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# Risk revealed by Lloyd's

## Clean technologies and hard-to-abate sectors

Lloyd's Futureset

AON

Batteries and grid

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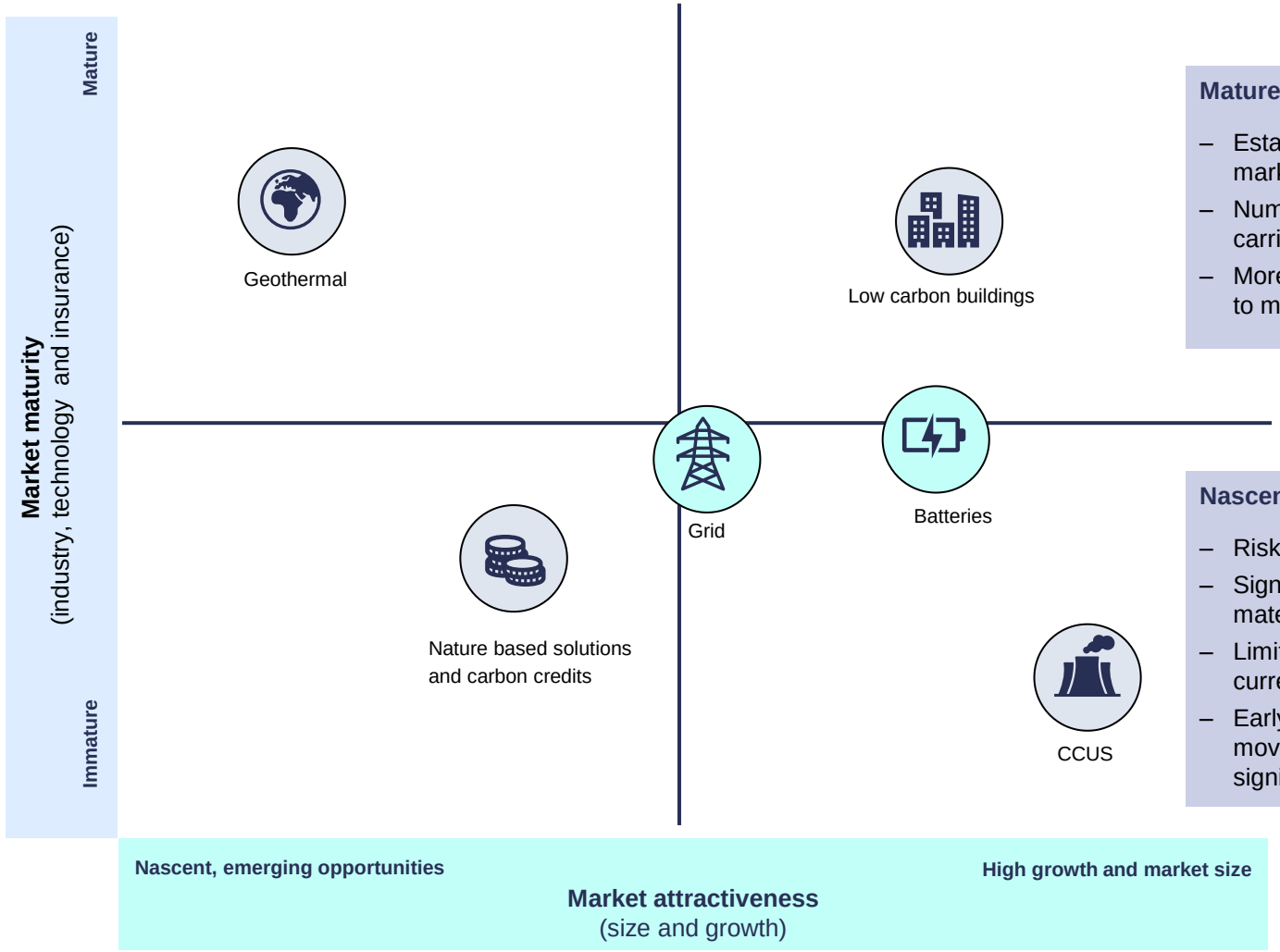
# Building a larger presence in emerging 'transition' technologies could help the insurance industry to lead innovation and grow sustainably

