - | - | - | - |
| 2019-20 | 263 | 263 | - | - | - | - | - | - | - | - |
| 2020-21 | 1,163 | 1,163 | - | - | - | - | - | - | - | - |
| 2021-22 | - | - | - | - | - | - | - | - | - | - |
| 2022-23 | - | - | - | - | - | - | - | - | - | - |
| 2023-24 | - | - | - | - | - | - | 9,600 | - | - | - |
| 2024-25 | - | - | - | - | - | - | - | - | - | - |
| 2025-26 | - | - | - | - | - | - | - | 9,600 | - | - |
| 2026-27 | - | - | - | - | - | - | - | - | - | - |
| 2027-28 | - | - | - | - | - | - | - | - | - | - |
| 2028-29 | - | - | - | - | - | - | - | - | - | - |
| 2029-30 | - | - | - | - | - | - | - | - | - | - |
| 2030-31 | - | - | - | - | - | - | - | - | - | - |
| 2031-32 | - | - | - | - | - | - | - | - | - | - |
| 2032-33 | - | - | - | - | - | - | - | - | - | - |
| 2033-34 | - | - | - | - | - | - | - | - | - | - |
| **NPV** | 32,940 | 28,236 | 1,817 | 5,027 | - | - | 4,149 | 3,443 | - | - |

# Barriers for framework uptake

- Economic barriers
  - Quantification of the costs and benefits of DERs is a significant task
  - Requires detailed data and detailed analysis so take time and resources
  - Stagnant demand growth may be an economic barrier in some areas
  - A reasonable body of experience in applying the framework is needed to understand effort and cost better
  - Cost and resources involved in such an assessment should decline rapidly with experience, although it will remain a substantial task
  - The value of customer reliability may be a barrier; the value customers place on reliable supply magnifies or dilutes the costs and benefits of DERs

# Barriers for framework uptake

- Technical barriers
  - Inherent complexity of undertaking any valuation methodology
  - Limitations on human resources, analytic capacity, data collection infrastructure and know-how within DNSPs
  - Data availability issues
    - smart meters are highly advantageous for accurately computing DER costs and benefits
  - Standards development
  - availability of the kind of data needed to thoroughly execute the framework
    - measurement equipment may need to be installed in substations for example

# Barriers for framework uptake

- Regulatory barriers
  - No regulations require DNSPs to undertake a cost/benefit analysis of existing and proposed DERs on their network, or to collect the necessary data
  - Regulations do not currently contemplate recovery of the costs incurred by DNSPs implementing DER cost and benefit valuations (including data acquisition costs where applicable)
  - Regulations must help (and definitely not hinder) transitioning network businesses to a high penetration DER world.

# Where to from here?

- Start by evaluating a few feeders in “opportunistic” cases
  - Assess the valuations to frame classification for library
- Put the framework into action
  - DNSPs strongly encouraged to consider the framework
  - Start the ‘library’; provide worked examples of different feeders
- Examine how benefits and costs identified can be fairly apportioned to the contributors
  - E.g., connection fees/payments, feed-in-tariffs, network tariffs, incentives

# Take home messages

This study produced a framework for Australian DNSPs to quantify the net cost or benefit of DERs to their expenditure on the distribution network

The framework is generic and is applicable to all Australian DNSPs and integrated power utilities.

Computational burden is biggest barrier. A feeder classification strategy has been suggested to reduce this, but more investigation is required.

The full report is published at: http://www.cleanenergycouncil.org.au/policy-advocacy/arena/FPDI-project/value-of-small-scale-generation.html

# Thank you

## Questions and feedback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