Era of Battery Storage

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Storage is increasingly in the news…

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

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Battery storage leaves fossil fuels and regulators in state of inertia

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

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Electricity storage is not new – pumped storage has a very long history – so why is it news today?

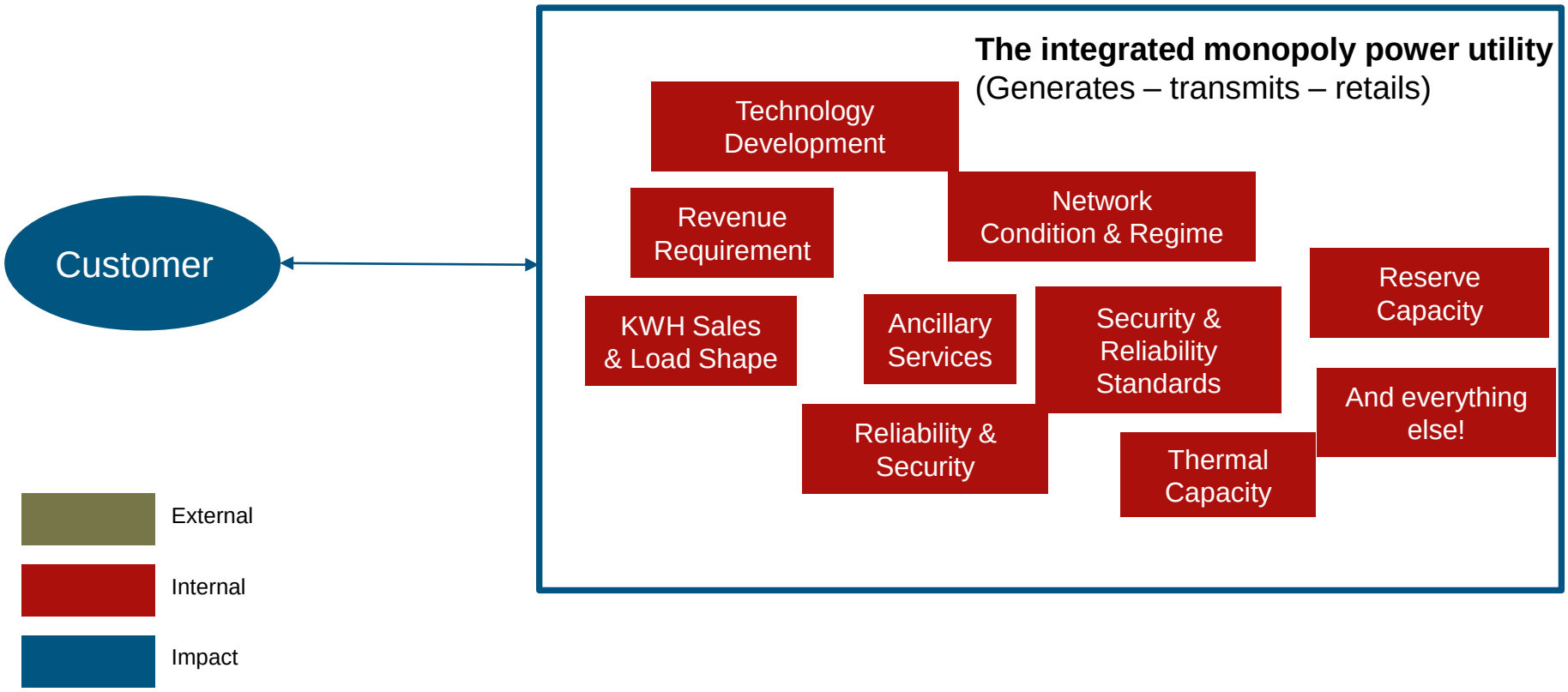
- Changing generation technology with falling generation costs
  - New storage technologies
  - New renewable generation technologies that have more synergies with storage

- Changing digital technology
  - Tech is now cool! (I-phone, Tesla Powerwall)
  - Faster computer chips and more bandwidth = more possibilities
  - Block-chain is enabling new kinds of transactions
  - Apps that allow customers to see real-time demand, power costs

- Changing market, policy and consumer environment
  - Increasingly aware of impact on environment
  - Policies to introduce openness, choice and competition in electricity

The rise of the "pro-sumer"

