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THE PROMISE OF HYBRID ASSETS
HARNESSING DISTRIBUTED ENERGY

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Resource Technology to Reduce Distribution Network Investment Costs by 15-30%

1. Executive Summary

This paper describes applications or 'use cases' for Distributed Energy Resources (DER) to reduce distribution network asset replacement or augmentation investment, beyond current best practice. It introduces new DER-integrated or hybrid asset solutions that we estimate deliver network investment savings of between 15% to 30% compared to current least cost network solutions. These use cases could save a billion dollars over the next five years in California alone. The paper concludes with a high level consideration of various procurement options to realise the savings.

2. The Missing Use Cases

DER technology, including battery storage, distributed generation, demand response and energy efficiency, is increasingly being recognized for its ability to deliver system-wide benefits through a range of services. Figure 1 displays the range of potential benefits currently recognised by the California Public Utilities Commission.

Figure 1 – California Public Utilities Commission List of Potential Locational Benefits

Type	Minimum Value Components to include in Locational Net Benefit Methodology
T&D	Avoided Sub-Transmission, Substation and Feeder Capital and Operating Expenditures
T&D	Avoided Distribution Voltage and Power Quality Capital and Operating Expenditures
T&D	Avoided Distribution Reliability and Resiliency Capital and Operating Expenditures
T&D	Avoided Transmission Capital and Operating Expenditures
G	Avoided Generation Energy
G	Avoided Generation Capacity
G	Avoided Flexible Resource Adequacy (RA) Procurement
G	Avoided Renewable Integration Costs
G	Avoided Renewable Portfolio Standard Compliance
G	Avoided Ancillary Service Costs
C	Any Societal Avoided Costs which can be Clearly Linked to the Development of DERs
C	Any Avoided Public Safety Costs which can be Clearly Linked to the Development of DERs
C	CO_2 Emissions Costs

Sources: CPUC, More than Smart, Energeia

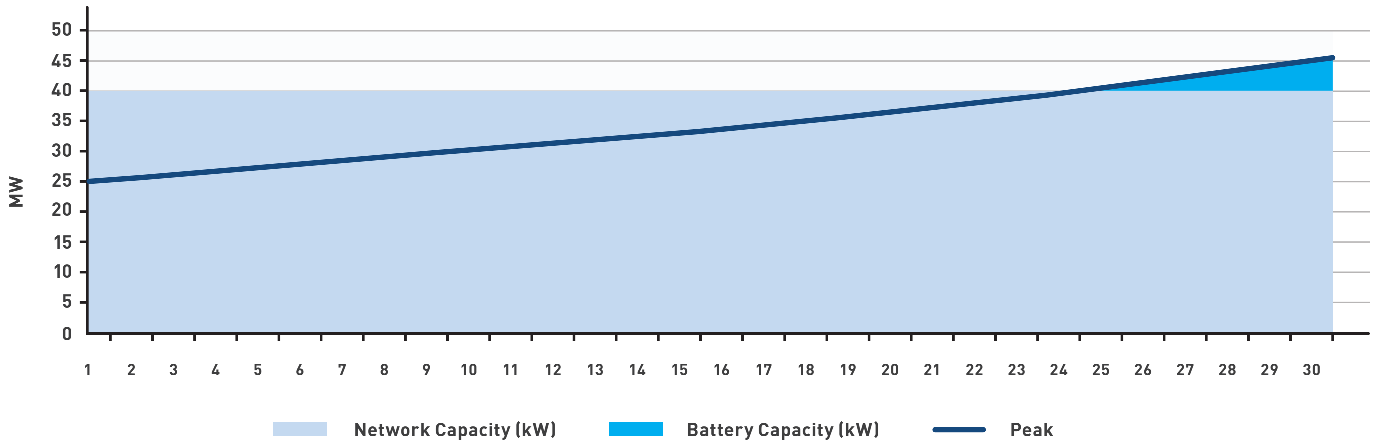
The mechanics of how DER can be used to reduce costs across wholesale energy, capacity and ancillary markets, or to reduce transmission or distribution costs driven by peak demand growth or renewable energy integration, appears to be relatively well understood. However, using DER to reduce costs driven by asset age and/or condition or as a permanent alternative to a network asset appears to be much less well understood and the subject of this paper.

