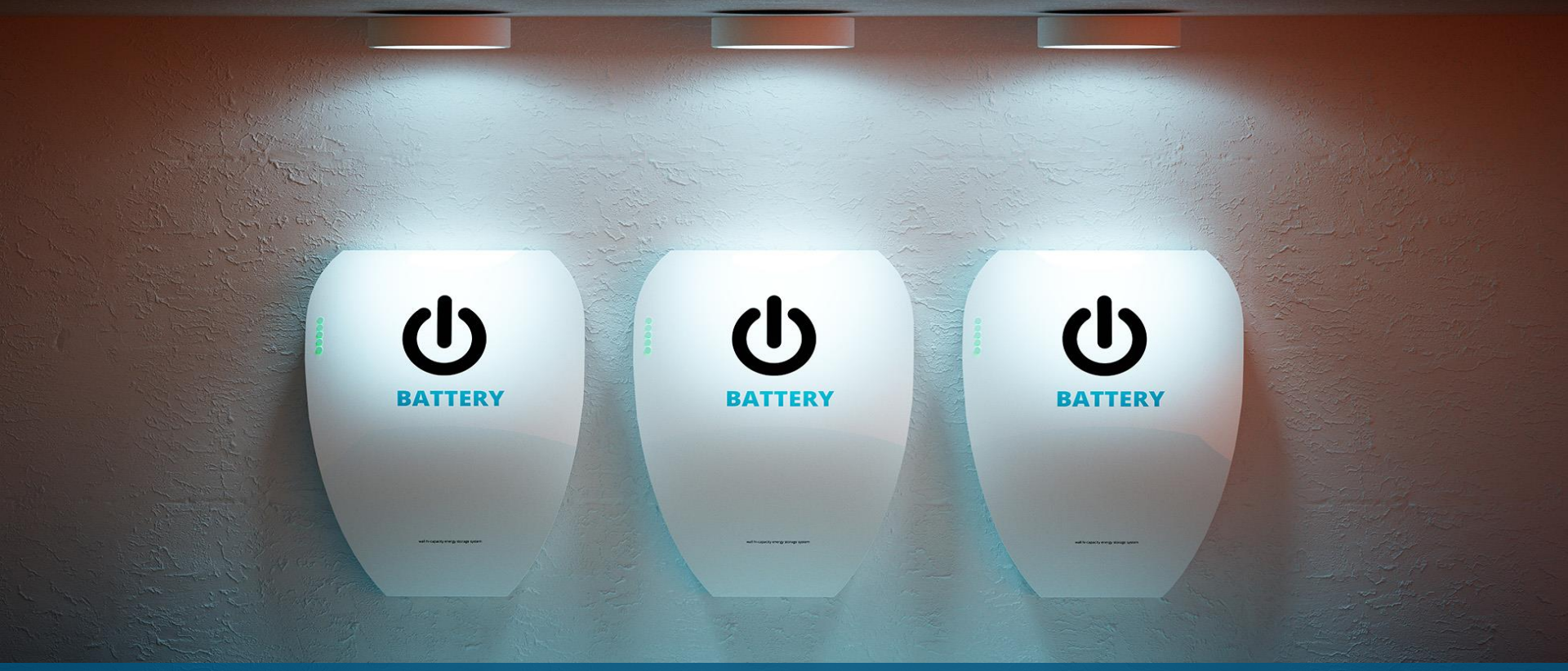


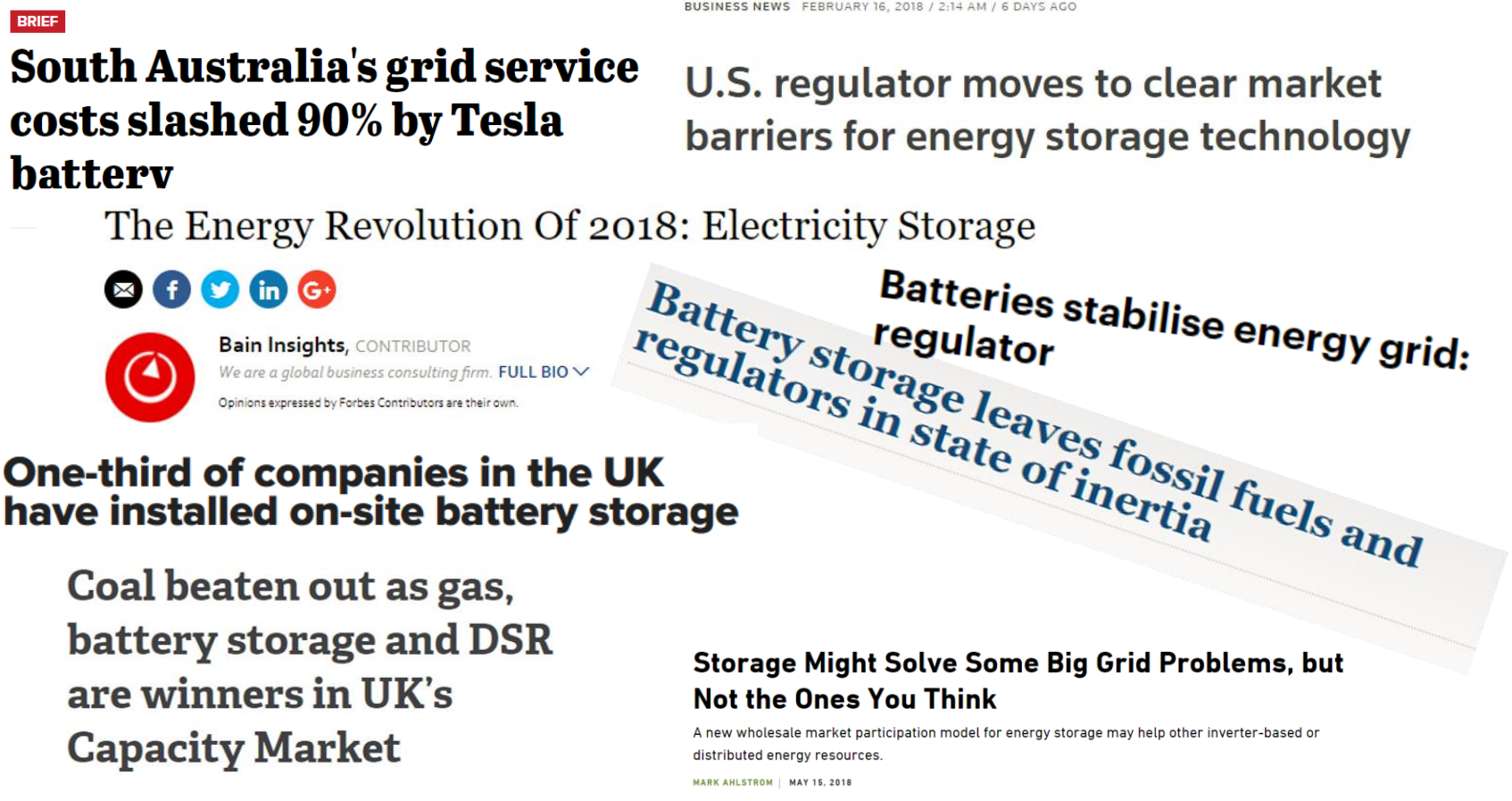
Opportunities for Battery Storage in Asia and Australia

The Lantau Group

July 2019

THE LANTAU GROUP

Early reports on storage continue making headlines…



BRIEF

South Australia's grid service costs slashed 90% by Tesla battery

BUSINESS NEWS FEBRUARY 16, 2018 / 2:14 AM / 6 DAYS AGO

U.S. regulator moves to clear market barriers for energy storage technology

The Energy Revolution Of 2018: Electricity Storage

Bain Insights, CONTRIBUTOR

We are a global business consulting firm. FULL BIO

Opinions expressed by Forbes Contributors are their own.

Batteries stabilise energy grid: regulator

Battery storage leaves fossil fuels and regulators in state of inertia

One-third of companies in the UK have installed on-site battery storage

Coal beaten out as gas, battery storage and DSR are winners in UK's Capacity Market

Storage Might Solve Some Big Grid Problems, but Not the Ones You Think

A new wholesale market participation model for energy storage may help other inverter-based or distributed energy resources.