Power Systems used to be simple



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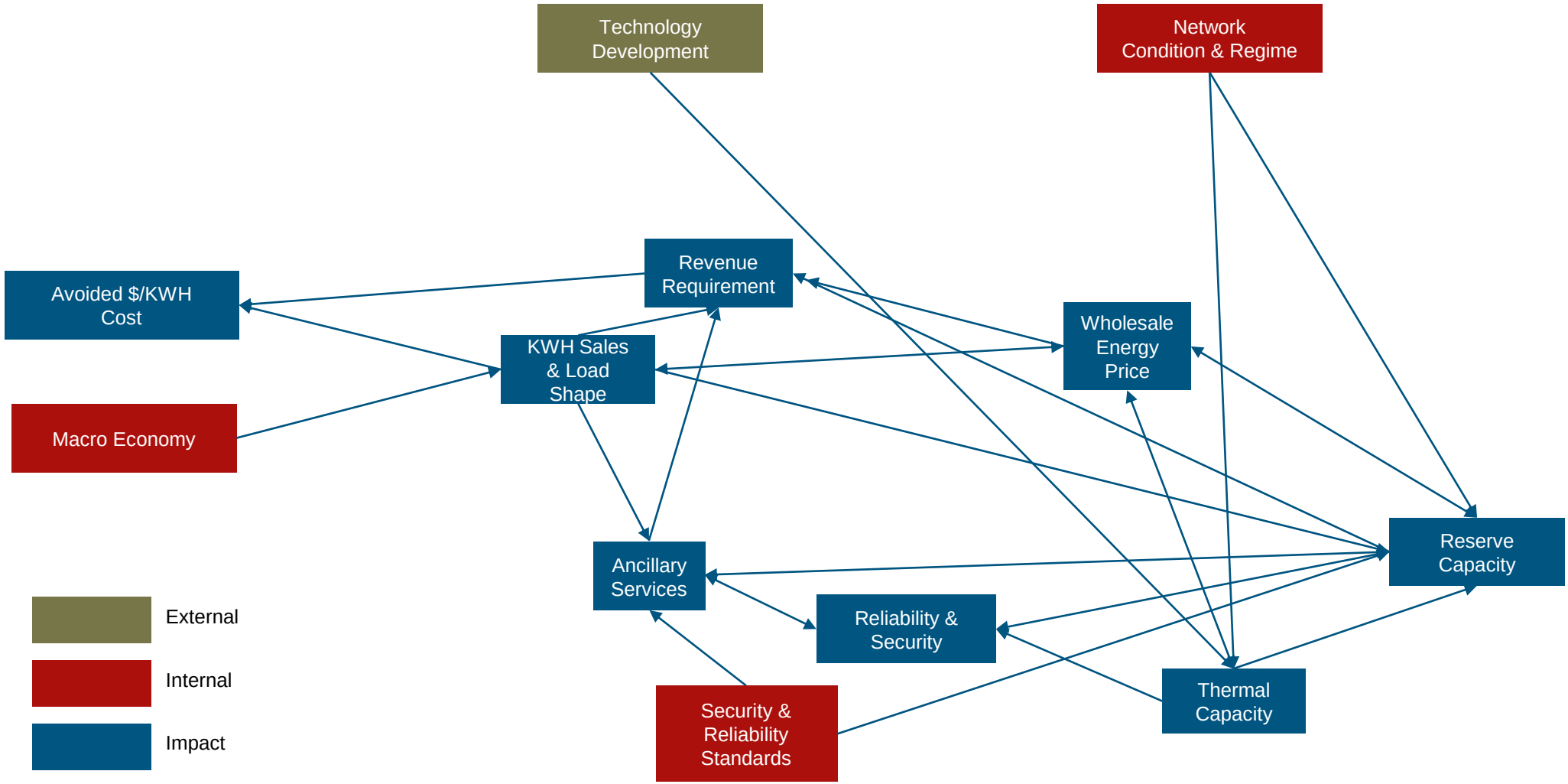
And then we started understanding and dissecting the different parts of the supply chain and the interactions between parts of it



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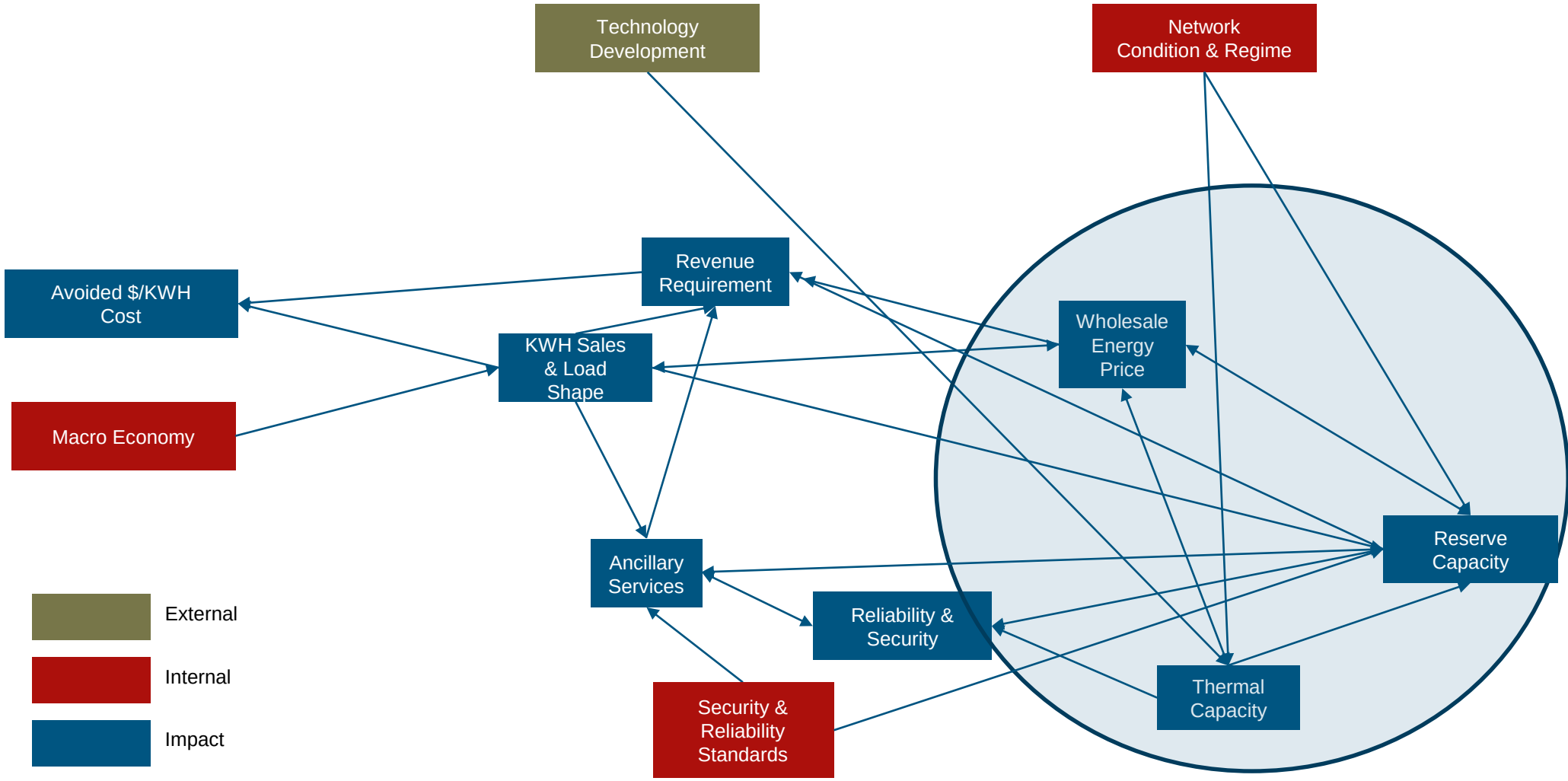
And then we separated out parts of the industry into “markets” and “regulatory” areas