3. The Deferral Use Case

When it comes to distribution network planning and asset management, DER and other nonnetwork solutions are not typically viewed as part of the distribution network itself. Instead, consideration is typically limited to using them as potential stop gap measures to defer investment by reducing peak demand when a distribution network asset is approaching its maximum capacity.

Figure 2 illustrates load growth in dark blue on a 40 MVA zone substation (shown as a blue area) over the first 25 years of its 50-year design lifetime. The design assumes that a 40 MVA transformer is installed in year one with a requirement for an additional 40 MVA transformer to be installed in a spare transformer bay after 25 years, rebalancing load between the two assets and supporting another 25 years of similar levels of load growth in the zone.

Figure 2 – Using Non-Network Alternatives to Defer Augmentation Capex



Source: Energeia

The bright blue sliver in the last 3 years represents a typical demand management activity, such as mobile diesel generators, energy efficiency programs or demand response, which enables the planned investment of the new 40MVA transformer to be deferred by 3-4 years, saving its weighted average cost of capital (WACC) over that time period.[1] At the end of the 3-4 years, the network investment occurs and the value of the demand management service falls to zero as the addition of the new transformer in year 31 leads to over-capacity in the location for the next 20 years or so.

4. New Investment Models Emerging

When it comes time to design a new asset or to replace an existing asset due to anticipated deterioration in its condition leading to rising safety, reliability and/or environmental risks, the full cost and risk reducing potential of DER-integrated assets, or hybrid assets, does not appear to be generally well-understood.

The industry has typically taken a view that while non-network solutions can effectively defer peak demand for a few years at relatively low cost, there is insufficient firm capacity available to provide service over a comparable period. Even where there is sufficient technical capacity of key nonnetwork alternatives such as energy efficiency or demand response, they can lose their low cost economic advantage as the required firm capacity moves beyond the low hanging fruit.

Relatively recent advances in key DER technologies, including solar PV, home energy management systems, and most importantly battery storage, mean that almost unlimited levels of capacity and energy are available in a given location, which along with the rapidly falling price of these resources, is increasingly challenging the conventional network investment wisdom.

New analysis from Energeia suggests that distribution networks that embrace DER-integrated hybrid asset strategies, could reduce their investment related costs by 10% to 30%, depending on whether peak demand is growing or falling and the current effectiveness of investment deferral activities. The savings are possible by harnessing the relatively granular nature of DER and its shorter lifecycle, enabling higher utilisation than the current investment model.

[1] Storage is indicated, but current practice more often uses mobile generators or demand response.