MARK AHLSTROM | MAY 15, 2018

Duke Energy to Invest $500 Million in Battery Storage Over 15 Years

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2018 was branded early as the main theme for energy revolution

GE gas plant to close 20 years early, become battery storage site — sign of the times?

Phil Dzikiy - Jun. 24th 2019 10:59 am ET @phildzikiy

Initial H-class turbine with steam cooling (slow start and ramping). Operating in California, looses money as cannot serve as baseload and unfit for peaking/balancing

Energy Storage Will Be Big Business Soon

A new asset class is coming to the energy industry.

What's interesting is that the news is from an investor website, which means that storage trickled in to the financial markets as a potential investment opportunity

GlidePath Builds Merchant Battery Plant in ERCOT, Bucking Industry Wisdom

Quinbrook-backed developer makes a pure merchant play in Texas, where there's no playbook for storage to succeed.

10 MW/10 MWh geared for balancing and Ancillary Services. ERCOT is experiencing historically low margins, but given revisions to scarcity pricing mechanism has significant price spikes that can support economics for merchant player.

4 GW Walcha project moves forward, massive solar+battery component seeks approval

Includes Wind, Solar, Battery and Pumped Hydro. However, the batter element is only 100 MW /150 MWh and the dispatchability is expected to come from Pumped Hydro.

Climate Changed

A Giant Battery Is Planned to Balance the U.K. Power Grid

1 GW battery + recip engine system to provide baseload and balancing. Turns out UK now requires 1s response in frequency regulation market (e.g. PH requires 18s)

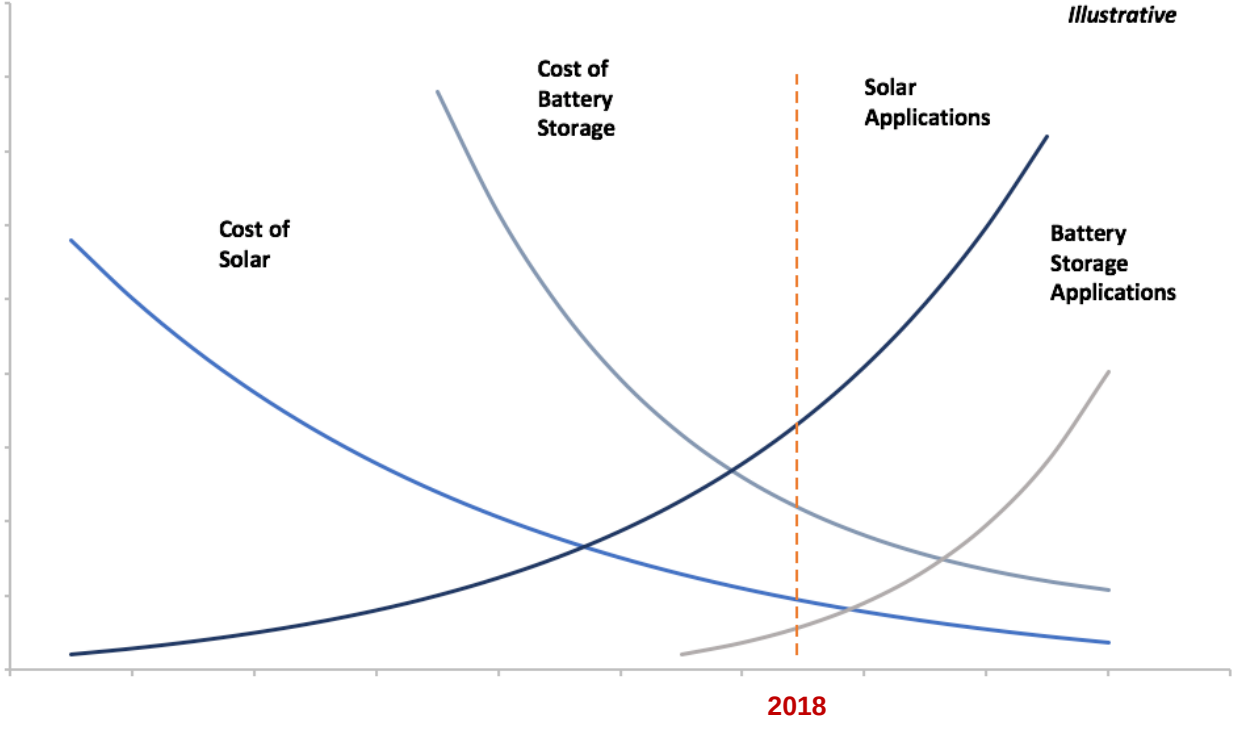
US energy storage market sees 232% year-on-year growth

Dynamics is changing from grid scale dominating in 2018 to BTM being main growth driver in 2019. California leads in BTM, while New Jersey, Arizona and Massachusetts are main grid scale deployers.
The UK market is expected to grow by 70% y-on-y

Arizona fire highlights challenges for energy storage

2019 appears to be cashing in on the momentum generated in 2018

Driven partially by improving economics



But also by demand side economics, regulations, and new business models

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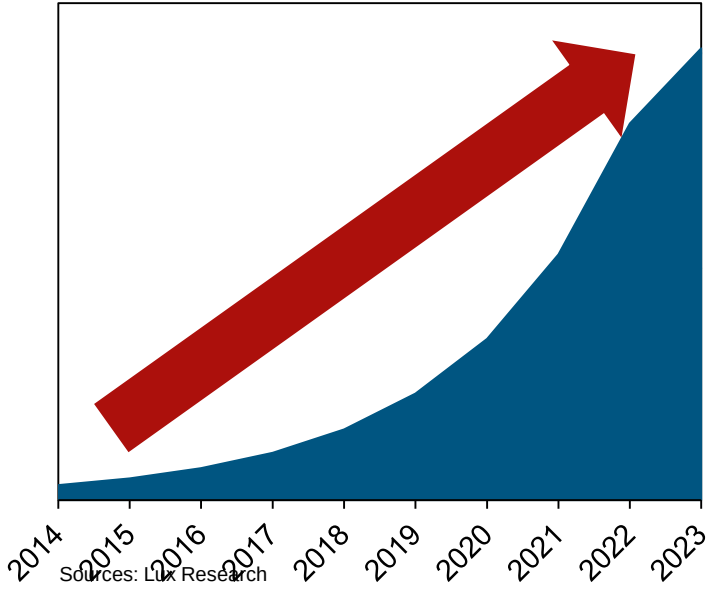
High expectations – but still at the early stage of growth in most Asian countries

Analysts see rapid growth and big impacts

- Core component of energy transformation
- Ability to make RE ubiquitous
- Peak reduction
- Bring energy to places without access
- Improving transmission systems
- Improving reliability
- Reducing energy bills

Energy Storage Revenue Growth



Sources: Lux Research

But this involves multiple applications, business models, locations, market structures and regulatory regimes
There isn't a single global strategy for battery storage adoption!