A Simple Market!

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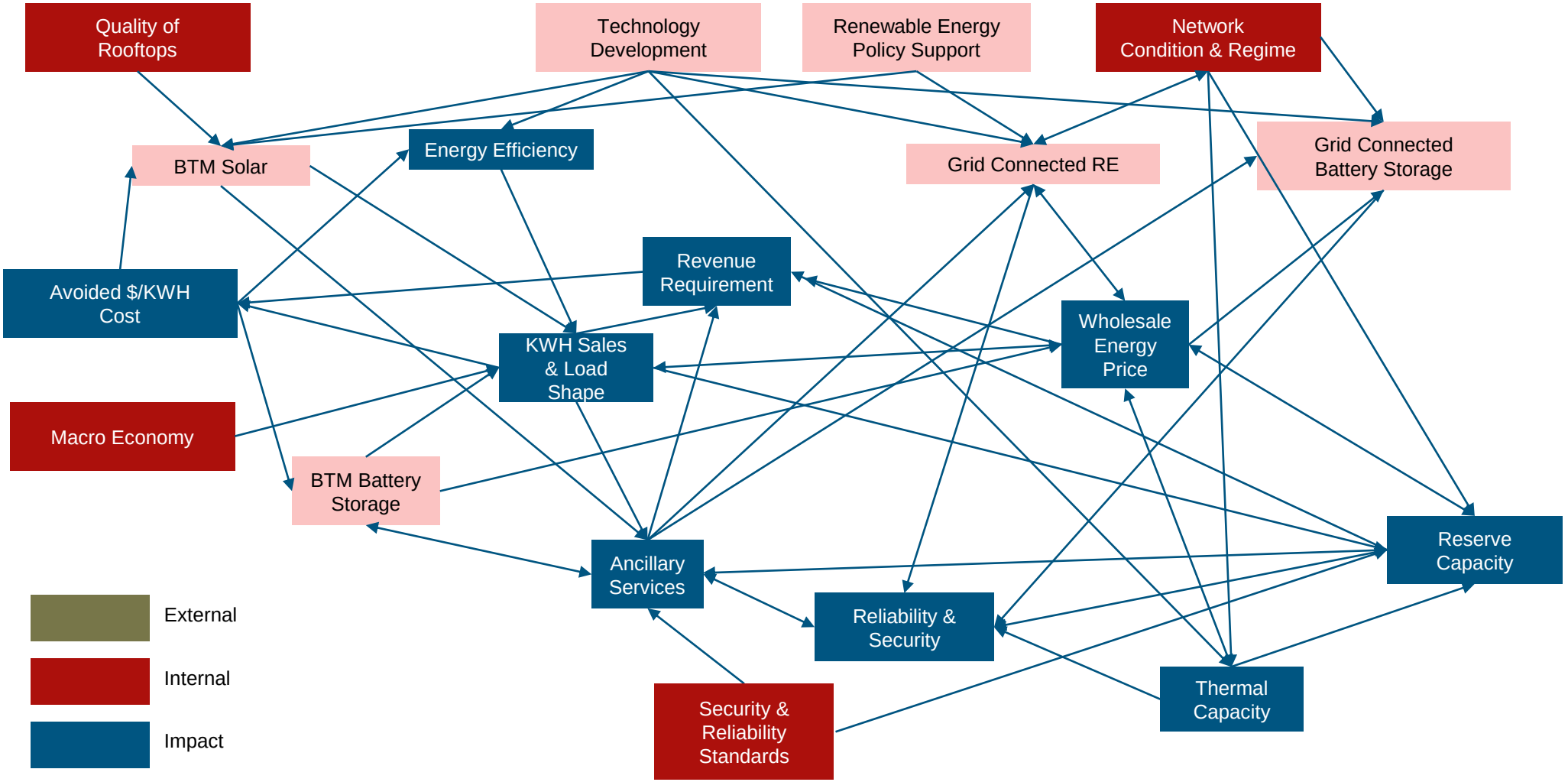
And then technology developments and policy changes made it more complex