## Opportunity assessment

The relative positioning of opportunities for the insurance industry have been weighted by:

1. **Attractiveness,** which considers both the growth and size of the market, and
2. **Maturity,** which takes into account both the wider industry and insurance market

| | Criteria | Weighting |
|---|---|---|
| Market attractiveness | Growth | 50% |
| | Size | 50% |
| Market maturity | Maturity of industry | 25% |
| | Maturity of tech | 25% |
| | Insurance capacity | 25% |
| | Insurance product maturity | 25% |




**Mature, sizeable existing markets**

- Established insurance products in market
- Number of existing products and carriers
- More innovative products required to meet emerging risks

**Nascent, emerging opportunities**

- Risks currently less known
- Significant opportunity expected to materialise in the longer term
- Limited insurance capacity currently
- Early action could support early mover advantage and capture significant future growth

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# Battery energy storage systems (BESS) are expected to play a pivotal role in reducing dependency on high carbon energy generation, accelerating the growth of renewables

## Industry and insurance market dynamics

- Battery pack prices have declined by 89% since 2010, driving growth in the sector which will play a crucial role in the energy transition
- Demand for batteries is expected to **grow more than 8x by 2030** and insurers will play a key role in helping clients manage the associated risks
- Energy storage is one of the emerging techs in which both **insurers and distribution partners have developed the most dedicated capabilities**

**60%** **Increase in installed capacity of grid-scale batteries in 2021 vs 2020**

Grid efficiency | Stationary energy storage | Industrial uses | Commercial and residential

Different applications of BESS require different characteristics, broadly summarised as **high power** (ancillary) or **high energy** (bulk energy). This is due to **variables in design** such as:

- Power rating (MW); storage duration (h); cycling or lifetime; self-discharge (%); energy density; efficiency (%); response time

| Key growth drivers | Headwinds |
|---|---|
| Government regulation | High cost of production |
| National renewable energy policy | Geopolitical uncertainty |
| Technology advances | Infrastructure costs |
| | Supply chain dependencies |

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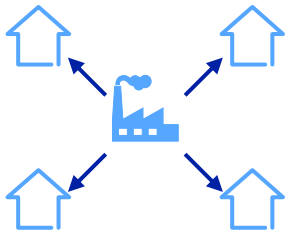
# To achieve net zero ambitions, global electricity grids require a significant upgrade to shift to flexible 'distributed' generation models

## Example electricity grid evolution

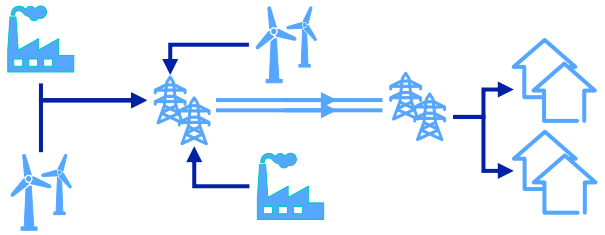
### Historical



#### Local generation

- In developing economies such as the UK, Europe and the US, local power facilities initially generated electricity for industry, gradually broadening their reach to supply to local communities
- Historically, coal was the main source of energy

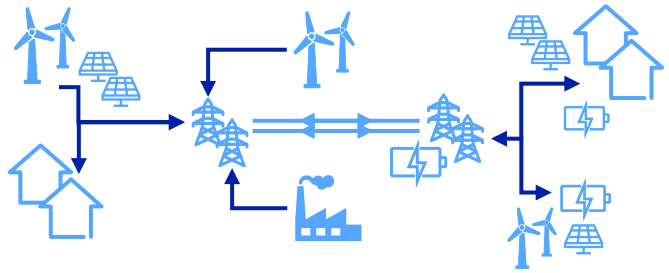
### As-is



#### Large-scale transmission and distribution

- Today, power generators are connected to "synchronous grids" with centralised control of transmission and distribution
- Renewable generators range from "large-scale" generation such as offshore wind, to small, "distributed" schemes such as household or small-scale solar with volatile outputs at varying voltage
- Designed specifically for large-scale energy generation, with unidirectional flow, global power grids are not suited to the volatile and often "embedded" nature of expanding renewables

