APRICUM

THE CLEANTECH ADVISORY.

Opportunities for solar energy and energy storage in a post-subsidy, Renewables 2.0 world

Solar Energy Workshop, Kuwait

December 2018

Agenda

- Introduction to Apricum
- The rise of Renewables 2.0
- An increasing role for energy storage
- Opportunities for solar and energy storage in Renewables 2.0

Appendix A

- Energy storage technologies

Apricum's exclusive sector focus: solar & wind, water, waste, energy storage, green mobility and digital energy.

Our expertise spans the entire value chains in these industries. We have a comprehensive overview of the market dynamics, drivers and economics, an intimate understanding of financing practices as well as a deep engineering-level understanding of the technical issues at play.

Increasingly, projects will combine elements of the below sectors – Apricum's strength is in projects that provide integrated solutions.

Solar & wind

- PV / CSP
- Onshore / Offshore wind
- Solar & wind materials

Energy storage

- Batteries
- Power-to-gas/X
- Storage materials

Water

- Desalination
- Water infrastructure
- Hydro power

Green mobility

- E-mobility
- Alternative fuels
- Charging infrastructure

Waste

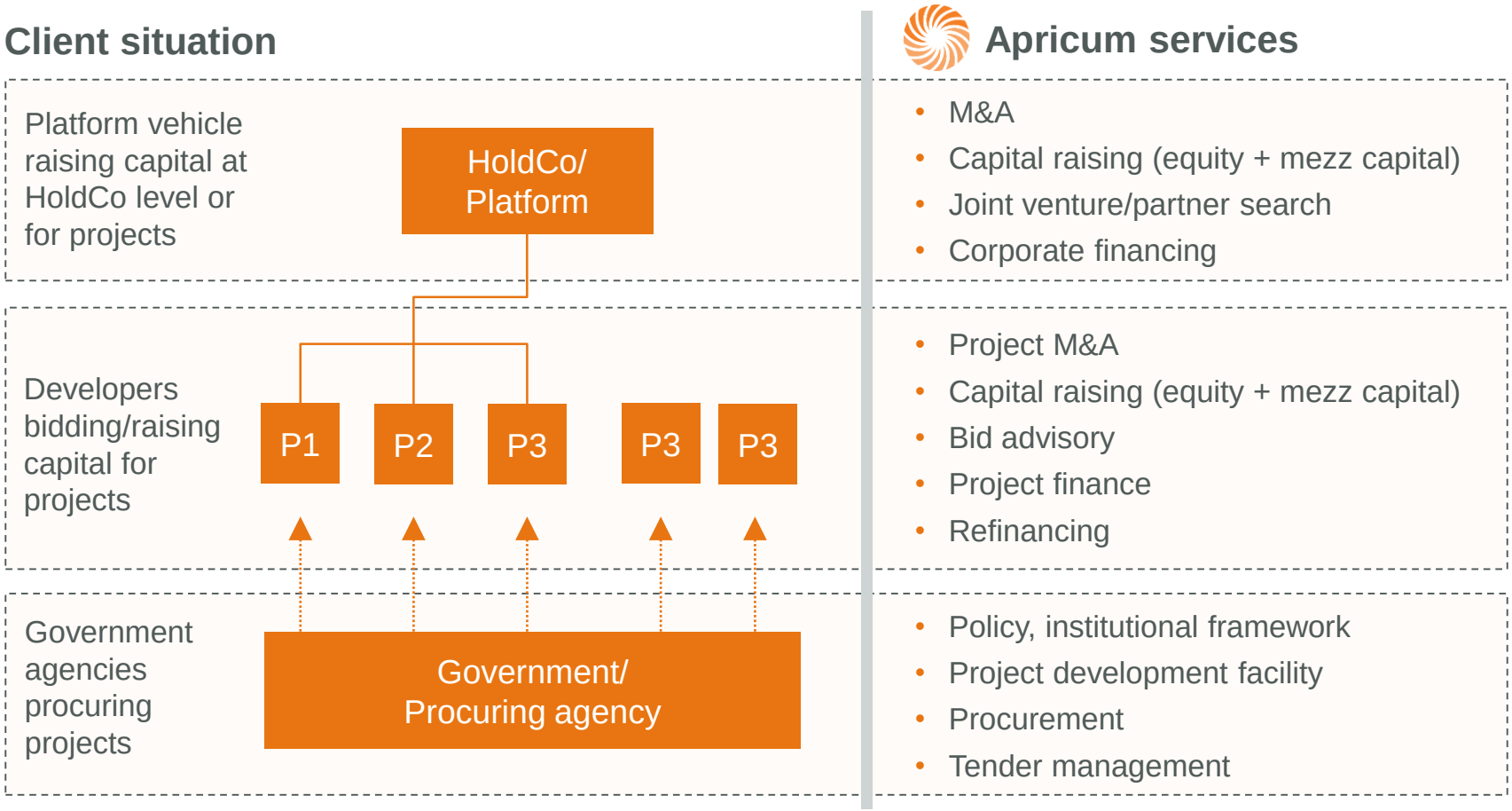
- Waste water treatment
- Waste to energy
- Municipal solid waste management