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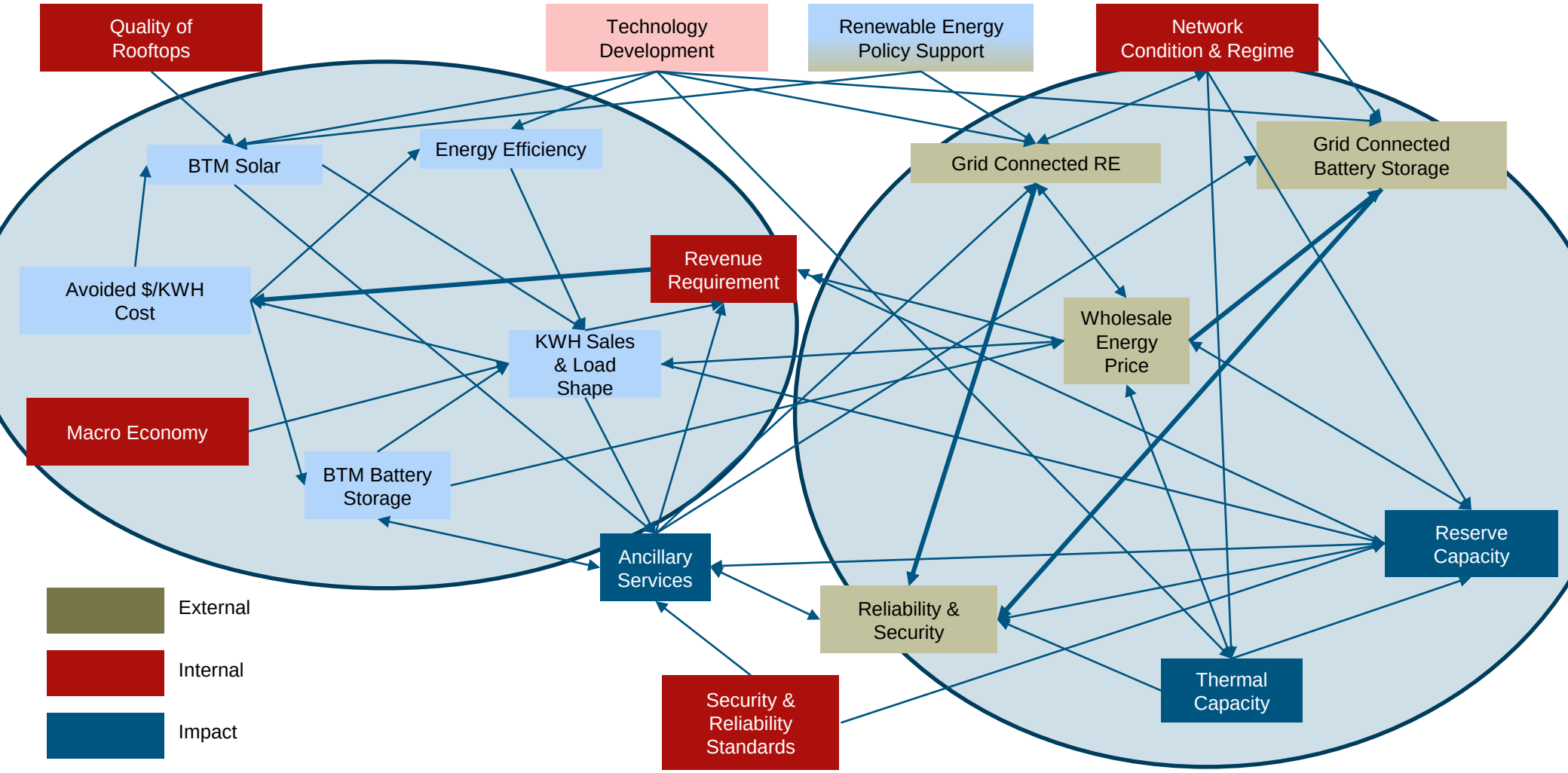
And new markets emerge – utility-scale and behind-the-meter