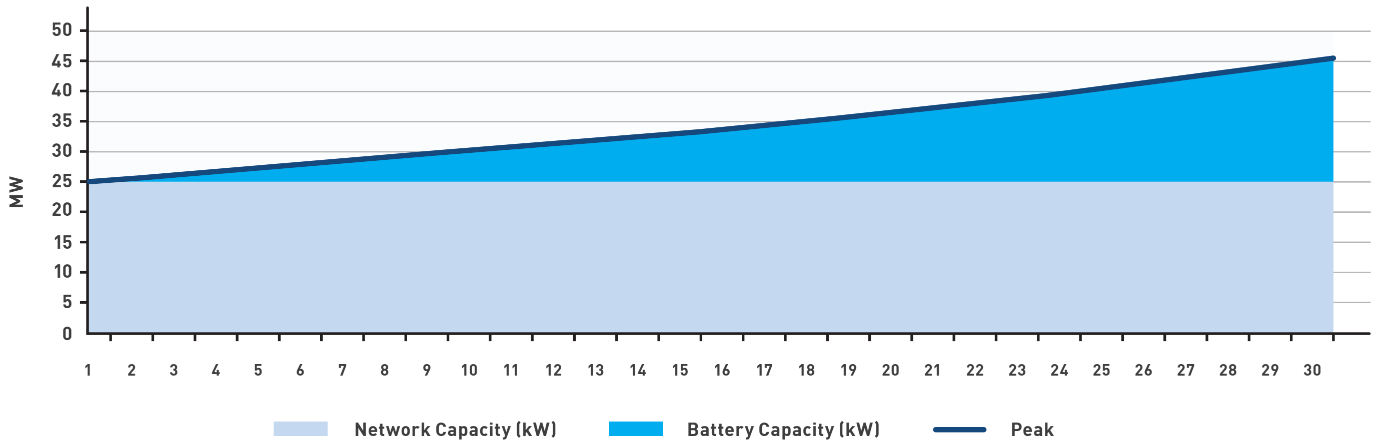
5. The Avoided Capacity Use Cases

Since the dawn of electrification, network planners and engineers built assets assuming long-term growth in peak demand. This has been due to the combination of population growth (of 1%-2%), and growth in underlying peak demand per connection (an additional 1%-2%), leading to net growth in peak demand of 3-4% per annum. The result is assets that are typically half loaded when they are first built, but become loaded over time as they reach their design life.

Energeia's analysis of the net benefits of a DER-integrated or 'hybrid' investment model when peak demand is growing is illustrated in Figure 3. It reflects the same peak demand growth conditions as Figure 2, but instead of installing a 40 MVA network asset solution when initial load is only 25 MVA, this investment model installs a 25 MVA network asset solution initially, and matches incremental growth with DER over time, maximising the utilisation of both network and DER assets.

Compared to the investment approach represented in Figure 2, the hybrid investment model delivers around a 15%-30% savings in capital costs in present value terms over the 30-year investment horizon.[2] The analysis assumes the same pre-tax WACC of 5% for DER and network assets, however, it may be that DER could have a lower WACC when financed at mortgage rates by residential investors, making its annualised cost even lower.

Figure 3 – Using DER to Minimise Network Capex when Peak Demand Growing

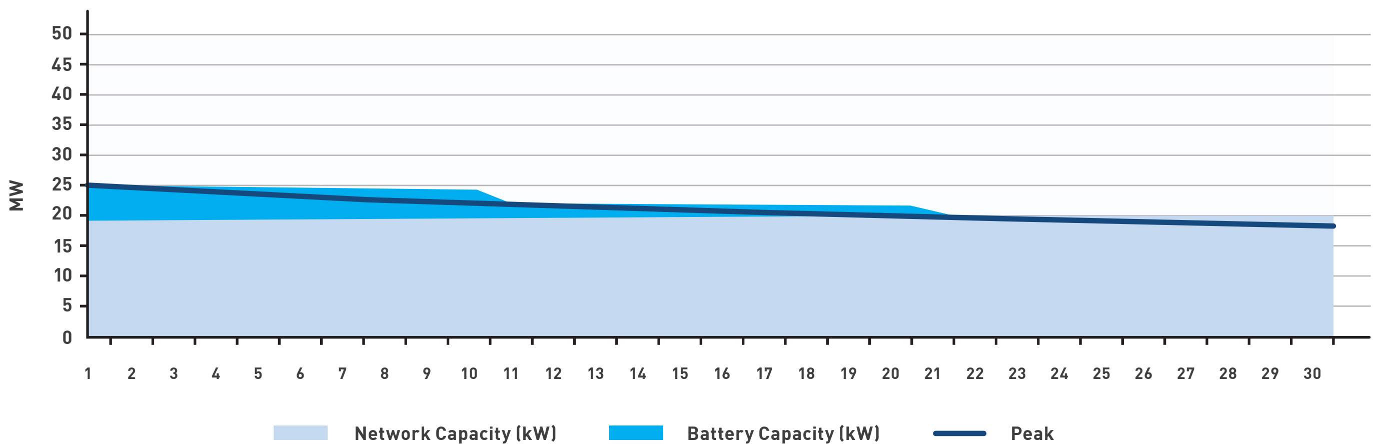


Source: Energeia

Energeia's analysis of the net benefits of a DER-integrated investment model when peak demand is expected to decline is illustrated in Figure 4. This scenario reflects the same starting peak demand condition as Figure 2, but instead of growing by 2% per year over 30 years, the assumption here is that demand falls by 1% per year.