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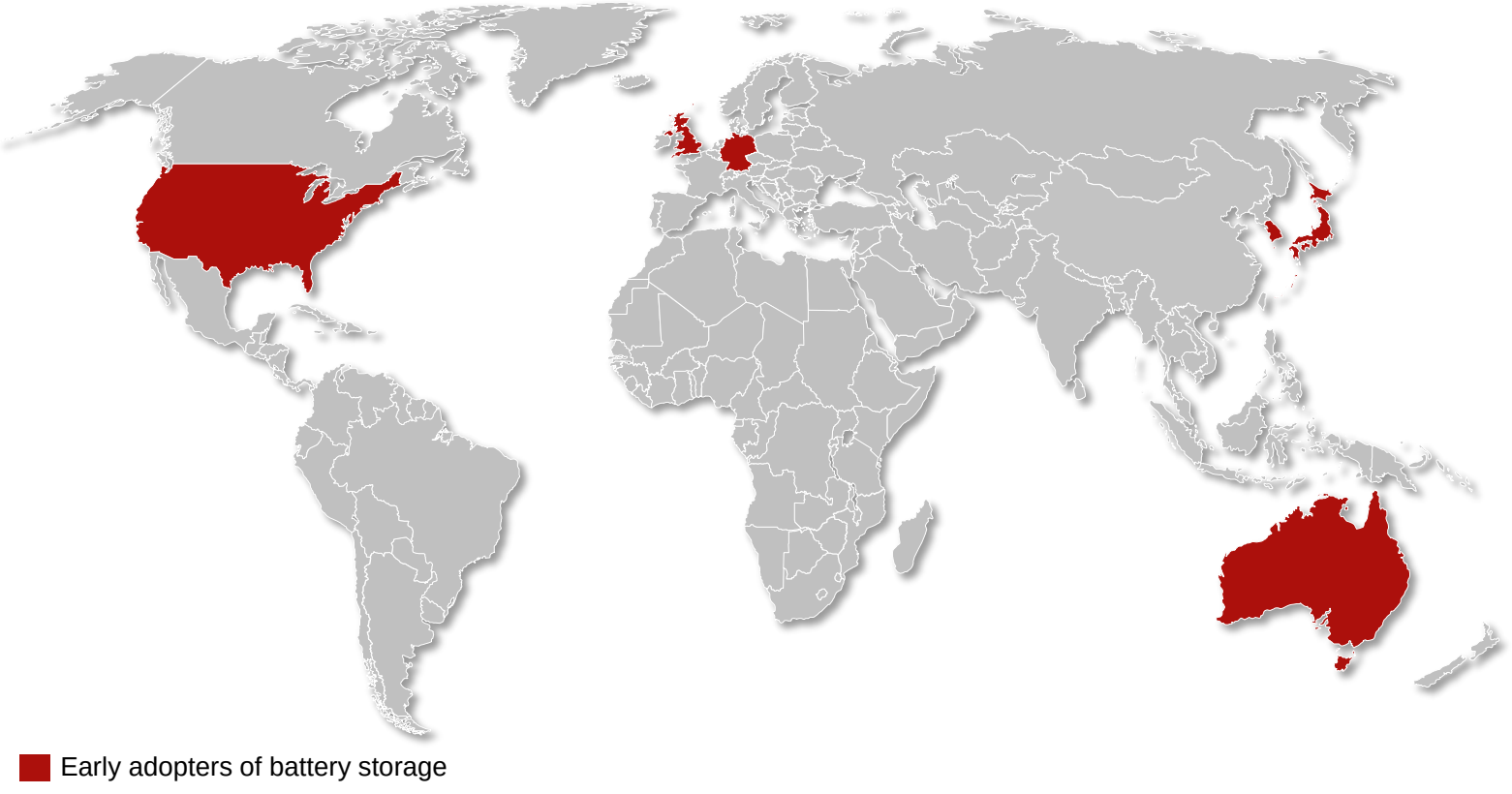
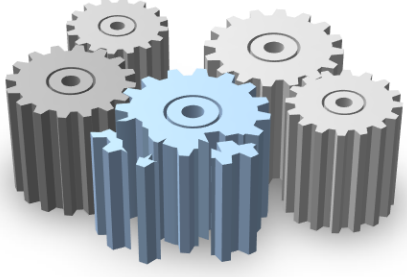
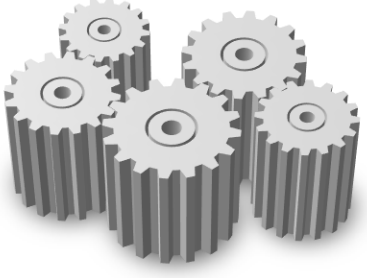
Energy storage deployment started in the US, Japan, Korea and Europe – countries developing storage technologies – while Australia has come on strong



Source: DOE Global Energy Storage Database

South East Asia is still in the early days of energy storage development





How will storage be deployed in Southeast Asia?

Battery storage means different things to different people

There is no *“one size fits all”*

There is no *“one battery fits all”* either

There are multiple commercial opportunities – many few commercial success stories (yet)

So let’s start at the beginning.

Energy Storage Applications & Business Models

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Battery storage does not operate in isolation

- Physically, batteries cannot operate without a supply and a demand for the power
  - “Solar plus storage”
  - “Utility storage”
  - “Micro-grid with storage”
- But commercially, they also make sense to be combined “with” something to make money
  - Renewables – to smooth out renewable generation
  - Markets – to provide ancillary services and arbitrage
  - Transmission lines – to open up new areas to renewables
  - Retail tariffs – to manage peak demand charges

Thinking about storage means thinking in multiple dimensions – physical and commercial arbitrage

The “Swiss army knife” of the power industry:

Energy storage is less a single business model than an array of valuable service that a battery can provide – understanding specific business models and revenue streams is crucial

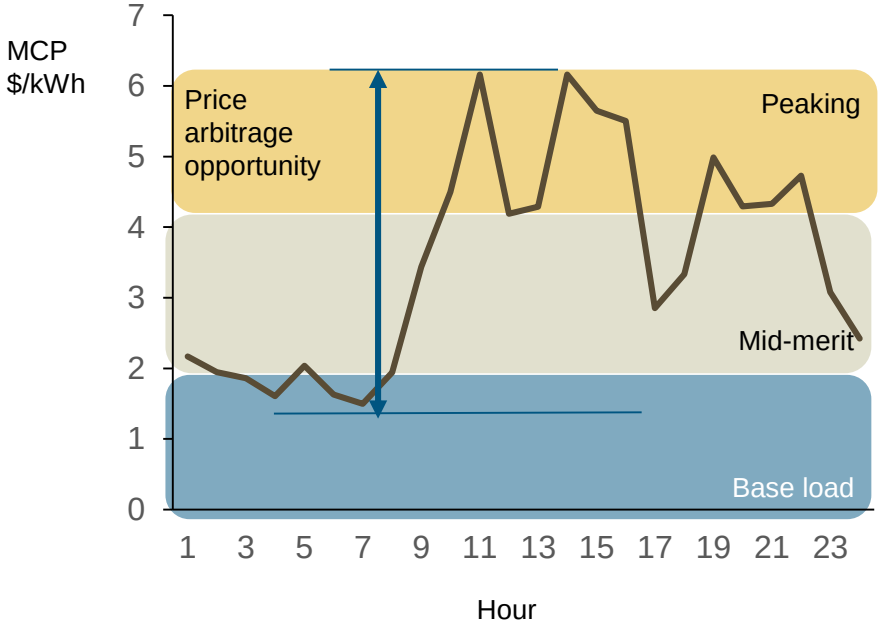
Ancillary Services	• The Philippines has the shortage of supply of AS, and NGCP’s (National Grid Corporation of the Philippines) mandate to sign new AS contracts. • Visayas is expected to have a growing need for AS, due to insufficient transmission capacity and solar penetration

BTM	• Behind-the-meter (BTM) applications for contestable consumers offers several advantages
	  • High retail tariffs relative to solar PV make solar shifting attractive
	  • Batteries enable demand charge reduction and other energy management
	  • Some revenue from arbitrage

Microgrids	• A significant portion of the population is off grid and pays high prices for electricity • Most off-grid areas in the Philippines use diesel generators to supply intermittent energy, there have been some recent projects to replace this with solar + storage with diesel back up • Batteries can support diesel optimization and increased RE usage
Grid-based batteries	• Grid-based batteries can provide a wide range of revenue earning services including arbitrage, RE management and transmission services and investment deferral • Philippines geography should further incentivize this
RE hybrid generators	• Much attention has been directed at combining RE and batteries to create baseload power • This doesn’t make sense in a FIT environment, where dispatch is already secure • Over time RE hybrid applications may have to compete against grid-based batteries

Energy Arbitrage

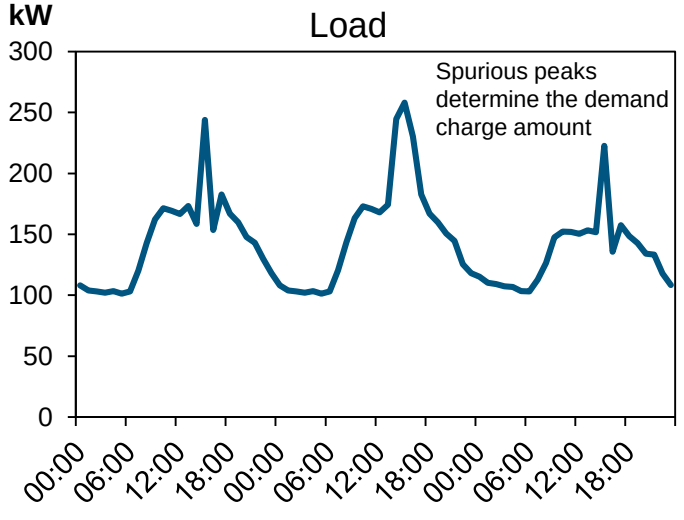
Energy Arbitrage



- Storage replaces the peaking capacity and improves utilization of baseload
- The steeper the merit order curve (highly peaky demand, e.g. due to hot and but short summer) the more value storage brings
- In the long term, the revenue opportunity for price arbitrage will tend towards the LRMC of storage
- Storage can also bring value to retailers by offering an ability to self balance offtake profile
- Energy arbitrage can also be executed at the retail level in case of time-of-use tariffs