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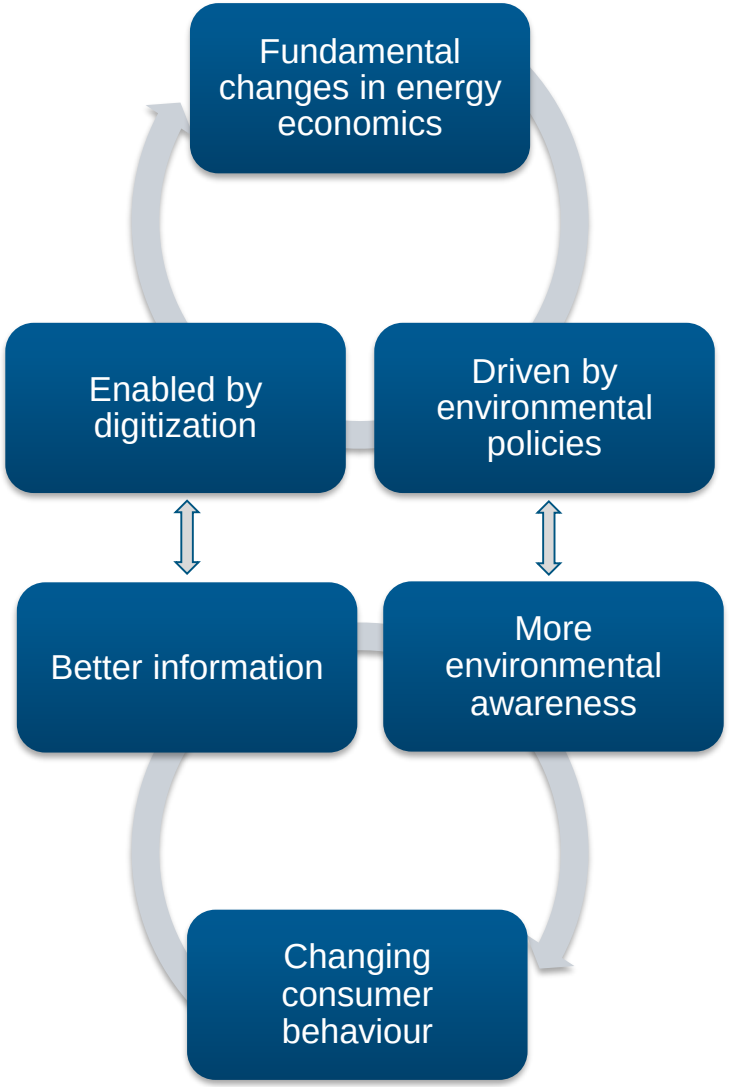
In summary, storage is just one part of the energy revolution



And it's not getting any simpler!

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So lets start with some simple definitions

Two of the primary uses or storage are **Energy** supply and **Power** supply. What do we mean by that?

Energy supply

When is it worth to store energy rather than not produce it?

Power supply

So far…

SUPPLY = DEMAND

While, with storage…

SUPPLY ≠ DEMAND

What is the value of such flexibility ?

Different storage technologies meet different needs

ENERGY

- Pumped hydro
- Compressed air storage
- Flow battery storage
- Synthetic gas storage

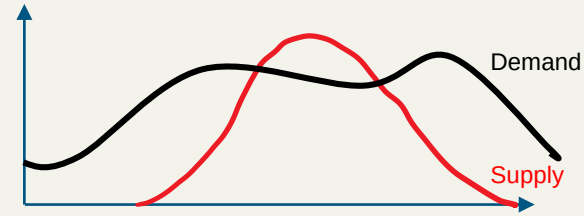
- Load shifting
- Strategic storage
- Arbitrage

- Ancillary Services
- Reliability
- System Security

- Flywheels
- Supercapacitors
- Superconducting magnetic storage
- Solid state battery storage

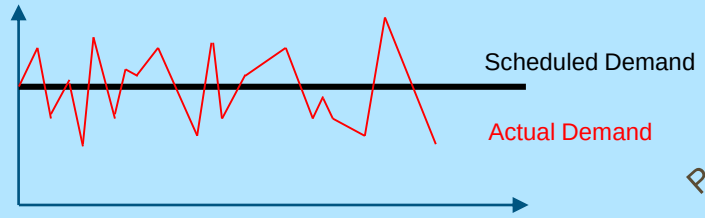
POWER

Storage value streams can require energy, power or a mixture of both



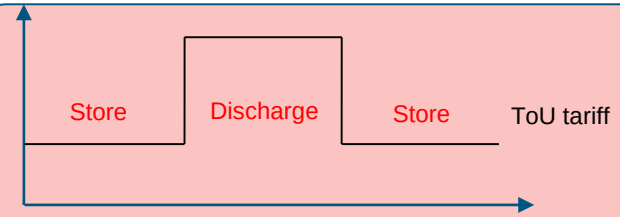
Mixture –depends on the shape of the contract

In the Philippines, PSAs typically require energy to come from a specific plant. Adding a storage plant may increase value of variable generator by firming up its output



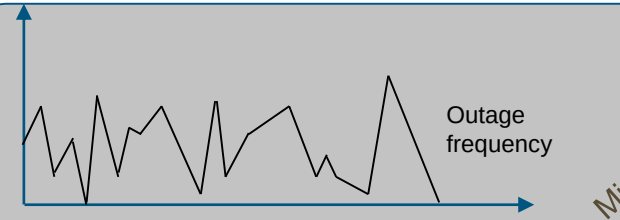
Primarily Power

Many jurisdictions allow storage for Ancillary Services. Characteristics of storage allow it to be particularly responsive for frequency regulation – matching very short term fluctuations in supply and demand



Primarily Energy

If price signals are available to end-user to adjust his consumption battery storage may be used for effective arbitrage of price signals (the classic use of pumped-storage) E.g. Time of use tariff or tariff with high demand charges



Mixture –depends on the shape of the generation and demand

In off-grid areas, battery storage may provide significant improvement to the power quality at competitive cost to other small-scale solutions (such as diesel) or to firm up renewables

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But to capture the value streams, the right commercial and regulatory mechanisms need to exist

- Combining solar plants with battery plants in the Philippines is a function of the regulatory desire for power contracts to reflect actual plant costs – it's not consistent with a market based approach
- Ancillary service definitions need to allow for more flexible definitions of storage - pumped storage already supplies significant ancillary services in the Philippines, why not batteries which can do much the same?
- Arbitrage of price signals requires those signals to shine through:
  - The very low market price caps in the WESM dampen the value of all peaking services
  - The lack of encouragement of tariffs that reflect actual time-of-use costs removes incentives from consumers to react to different prices in real time
- In off-grid areas, increased understanding by local EC's and SPUG of the advantages of hybrid technologies could result in significantly more renewable penetration, more batteries and more importantly – higher power quality and lower price for consumers!
  - But barriers exist and the process remains hard.