Digital energy

- Energy management systems
- Integrated building energy systems
- Virtual power plants

Apricum Project advisory practice.

Apricum's advisory services across the capital structure of projects and platform vehicles



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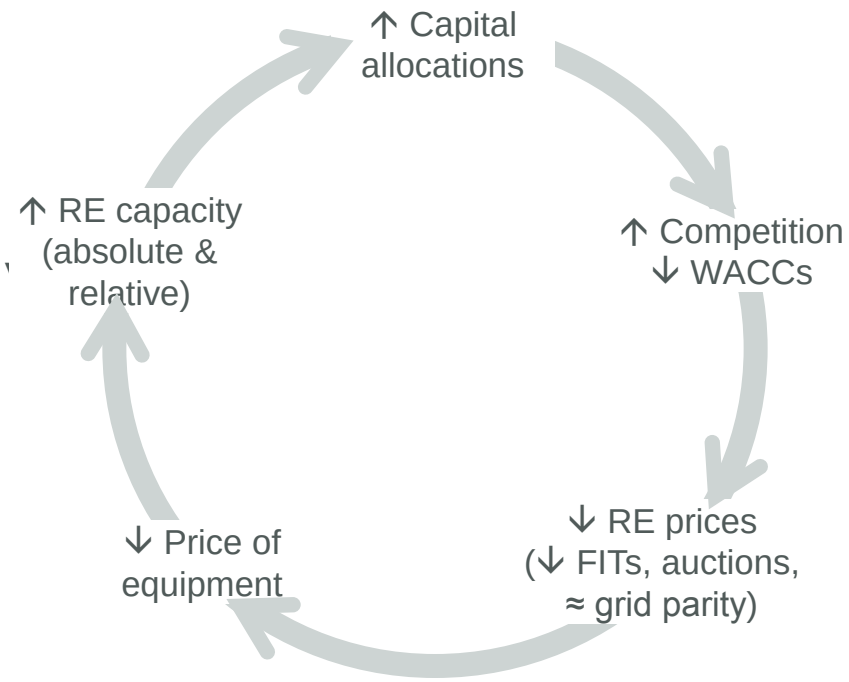
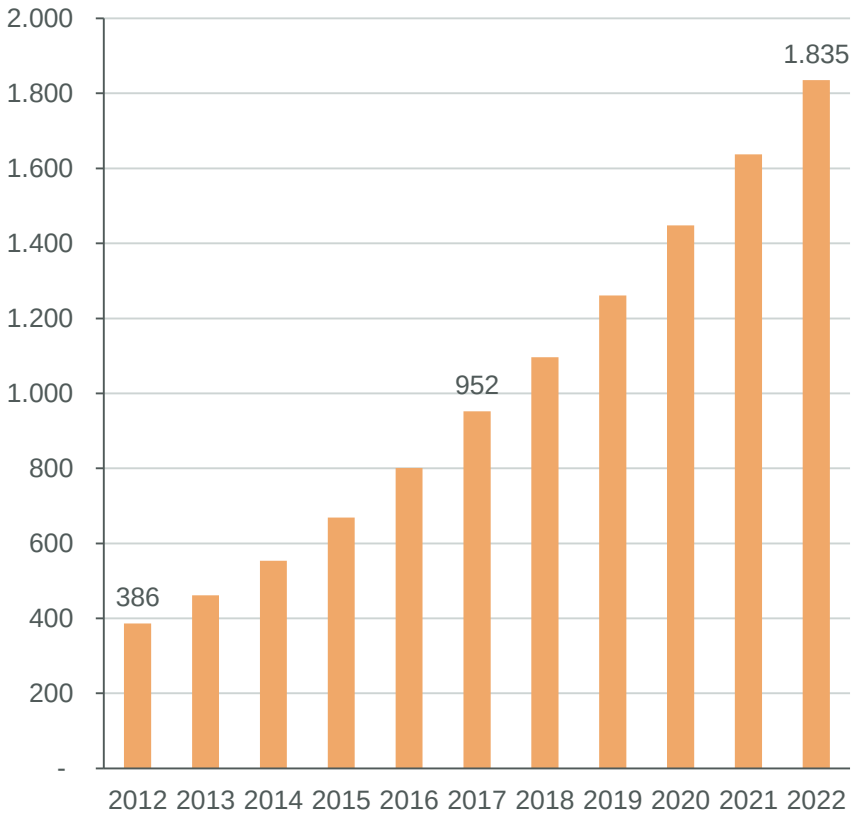
There has been a significant increase in renewables installed capacity globally