A conventional planning approach might install a network asset sized to meet the 25 MVA initial load following several years of demand management to defer the investment.[3] The DER-integrated approach shown in Figure 4 instead installs a 20 MVA network solution, which is expect to be highly utilised over the first 30-year period, supported by 5MVA of storage initially.[4] The storage is replaced after 10 years by a 2.5 MVA storage asset, sized to meet peak demand in year 11.

Figure 4 – Using DER to Minimise Network Capex When Peak Demand Declining



Source: Energeia

[2] The lower bound occurs where a 3-year deferral is being achieved at the beginning of the investment.
[3] This scenario is only just beginning to emerge so the example is largely hypothetical.
[4] The DER-integrated approach would also defer investment as per the conventional approach.

In summary, the DER-integrated approaches illustrated above save money even compared to progressive network investment based approaches by harnessing two key advantages of DER. The first is its greater range of sizes, particularly smaller sizes, to better fit conditions of declining load, and the second is its shorter asset lifetimes, limiting exposure to long-term under-utilisation.[5]

6. Delivering Hybrid Asset Solutions

Who supplies the DER in the above use cases is not as important as the availability of the necessary DER capacity at the time it is required (firmness), and its operation and procurement at the least possible cost. Work is underway to better define best practice industry approaches for procuring the right amount of DER in the right place at the time, but the industry has a long way to travel before the above models are able to be fully realised in practice.

A key implication of the above use cases analysis is that, while it is possible to set peak rates or nontariff incentives equal to the level of avoidable future investment costs, and encourage lower cost alternatives to emerge over time, it will be important that the signals reflect the least cost approach shown in Figures 3 and 4, and not the current, higher cost approach.

Given the least cost approach may lead to DER only becoming viable as the investment trigger approaches, and the timeframes needed to develop and implement a targeted marketing program, it may be necessary to establish a DER provider of last resort role to ensure that the necessary DER services are available as needed. The utility may be well placed to play this role, as they are likely to have access to a range of suitable locations for installing DER, including existing poles.

7. What's at Stake

Much of today's electricity distribution system was built in the 1950s and 1960s, and is rapidly approaching its end-of-life as equipment becomes more expensive to maintain, less reliable and safety risks increase. As demand flattens, and even begins to fall in areas seeing large investments in DER, asset replacement is becoming the largest investment driver by far.

Australia's distribution network service provider's expect to invest $50 billion over the 2014-2020 period, and an additional $80 billion over the 2020-2030 period.[6] Assuming the above uses cases could be equally applied to 50% of this expected investment, it would save consumers over $1 billion million per year to 2020, or $8 billion over the next ten years in present value terms.

Compare this to applying DER to defer 50% of planned investment for 3 years, which might be considered best practice at the moment. This approach saves about 25-50% of the amount estimated for the avoided use cases, depending on assumptions with respect asset utilisation, e.g. whether the DER assets will be able to be rotated between deferral sites to keep them utilised.

[5] Although beyond the scope of this paper, real-options benefits are expected to add significant value as well.
[6] Electricity Networks Association, Future of Energy Networks, December 2013.

ABOUT ENERGEIA

Energeia is a global leader in the economics, system impacts and business opportunities of electric vehicles. Established in 2009 in Sydney, Australia, the company opened its first US office in 2015 in California, another world leader in distributed energy technology adoption. For more information about how to best integrate distributed energy technology into your energy system, network, business model, or operations, please contact us at one of our offices listed below.

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