Currently in the Philippines most projects are delayed or only in proposal stage

- 10 MW Masinloc energy storage project (AES) – stand alone (ERC approval delayed)
- 40 MW Kabankalan energy storage project (AES) – stand alone (delayed)
- 30 MW Negros energy storage project (Silay Global Energy Solutions) – solar colocation (proposed)
- 8 MWh Mindoro micro-grid storage (Solar Philippines) – solar colocation (off-grid)
- 50 MWh Tarlac energy storage project (Solar Philippines) – solar colocation (proposed)
- 50 – 80 MW behind-the-meter energy storage (Sonnen + Natural Solar) – distributed storage (potential)

Source: Press releases

But internationally we see clarity of regulations has helped to underpin storage activity

California's big battery experiment: a turning point for energy storage?

- Mandated amount of storage to be procured by utilities for security of supply

German Energy Storage Market to Reach $1B by 2021

GTM Research's latest report provides a roadmap for one of the world's most successful storage markets.

- Introducing storage regulation in the EU's "Winter Package"

ENERGY STORAGE

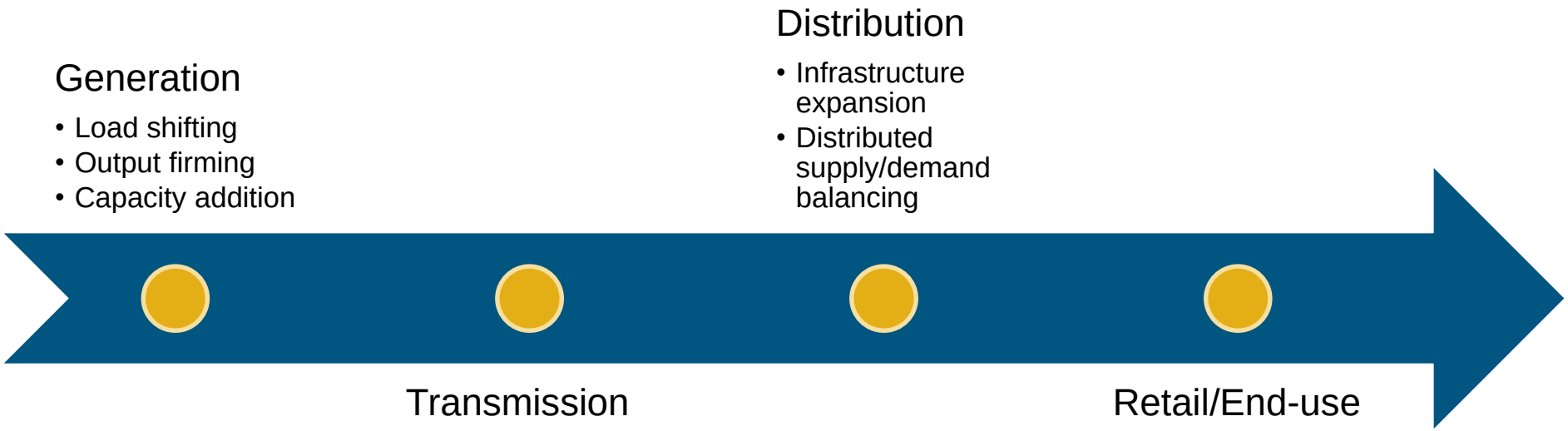
The UK Could Install 12 Gigawatts of Energy Storage by 2021