Virtuous cycle of renewables investment has driven down delivered cost of energy



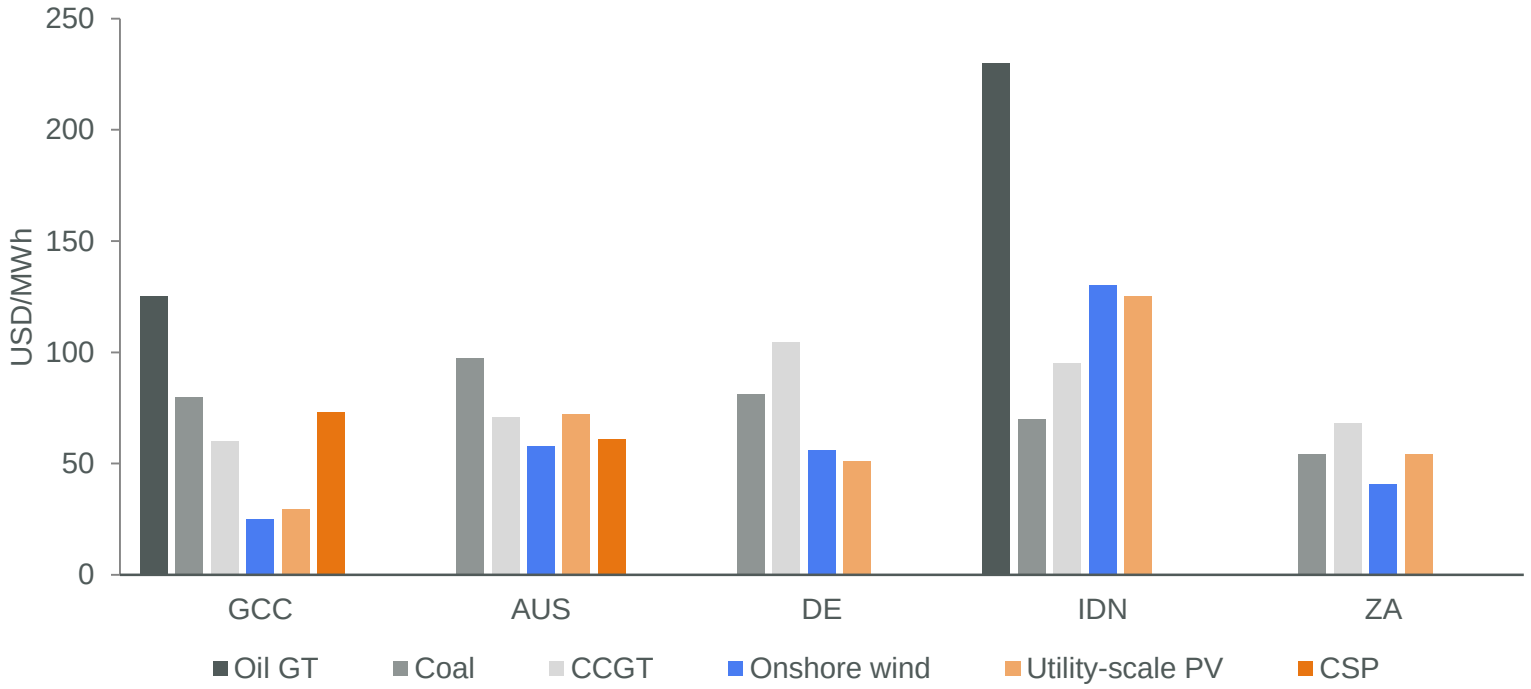
Global installed wind and solar capacity (GW)