Demand charges – a special case of arbitrage

Energy management/ Demand charges



Retail opportunity for storage

Demand charge management

Tariff = **highest instantaneous consumption** + total consumption

Time-of-use arbitrage

Tariff = peak consumption + off-peak consumption

Enables or Demand Side Management

Tariff = Consumption – DSM provision

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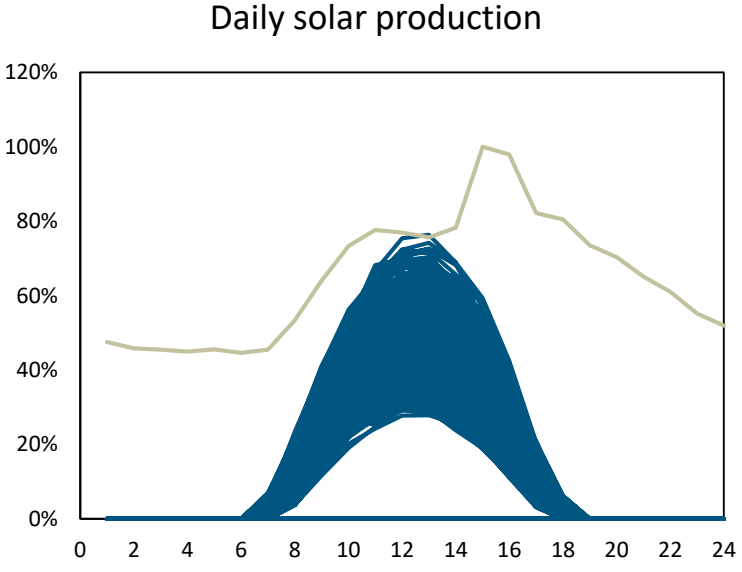
VRE integration

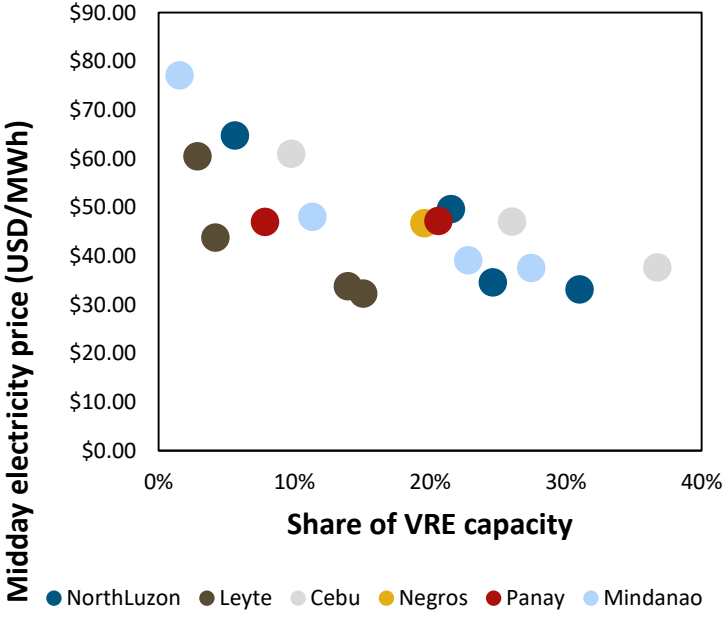
Variable Renewable Integration

- **Dispatchability**
- **System stability**

Lack of ability to dispatch VRE will lead to reducing profitability of VRE project of similar generation profile. Combining VRE with storage can give an opportunity to charge the storage at hours of high generation and dispatch during the hours of high price.

VRE is a source of additional supply-demand variability and as such it creates additional demand for Ancillary Services. Storage can reduce the output variability of VRE.





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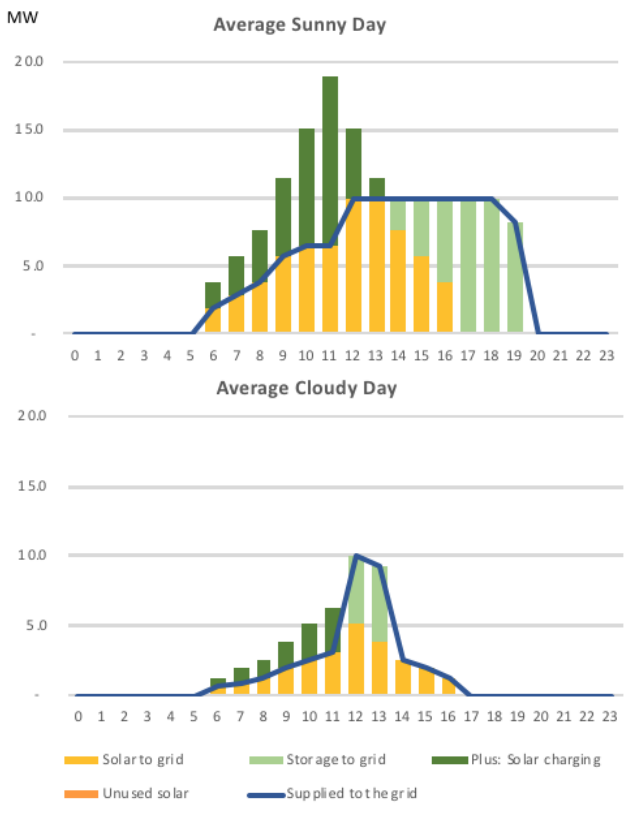
Combining solar and storage “behind the meter”



Solar PV has a set of characteristics that can make it extremely attractive for industrial facilities:

- Lower cost of electricity
- Can be a good match with peak demand
- Energy price hedge
- CSR and supplier criteria

And a set of drawbacks:

- Intermittent supply means it is not as effective in reducing the demand curve
- Solar PV application may have to be sized close to lowest match in demand profile

Energy storage can optimize solar PV, allowing:

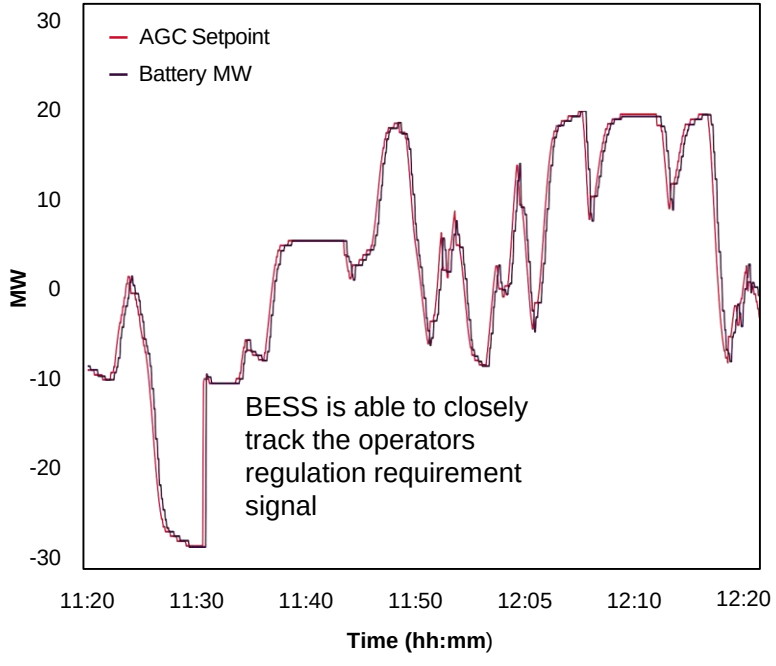
- A larger quantity of solar PV
- More efficient use of solar power