- One of the first countries to regulate storage

Here's How Australia is Leading the Energy Storage Revolution

- Supports behind-the-meter developments
- Seeks to regulate storage

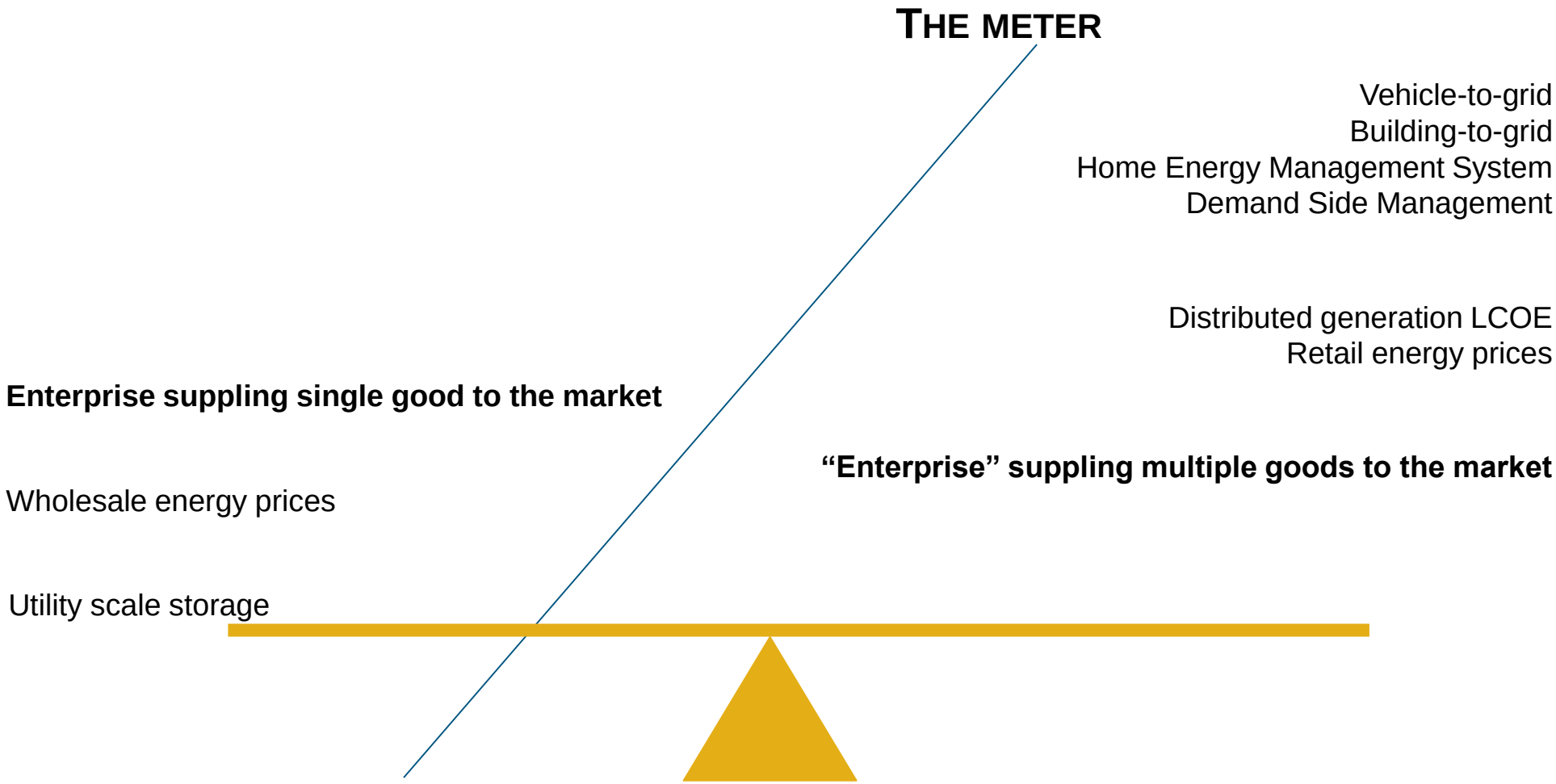
One of the issues that needs to be address is:
Can a storage facility provide multiple services at once and lower its costs?



- In theory, storage can provide multiple services at once
- However, reliability requirements and provisions enacted to set-up power market may require physical unbundling of services provided by a single facility
- Locational demand for some services may be the technical reason for such limitation

Regulatory developments hint that utility-scale storage facilities may be required to provide single service only – but the jury is still out

The other key issue is:
Should storage be utility scale or behind-the-meter?



Which side will the scale tip?

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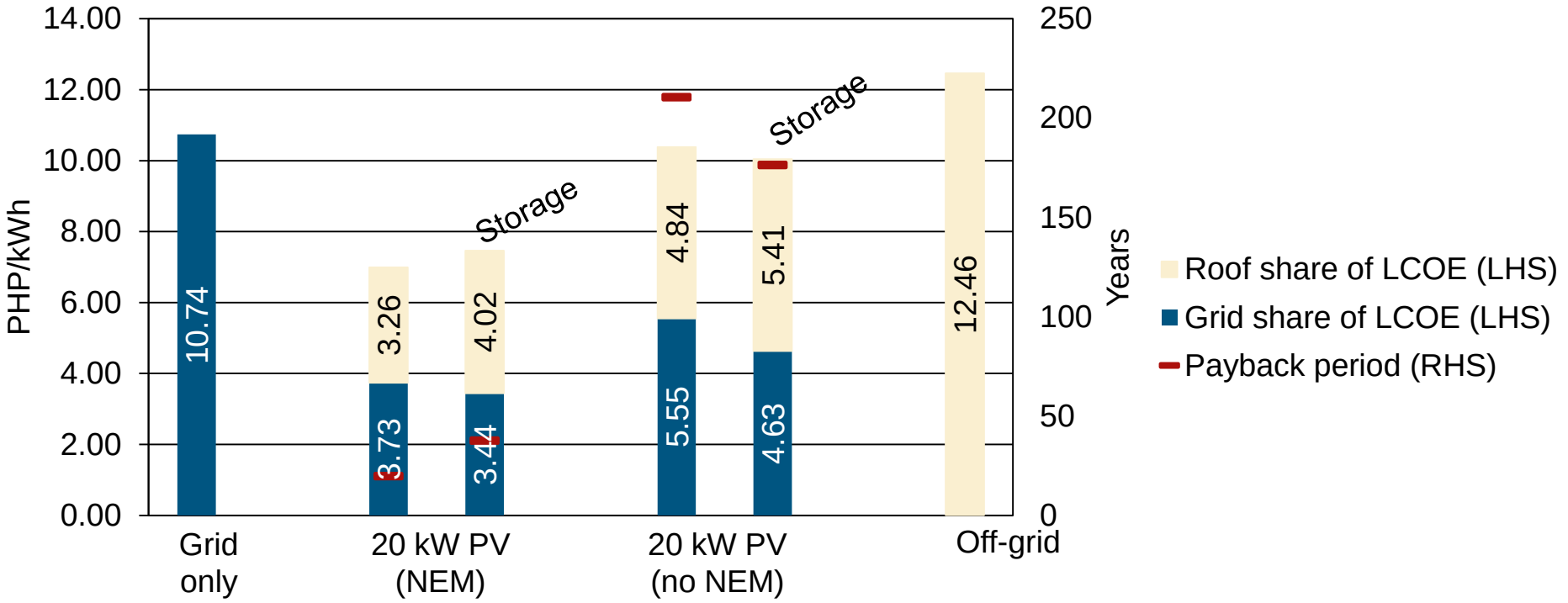
Economics of behind-the-meter storage