Source: Apricum solar and wind market models, Q2/2018

Renewables increasingly cost competitive

The LCOE of renewable energy in comparison to conventional energy technologies in selected countries (USD/MWh)

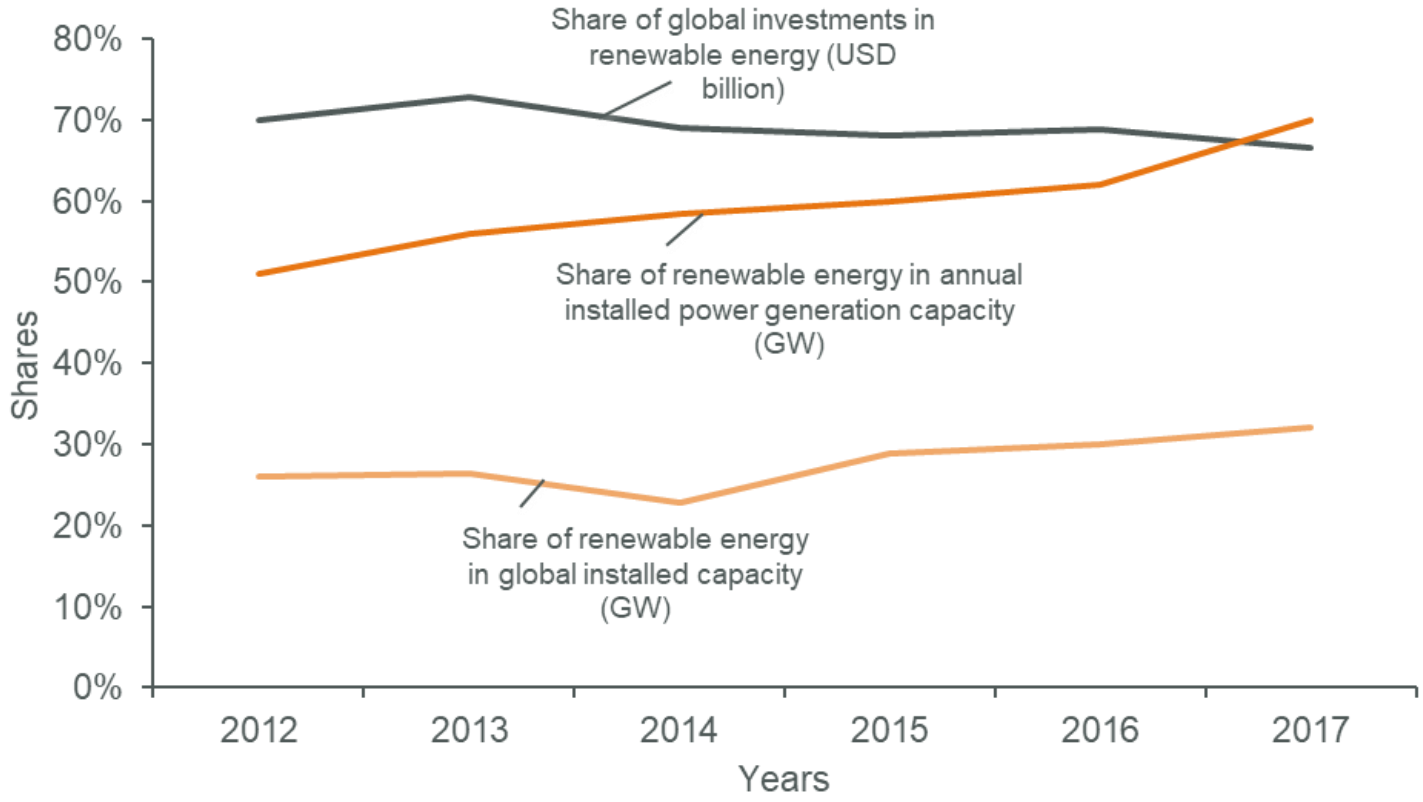


GCC= Gulf Cooperation Council countries; AUS = Australia; DE = Germany; IDN = Indonesia; ZA = South Africa; GT= Gas turbine; CCGT = combined cycle gas turbine; PV = photovoltaic; CSP = concentrated solar power

Source: BNEF (2017), IRENA (2016, 2018), Fraunhofer Institut (2018), IEA (2016), Businesswire (2017), DEWA (2018), SCIELO (2016),

Share of renewables capacity, penetration of renewables rising

Share of renewable energy in total power sector generation investment, global installed capacity and annual installed capacity (%)