Ancillary Services

Ancillary Services

Grid Services that are needed to keep the power system safe and reliable

Battery Energy Storage



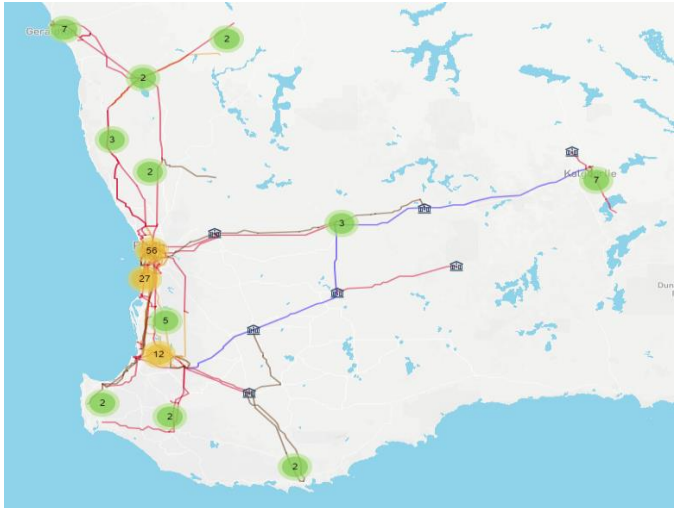
Growing penetration of the VRE creates additional demand for Ancillary Services to instantaneously match the supply and demand

The suitability of existing Ancillary Services technologies is being more and more put to test with increasing penetration of VRE

Storage technologies offer superior flexibility characteristics as compared to conventional Ancillary Services technologies, albeit such flexibility is currently not being remunerated

Network Augmentation

Network Augmentation



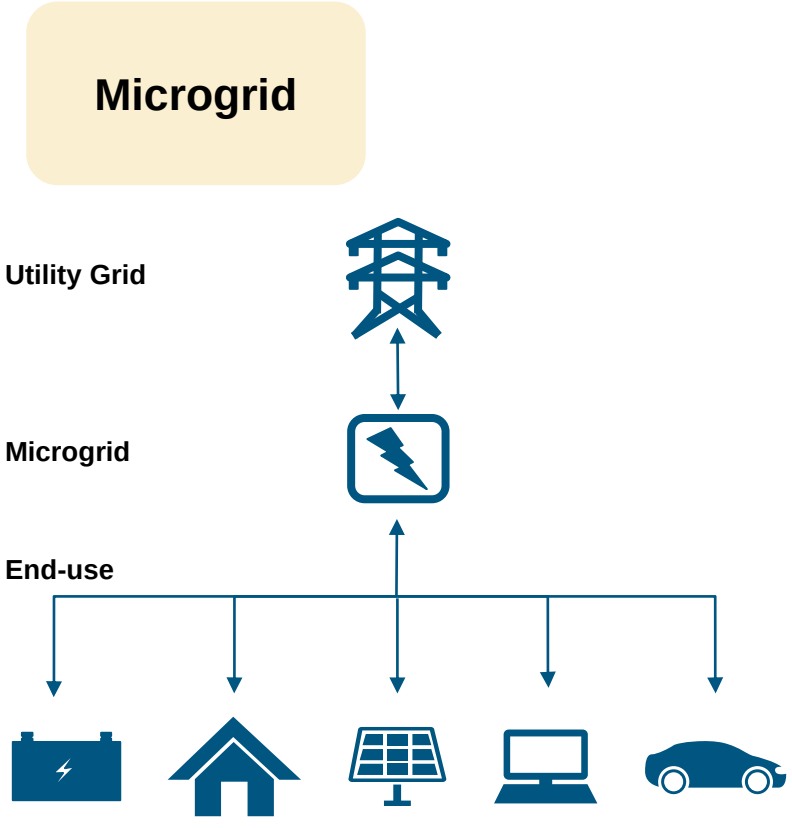
As the demand grows in radially connected load centers, the network throughput upgrades may be needed to serve the peak demand.

Often such upgrade may be deferred by strategic installation of the storage asset to unload the overloaded substation.

Strategically located storage can either supply peak demand downstream from the overloaded segment or shift the injection from VRE to a less congested time period.

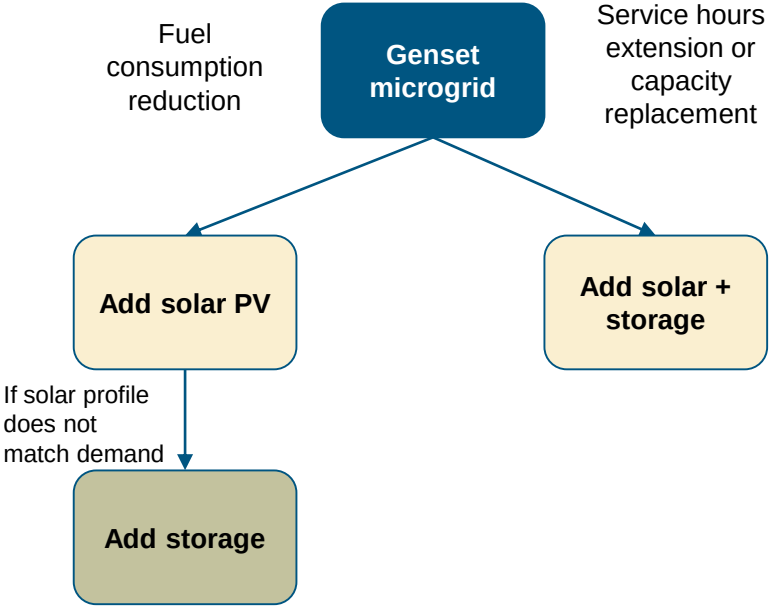
The values that storage captures here is the investment deferment and also smoothening out of interregional price spreads due to congestion.

Microgrids

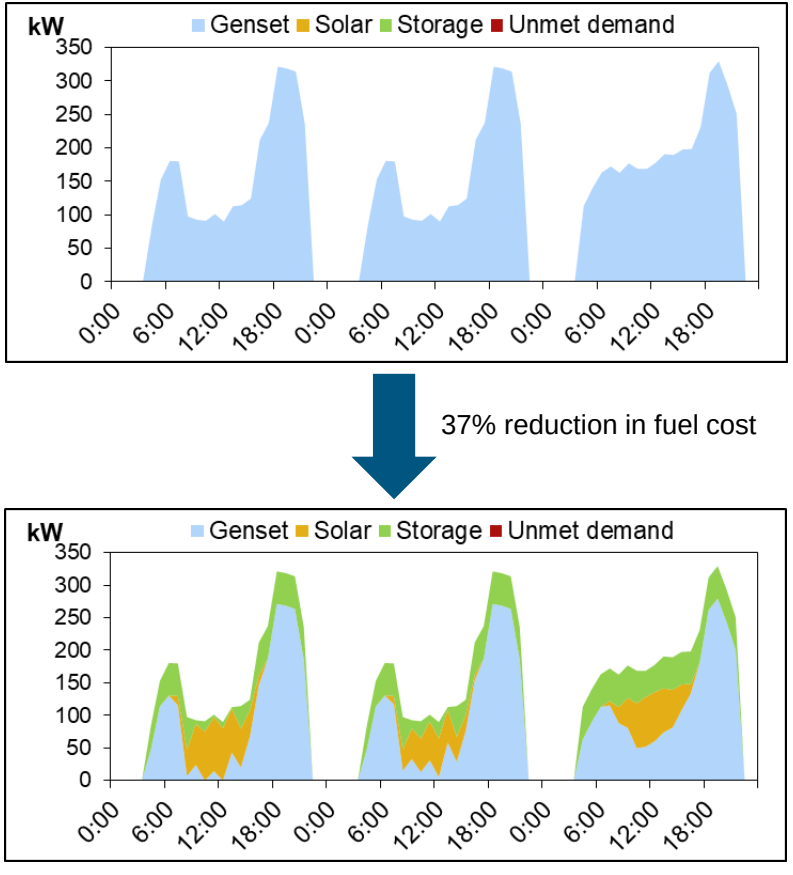


- Storage can be used in combination in small scale VRE to lower the aggregate LCOE of such system by tapping into low cost, but unreliable VRE supply.
- Additionally, storage can be used as an alternative to replacement of existing aged generating units.
- Opportunity for storage in the microgrid application is typically scattered and limited by the grid size, albeit strong economic fundamentals support the multiple adoption of storage in this type of applications globally.

How solar and storage adds value to the microgrid areas



Managing fuel supply chain is challenging in the remote areas. Furthermore, diversifying the supply options away from liquid fuel improves the resiliency of the remote communities.