Source: TLG TFCF Model

Presently, limited business case exists for storage behind the meter

Based on Merlaco's GSA tariff, 5 kW peak and 1285 kWh/m consumption
850 $/kW PV and 200 $/kWh Storage, USD/PHP = 0.02
Assuming NEM credits

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But sometimes it not just about the economics

- With a net metering limitation of 100kW, some customers see storage as the solution to improving the economics of a larger scale roof-top solar solution, particularly if they have non-day time load
- And with net metering paying back only average generation charges, a storage solution gives access to “whole of tariff” benefits for customers with a single variable tariff
- But also… with storage you don’t have to deal with the local DU!
  - Avoid the charges associated with net metering?
  - Avoid the hassle of getting an impact study done?
  - (But get the electrical wiring right, or you end up being metered for the solar you produce rather than the lack of grid consumption!)

Many of the above drivers are not necessarily sensible or stable – driven by regulatory choices or retailer behaviour

Impact of behind-the-meter storage on the utility business

In some cases when rates are designed to recover fixed costs through volumetric charges, storage + solar may hinder the revenue collection of the utility.

Battery storage is particularly appealing if a customer has high demand charges and low-to-medium load factor. However, in multiple cases, such demand charges can be effectively reduced with PV (as often the demand is weather correlated).

With proper rate design and value reflecting pricing, storage behind the meter can lower the overall system costs… poorly designed, it adds to them

Will the future be behind-the-meter?

- Storage installed behind-the-meter offers yet another chance to experiment with demand response.
- Thus far the DR programs failed largely due to political troublesomeness, lack of firm response and inconvenience to end-users.
- Differing between energy supply and power supply may help better managing the implementation of storage behind-the-meter.
- Power supply is more costly to supply from demand side, however, behind-the-meter storage makes it possible.
- Energy supply from demand response works without storage, e.g. ice battery, nest, pumping, smelting, etc.

"*They can because they think they can*"
- Virgil, 70 BC

Despite behind-the-meter developments appear more economic on paper, most action happens on utility-scale (with notable exception of Australia)

Why do we need storage in the long term?

- One of the unmentioned benefits of storage is that it enables low-emission technologies, like solar and wind to increase their share in generation mix.

- At average capacity factor of 20% for solar, this technology can hardly contribute more than 20% of energy without storage if current status quo of consuming energy is to be preserved.

- Significant overbuild of low-CF capacity and development of “energy” storage technologies is needed to allow significant share of energy to come from low CF sources.

- Sample calculation. If 1 MW of technology A has CF of 20% to supply 1 MW of firm output 5 MW of technology A need to be installed paired with storage able to absorb 4 MW of excess generation and enough capacity to supply 1 MW for 80% of the time horizon (19.2 MWh). In cost perspective, technology A (plus 4MW/19.2 MWh of storage) must be more than 5 times cheaper (per kW) than conventional source in order to be able to supply 100% of the energy needs.

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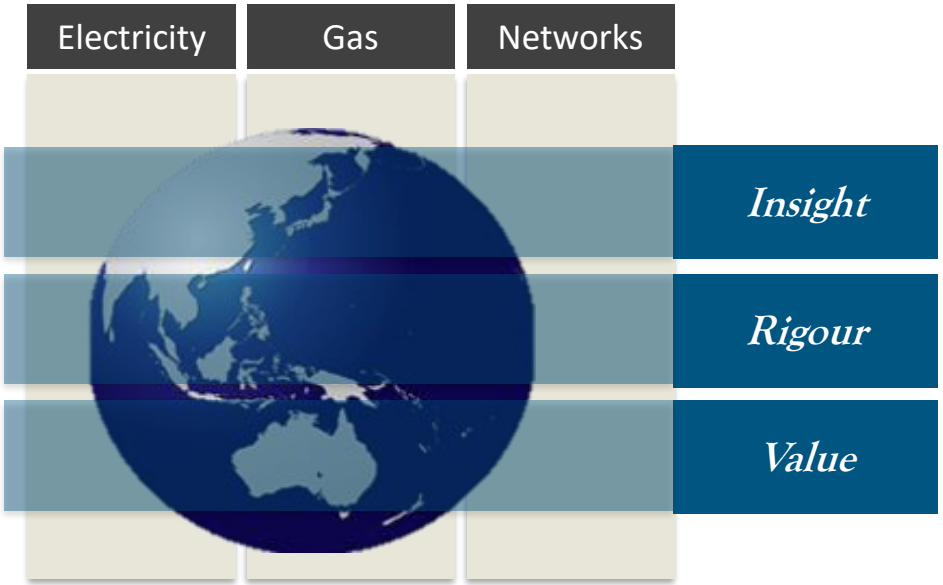

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