Source: Global Status Reports (2013, 2014, 2015, 2016, 2017, 2018), International Energy Agency (2017, 2018)

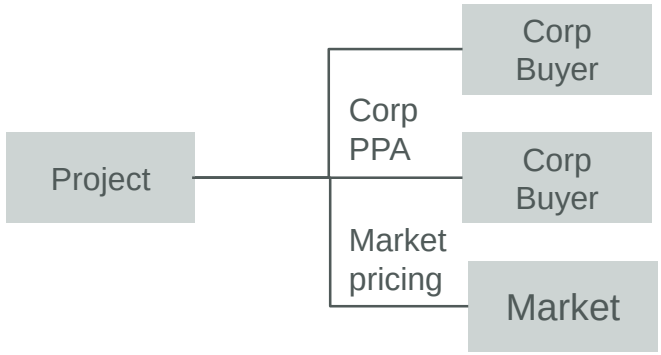
Renewables 1.0 vs Renewables 2.0

Renewables 1.0

- Single buyer of generation
  - Typically through state-sponsored off-take agreements
- Revenue certainty (price and volume)
  - Initially through FIT and other subsidy / promotional schemes
  - More recently a shift to competitive auctions
- Stable return to capital

Renewables 2.0

- Move away from state-sponsored procurement – focus on market and private sector mechanisms
- Potentially multiple (stacked) revenue streams
- Less certainty of revenue, including possible merchant risk exposure
- Greater revenue and technical complexity
- Greater variability in cash flow, returns