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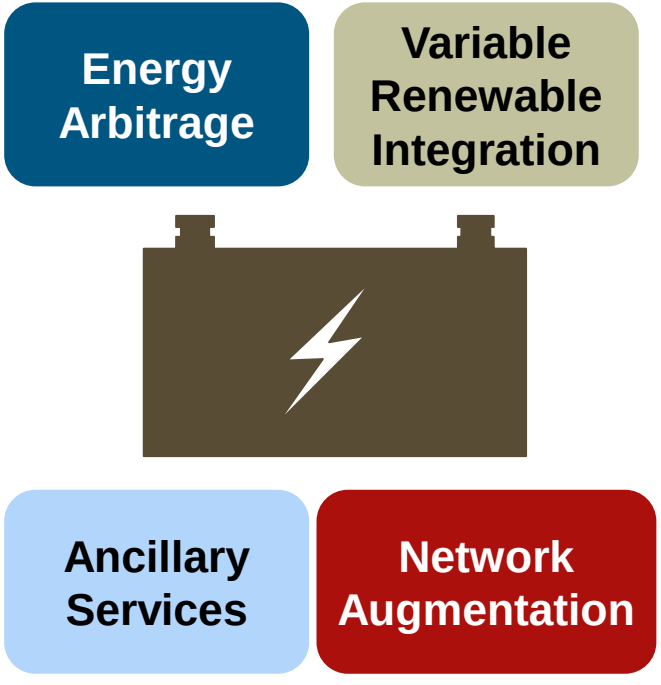
Stacking services

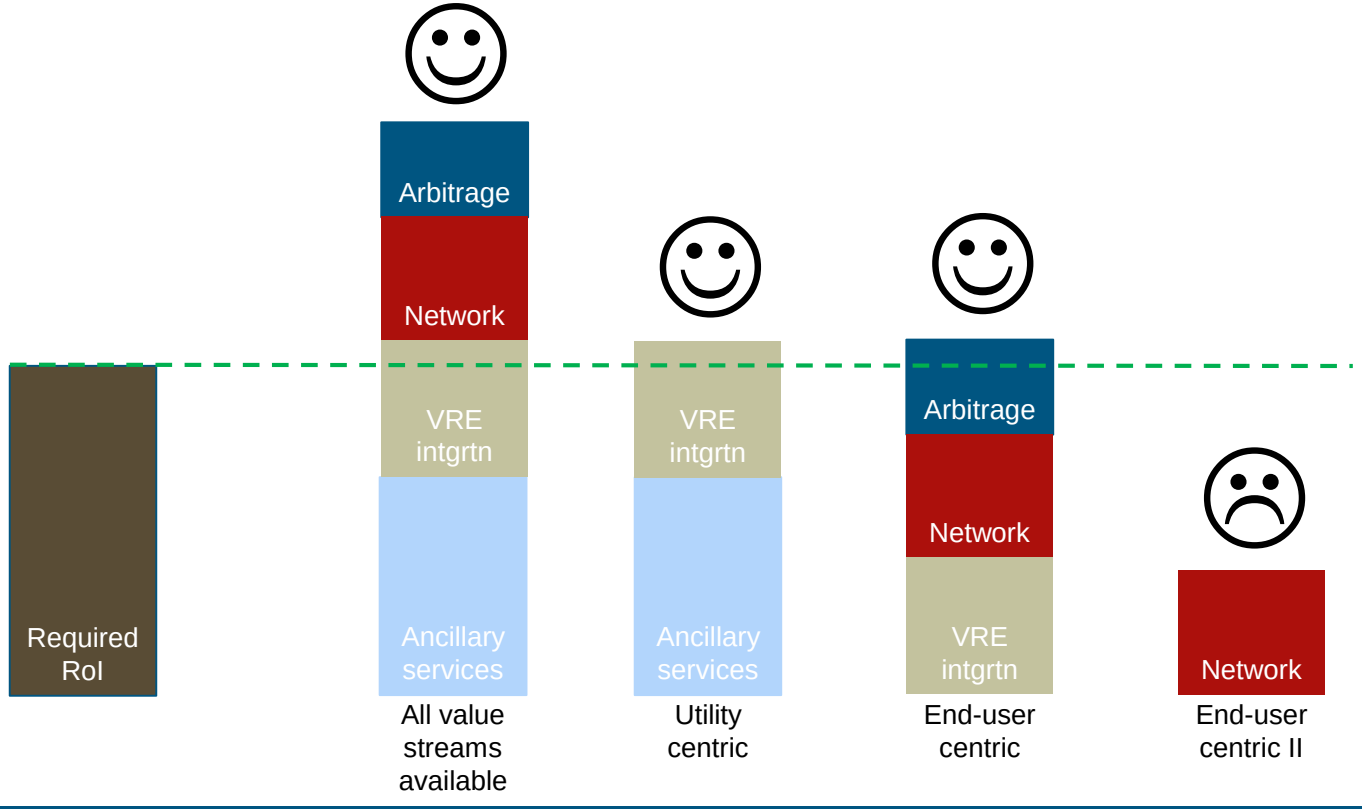


Storage devices have an ability to **supply multiple services at the same time**, the microgrid application is a perfect example of combining several of the value streams in one.

Combining multiple value streams helps **strengthen the business case** of storage project while at the same time offering a risk management tool based on **revenue source diversification**.

Australia is currently a key country in the region where service stackability is being tested.

“STACKABILITY” of energy storage



Maximizing the realizable value of energy storage requires finding “use cases” where multiple value sources are compatible

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How to find opportunity for storage ?

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Four “lenses” framework

- **Drivers**
  - RE penetration
  - Power quality
  - Grid topology
- **Policy & Regulations (enabler or barrier?)**
  - Is storage allowed to participate?
  - What market segments are there for storage to participate?
- **Commercial enablers and barriers**
  - Tariff structure & contestability
  - Wholesale/AS market spreads
- **Competitive landscape**
  - Are there any assets or plans?
  - Who are the competitors?

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Mapping these lenses to issues allows us to answer key questions

Regulatory overview	Temporal price spreads	Are there any grid locations with oversized storage	Existing ESS
Market structure	Availability of low cost charging, spare RE energy	Penetration of RE behind the meter	Planned ESS
Can storage participate?	Looming demand for additional AS	Is the local community open to invest in storage	Are these pilot plants or commercial plants?
Is storage recognized as separate asset type?	High out-of-solar-hour peak	How well is the grid integrated?	Who are the technology providers/operators?
How does storage operator pays for grid usage?			

Example: Australia is one of the few markets with a strong bottom up interest in the storage technologies combined with the strong fundamentals

Regulatory

- Australia's states have various regulations pertaining participation of storage in the energy market. While Eastern states were allowing storage participation in the market for a while already Western Australia only recently changed its regulation.
- Storage can participate in wholesale as well as Ancillary Service markets
- Storage can be used by grid operators in whole Australia to improve power quality in remote locations
- Australia has two power markets, WEM and NEM. NEM is bigger energy only market, while WEM is smaller energy + capacity market
- WEM is looking to co-optimise AS with energy, while this is already done in NEM

Commercial

- Australia has a significant market opportunity in the wholesale and retail price arbitrage with the wholesale price spread in some locations reaching 90 AUD/MWh while some of the customers opt in for ToU tariff with significant price differential forming an interesting opportunity for bill management and price arbitrage
- Likewise, regulatory change with ancillary services is leading to more refined definitions of Ancillary Service and likely unprecedented market niche for storage
- Flawed design of FiT for residential customers resulted in significant amount of end-user with solar overcapacity not being compensated for their grid exports, thus creating ESS opportunity
- Some States such as Victoria are giving subsidies to households to install batteries – also driving growth

Drivers

- Australia enjoys high penetration of renewable energy driven largely by positive outlook of local community but also by impact investors
- This high penetration of RE combined with thinly laid out electric grid poses significant challenges for managing variability in the grid and thus creating demand for ESS technologies, either stabilising the output from RE or providing AS
- Multiple remote habitats are potentially cheaper to supply as microgrids than by long radial grid expansion thus creating opportunity for ESS
- Across multiple offgrid areas in the Australia's outback the mining industry is a noteworthy potential user of the ESS