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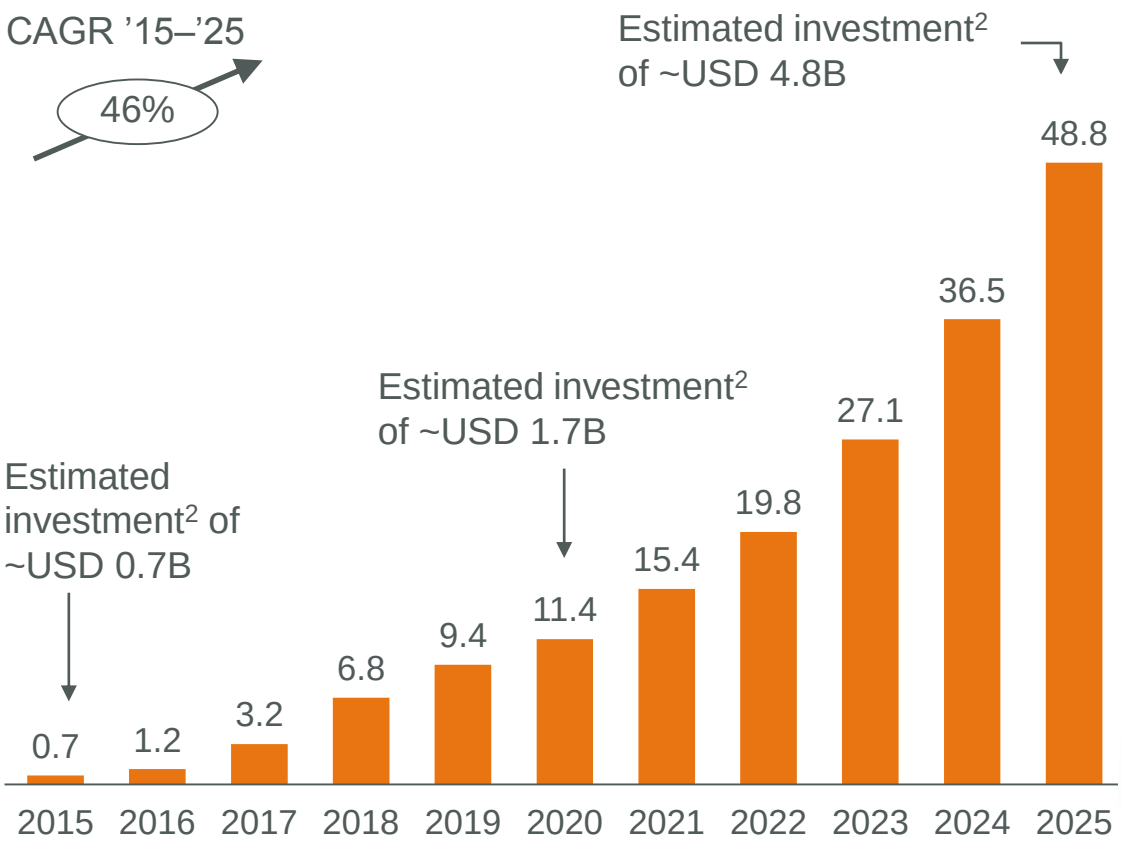
Dramatic demand growth expected for energy storage.

Market stationary battery storage systems [GWh][1]