Competitors

- Australia has by far the largest number of storage assets installed and under construction with diverse portfolio of competitors including the conglomerates like Samsung, Siemens, Tesla, AES, etc.
- A quick scan of recent additions reveals about 450 MW of existing and planned capacity with ~1000 MWh of storage playing multiple roles from energy arbitrage, AS provision (frequency and contingency) to grid strain relief and technology testing
- South Australia and Victoria are the major states for capacity additions.
- ARENA provided funding for majority of the early installations with the newer installation tapping into traditional funding sources

In many aspects Australia leads the adoption race of battery storage

- Besides being a home to largely successful (in terms of marketing and market effects) Hornsdale Reserve – the largest battery storage in the world, Australia has a number of other battery storage implementations ranging from behind-the-meter (VPP and solar-storage systems), through utility scale (Hornsdale) and network management (Dalrymple Battery Storage) to hybrid micro-grid applications (Western Australia's Horizon Power and mines).
- Most of these projects are being developed driven by economics:
  - Lower supply cost in remote areas, especially mining applications;
  - Ability to dispatch intermittent solar/wind at higher price periods;
  - Avoidance of energy spillage form BTM solar in case no NEM is available.
- However, there also is a strong support from the government to subsidise these projects:
  - Hornsdale Reserve is being paid a lump sump each year for "reserve services", justified by inability to properly price supplied services in the existing market environment;
  - Governments in most of the Australian states developed some form of support either via subsidy grants (up to 6000 AUD) or interest free loans for solar+storage systems (Victoria, New South Wales, Queensland & South Australia) or through underwriting virtual power plant testing (Western Australia & South Australia) or by supporting edge-of-the grid improvements (Western Australia, & Northern Territories)

Similar to Australia, the bottom up demand for storage is obvious in the Philippines, but with developing country issues

Regulatory

- Exact regulatory treatment of energy storage has not been determined yet. The DOE issued a draft circular in August 2018 requesting the ERC to address key issues pertaining to cost recovery mechanism, pricing structure and delivery charges, etc.
- All energy is dispatched through an 'energy only' spot market (WESM) including contracted plants with PSAs
- Ancillary services are procured by the transmission system operator NGCP, though plans exist for regulating and contingency reserves to be co-optimized with energy in the WESM (delayed by NGCP inaction)
- ERC recently approved a battery Ancillary Services Procurement Agreement application between Advancion (AES subsidiary) and NGCP

Commercial

- Price arbitrage opportunities persist in Visayas where daytime prices are depressed by solar penetration, while evening peak is at times met by expensive diesel gensets
- However, low market price caps in the WESM dampen the value of storage and peaking services
- There is an acute shortage of ancillary services particularly in Visayas, where some forms of reserve are outsourced to Luzon.
- Despite existence of the NEM program with some of the retailers, the 100 kW cap and bureaucratic difficulties play in hand of ESS

Drivers

- The development of RE in the Philippines has been promoted via policy instruments introduced by the RE Act (2008) including the FIT, net-metering of RE, Renewable Portfolio Standard (RPS), Renewable Energy Market (REM) and RE Certificates, among others
- The FIT led to a short term thrust in RE development, but future RE investments will likely benefit from the proposed 35% target energy mix envisaged in the RPS
- Localised solar penetration with limited transmission capacity (in Visayas) and slow transmission development may present opportunities for energy storage application
- Small islands and offgrid areas, which traditionally relied on expensive diesel generators with unreliable fuel supplies, are ripe for RE and storage deployment though offtaker credit risk will be high and dealing with the incumbent NPC Small Power Utilities Group for off-grid regions is known to be difficult
- Multiple storage plants are potential competitors for ESS in provision of AS

Competitors

- There is a limited number of operational storage projects along with many proposed ones in the Philippines, with the largest existing project being the 10MW Masinloc energy storage project by Advancion (AES).
- Solar Philippines, the largest solar developer in the Philippines, has an existing 2MW solar, 2MWh and 2MW diesel-back-up microgrid project in Paluan, Mindoro
- Other proposed projects exist by players such as Aboitiz, Marubeni, Sonnen, and Silay Global Energy Solutions
- Solar Home Systems are being piloted in numerous remote sites as an alternative to the expansion of the distribution grid

Low electricity tariffs, modest RE penetration and a lack of clarity over energy storage regulations or policies means the opportunity for batteries is highly uncertain in Malaysia

Regulatory

- Peninsular Malaysia and Sabah are subject to national energy supply laws and are regulated by ST, whilst Sarawak has its own energy laws and regulator
- PPAs/SLAs between TNB and IPPs remain the status quo, but the introduction of NEDA (New Electricity Dispatch Arrangement) has provided a mechanism for generators to offer capacity on a merchant basis.
- The need for new generation capacity is assessed by ST, and procured via competitive tenders by the Single Buyer
- There appears to be no specific regulations for battery energy storage in Malaysia yet

Commercial

- Electricity tariffs in Malaysia, among the lowest in the region, will remain low for domestic consumers as the new administration recently announced subsidies to shield them from the rising fuel costs.
- Ancillary services, which are procured under PPAs/SLAs and dispatched by the GSO (Grid System Operator), may offer a possible opportunity for energy storage, but there are no known precedents (of using battery technology in Malaysia) so there is considerable uncertainty as to how it is viewed by ST, Single Buyer and the GS

Drivers

- The level of RE penetration in Malaysia is still modest, with about 358MW of grid-connected PV as of 2017
- Solar PV development in Peninsular Malaysia and Sabah is supported by Large Scale Solar (LSS) and Net Energy Metering (NEM) programmes, which have quotas of 1,000MW and 500MW respectively
- There are planned transmission augmentations projects in Peninsular Malaysia to relieve system constraints
- RE policy in Sarawak, which experience high levels of precipitation, is more focused on hydro. Sarawak's heavy reliance on hydro would indicate that there is limited scope of other forms of storage
- Albeit microgrid application in remote regions of Sarawak and Sabah could be potentially interesting

Competitors

- The Secretary-General of the Ministry of Energy revealed in 2015 that discussions were underway to implement a national energy storage system, but there have been few signs of progress from the Government
- Some private sector collaborations have been announced such as the tie-up between Cypark Resources Bhd with the German 21st Century Clean Energy GmbH & Co, and Sunway Berhad of Malaysia with Comtec Solar Systems Group of China.

Singapore is a price example of a top down approach to the energy market, with the demand for ESS driven and managed by the government authorities

Regulatory

- Singapore allows ESS participation in the wholesale market
- Singapore is the most advanced energy/ancillary services market in the SEA including the electricity futures trading
- Singapore is trailing full contestability in the Jurong region and is planning to expand island-wide
- Some of the retailers also own ESS
- Local grid operator/SOLR is considering investing in storage under regulatory sandbox
- EMA granted two grants to RES to procure and testbed energy storage in Singapore

Commercial

- Singapore is at the verge of opening up full retail contestability with a pilot program run in the Jurong island
- Retail offers to contestable markets are of two types, flat tariff or NEMS-indexed tariff with ceiling and floor price
- Present tariff structure offer limited opportunity for storage
- The NEMS has a flat merit order curve dominated by gas units, albeit there is significant market power being exercised leading to occasional price peaks that could be arbitraged by a storage operator
- NEMS situation can be summarised as unhealthy thus hinting to expected market changes that may increase market volatility

Drivers

- Singapore is a fairly compact power system with a few outlying islands depending on diesel generators
- The main grid has one of the highest reliability standard
- There is limited penetration of renewable energy with some CSR projects (including SolarNova) pushing for the adoption of the rooftop solar panels
- The country targets capacity of 1 GW post 2020, albeit is not on track of trajectory to meet this target anytime before 2035

Competitors

- Two storage projects are currently being commissioned in Singapore, the CW Group lithium ion battery and Red Dot Power's vanadium flow battery (4.4 MW/4.4 MWh)
- The companies owning the assets received grants for test bedding the technology from the EMA. The assets are to be operational through the end of 2022.
- The companies are also RES, albeit without any generation assets thus offering energy supply solely based on wholesale market trading and storage.
- Suppliers include Wartsilla and Younicos

Thailand's storage potential is limited by regulatory regime and relatively small sophistication in retail tariff pricing

Regulatory

- Enhanced single buyer electricity market structure does not enable easy access to the grid
- Policy-makers currently making substantial revisions to national Power Development Plan
- Proposed net-metering scheme could compete with storage
- High potential for distribution reforms that would allow greater ability for corporate users to buy RE across the grid
- Completed PPA award program for firm renewable energy, which favored biomass based generation, but could be a platform for a future RE hybrid PPA program

Commercial

- Relatively low electricity costs, demand charges and peak-off peak spreads, making storage variability difficult
- Looming large LNG dependency has the potential to substantially increase electricity costs
- Although rooftop solar PV is less expensive then retail power
- Utility-scale is not substantially less expensive than conventional generation, making an RE-hybrid program unlikely
- Existing RE generators have uncertain supply profile thus forming issues as PPAs require predictable supply

Drivers

- Centralized market and extensive grid provide access to almost all users and adequate power quality to industry
- Largest quantity of installed variable RE is SEAsia with almost 3MW of utility scale and a rapidly growing rooftop
- Intermittent RE generation regarded as a problem by utilities
- Demand charge and sophisticated metering applied to large subset of industry
- No off-grid or micro-grid opportunities

Competitors

- EGAT is currently installing three grid-based battery pilot projects, two of which are designed to manage grid impacts of RE. The third provides access to a remote province, but is unlikely to be replicable
- Current energy plans emphasize technology, including storage – although this is largely aspirational
- EGAT mandated not to compete with private sector
- Capable local industry with domestic and international RE assets

As solar subsidies fade away in Japan, storage is increasingly seen as a way to keep the solar boom alive

- Japan started its FiT program for solar in 2009 and subsequently increased the rates in the wake of Fukushima disaster to further spur the growth of the sector
- Around 50 GW of yet-to-develop solar plants are racing to get their network connection agreement signed by 2020 in order to qualify for the old FiT level. In case of failure to do so, the subsidy falls to 0.19 USD/kWh.
- Adding to this, the initial FiT signed in 2009 are starting to roll-off post 2019, creating additional demand from residential consumers to consume their overgeneration with help of storage rather than feed to the grid at a much lower rate.
- Japan is also home to the biggest battery in Asia (also developed by Tesla), however the battery's role is to back up the railway traction in case of an emergency.
- Another "biggest" is also coming to Japan, Mitsubishi is expected to deliver a 240 MW/720 MWh storage system to a substation in Hokkaido. The role of the battery is to reinforce the grid to allow more wind generation from the region. The battery is expected to be operation in Q2 2023.

Innovation unlocking new opportunities

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Storage technology is evolving, with it new opportunities are unlocked

Existing	Commercialization	Demonstration	Demonstration
Lead acid batteries • The first batteries that were commercially applied in the power and mobility sectors	**Lithium Ion batteries** • Lithium Ion batteries were a technology developed for mobile applications like gadgets and cars, however, due to the price declines achieved by popularity of the gadgets and cars projected this technology interesting for applications in the power sector (which had another technology, NaS, developed for it)	**Flow batteries** • Lithium Ion batteries have two main limitations, rendering them less useful for some applications in the power market, these are autonomy limited to 2-4 hours and thermal management issues. • Flow batteries are overcoming those issues by allowing longer autonomy times and easier thermal management	**Hydrogen/Hydro** • Hydro is the most establish form of energy storage in the power system, however is limited by the site availability. Hydro allows seasonal storage and autonomy going into days or weeks, similar features can be achieved with hydrogen energy storage
Microgrid	Microgrid	Microgrid	Microgrid
Ancillary Services	Ancillary Services	Ancillary Services	Ancillary Services
RE firming	RE firming	RE firming	RE firming
Capacity Markets	Peaking Power	Peaking Power	Peaking Power
Peaking Power	Arbitrage/balancing	Arbitrage/balancing	Arbitrage/balancing
Seasonal storage	Network Services	Network Services	Network Services
Security of supply	Capacity Markets	Capacity Markets	Capacity Markets
Arbitrage/balancing	Seasonal storage	Seasonal storage	Seasonal storage
Network Services	Security of supply	Security of supply	Security of supply

AT WHAT COST??

For a more detailed analysis of specific opportunities, we use our battery model

Key results metrics

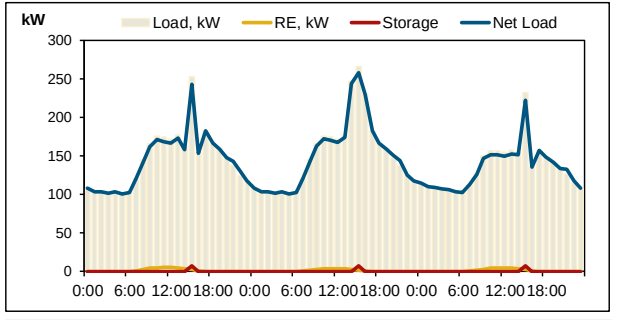
TLG's Time-frame Capacity Factor Model (The Philippines)

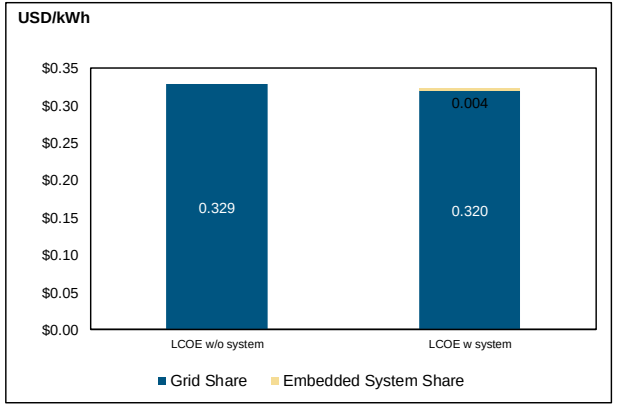
Inputs

Technical inputs		
Solar PV power rating	10	kW
Number of battery packs	10	
Storage capacity	20.00	kWh
Storage power rating	7.20	kW
Capex inputs		
Battery Cell Capex	$210.00	USD/kWh
Battery BoS Capex	$615.00	USD/kW
Battery Total Capex	$431.40	USD/kWh
Solar PV Capex	$850.00	USD/kW
Opex		
Battery Opex	$2.10	USD/kWh
Solar PV Opex	$63.75	USD/kWh
Electricity tariffs		
Tariff escalation	5.00%	
Years to escalate prices	25	
General		
Peak demand	200	kW
Senstivity (what if scenarios)		
Net Metering Limit	100	kW
Net Metering Rate	$0.10	USD/kWh
Demand Charge Multiplier	2	

Summary Results

Returns		
IRR	27.10%	
NPV	$29,243.56	$
Payback period	0.37	Years
Investment		
Investment costs	$21,402.27	$
Total O&M costs	$6,342.62	$
Peak demand and charges		
Peak - without system	297.34	kW
Peak - with system	286.80	kW
Charge - without system	$73,888.48	$/yr
Charge - with system	$70,939.60	$/yr
Electricity charges		
Reduced demand charges	$44,093.24	$
Reduced usage charges	$29,063.08	$
Total O&M costs	-$6,342.62	$
NEM income	$0.00	$
Total net savings	$66,813.70	$
Resulting electricity prices		
LCOE - without system	$0.329	USD/kWh
LCOE - with system	$0.325	USD/kWh
LCOE reduction	1.39%	





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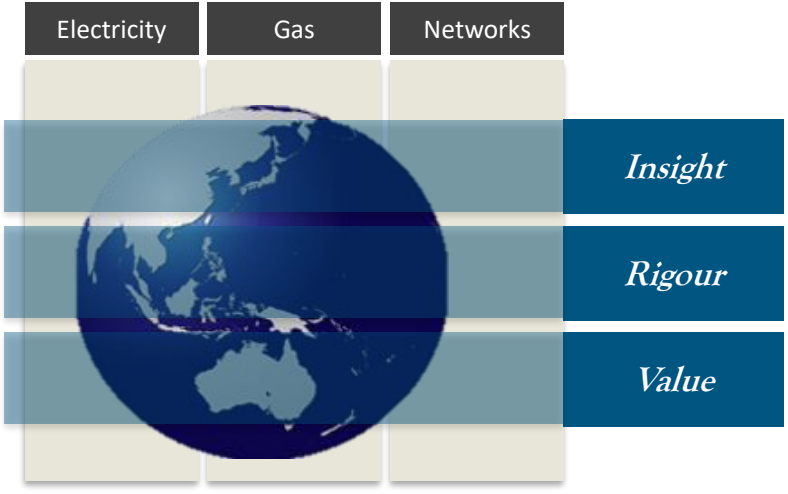

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