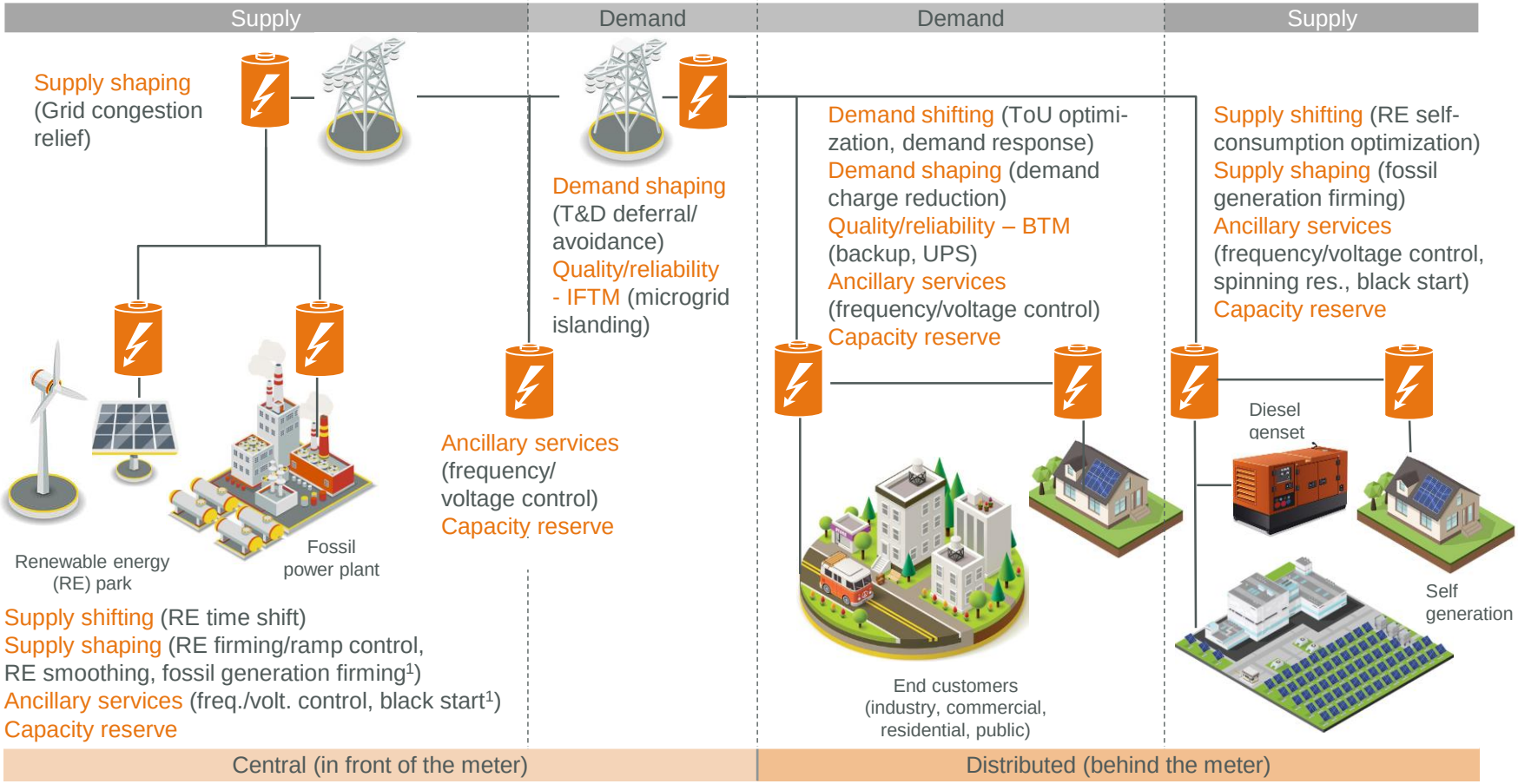
FT “The global supply of batteries for electric cars and energy storage is expected to more than double by 2020” (Jan, 2018)

Bloomberg New Energy Finance “The global energy storage market will double six times between 2016 and 2030” (Nov, 2017)

Source: Apricum stationary battery market forecast Q1/2018 in cooperation with Cairn ERA; 1) Excluding uninterruptable power supply; 2) AC installed system

Demand expected to address a range of energy storage use cases, applied across all facets of the energy system.

Overview of energy storage use cases, across centralized and distributed generation



1) Use cases co-located with fossil generation

Demand alone is not enough – energy storage needs to be competitive and relies on suitable frameworks.

Drivers of energy storage market

1 Demand for…

- a …increased flexibility in the power system
- b …replacements/ expansion of grid and generation infrastructure
- c …optimization of (combined) sources of power supply
- d …adequate quality and reliability of power supply

2 Competitiveness on…

- …CAPEX
- …lifetime costs
- …durability

3 Framework in place to…

- …allow for bankable energy storage projects
- …remove barriers for storage to participate in markets

Source: Apricum analysis

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Opportunities in the post-subsidy, Renewables 2.0 world

The increasing competitiveness of renewables and energy storage opens new opportunities in the post subsidy, Renewables 2.0 world

- Expanding interest in Corporate PPAs as companies contract directly for renewable energy supply
  - Driven by sustainability commitments and desire to manage long-term energy supply costs
  - Focus to date on developed regions (US, Europe), but increasing interest in other regions
- Growing importance of distributed generation
  - Especially in light of rising cost (and, in some cases, lack) of T&D infrastructure
- Hybrid projects are also gaining traction
  - Coupling renewables (wind and solar) with energy storage
  - RE + ES also in conjunction with conventional energy
- Regulatory frameworks and financing solutions will need to evolve and adapt to the changing Renewables 2.0 world

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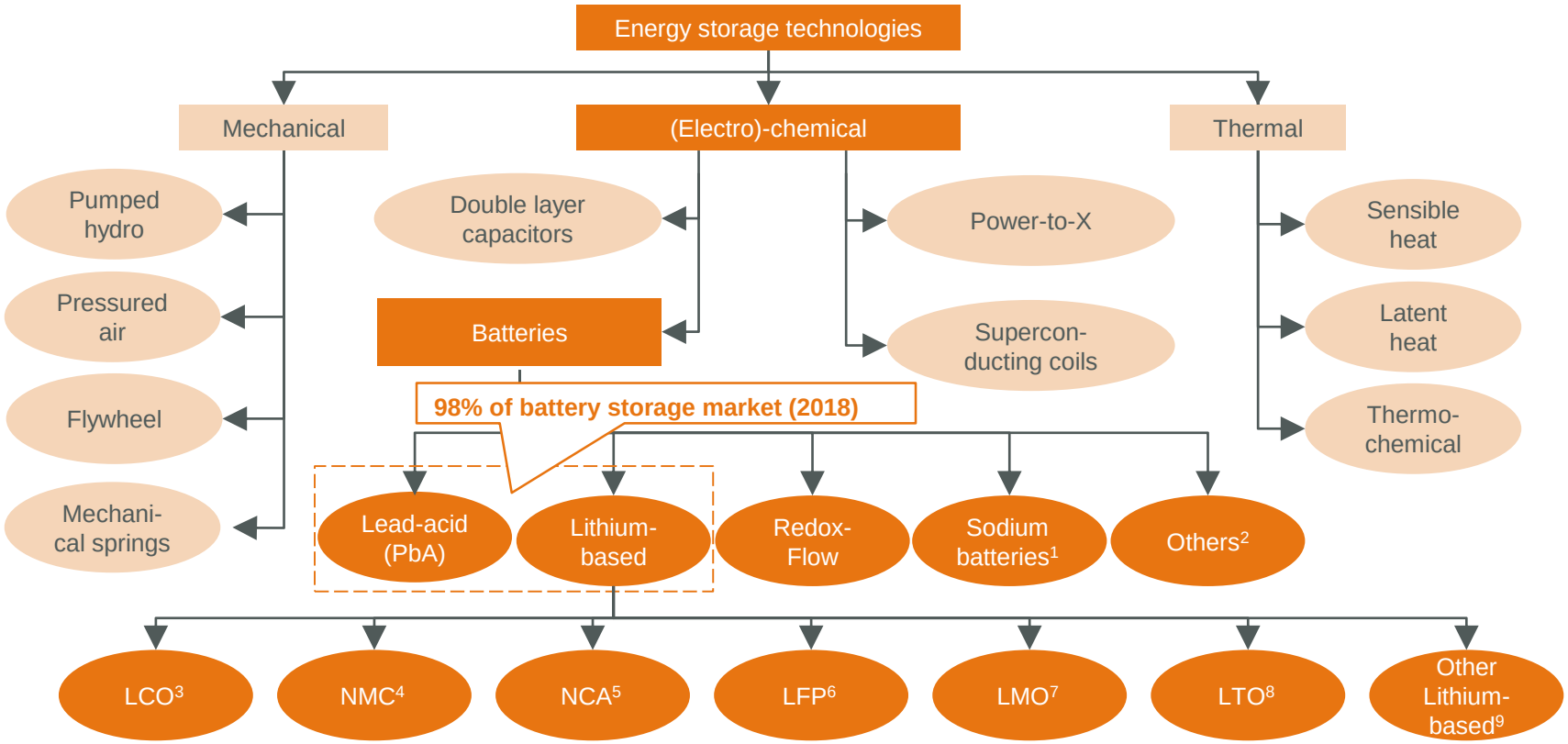
Various energy storage technologies exist – but which is the right one for the targeted use case?

Overview energy storage technologies



Source: Apricum analysis; 1) Includes NaS, NaNiCl and Sodium-ion batteries; 2) E.g., Zinc-Air, liquid metal batteries, NiMH, NiCd; 3) Lithium Cobalt Oxide; 4) Lithium Nickel Manganese Cobalt Oxide; 5) Lithium Nickel Cobalt Aluminum Oxide; 6) Lithium Iron Phosphate; 7) Lithium Manganese Oxide; 8) Lithium Titanate; 9) Including Li-metal, Li-S and Li-air batteries

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