### To-be



#### Distributed generation

- Large investments and significant re-engineering is required to counteract regional bottlenecks and develop "distributed" generation on an interconnected and flexible grid
- Excess supply of renewable electricity is either stored locally or transmitted towards high-demand centers through distribution system operators, allowing for almost unlimited addition of renewable electricity generation to the grid
- Expected decrease in future generation costs are expected to outweigh construction costs

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# Moving to a 'distributed' electricity transmission model will enable the grid to support all renewables solutions, but solutions such as BESS are needed for surety of supply

## Transformation to distributed generation

Wide-scale transformation of electricity systems to a distributed generation model, has several advantages:

- Enables climate adapted technology to remain effective under the fluctuating weather circumstances, facilitating evolution away from fossil fuels in the transportation, industry and building sectors
- Improves resilience and efficiency of the electricity grid
- Facilitates connection of low-carbon industrial buildings providing embedded, local, renewable generation
- Supports transition towards electrified alternatives in transport and heating, empowering end-customers to be part of the journey through "green-homes" and other energy efficiency initiatives
- Supports reduction in emissions aligned with reduction in back-up capacity

## Success relies on management of fluctuating generation and demand profiles and the associated engineering challenges

### Additional opportunities presented by distributed and renewable generation

**Interconnectors** – Global electricity networks are increasingly interconnected, enabling more flexible supply and demand management, access to additional supply and offshore connection

**Energy storage** – Storage in the form of BESS and mechanical systems, such as pumped hydro are in demand for system balancing and frequency control

**Hydrogen** – Oversupply of renewables can be directly used to produce green hydrogen

**Smart grids** – Enables advanced metering, demand and supply management along with access to small-scale generation that might otherwise be lost

### Headwinds and key challenges posed to delivery

**Grid instability** – Moving to a decentralised system, with additional low-voltage and intermittent/fluctuating sources increases the risk of wider system instability. This in turn drives a need for reactive compensation equipment increasing the cost of system management

**Aging infrastructure** - A 50-year lifespan is common for transmission lines and associated equipment. Globally, most power grids are aged and already require significant investment. In the US, for example, power transformers with an average age of more >40 years, currently manage 90% of all electricity flow

**Political pressure** - Local government policies may overrule interconnector demands creating engineering challenge and construction imperative

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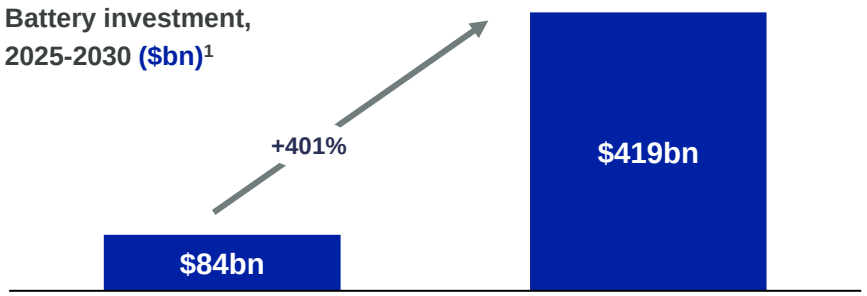
# Supply chain challenges and natural resource concerns have limited BESS to date, but policy changes, recycling solutions and advances in technology are unlocking future growth

## Global investment breakdown




## Current market trends

- **US: Inflation reduction act** allows battery developer easier claim of investment tax credits; plan to install 22GW more capacity by 2026
- **UK:** Has more than 16GW of battery storage currently operating, under construction or in the pipeline across 496 projects
- **Australia:** Constructing 8 large batteries and 58 community batteries across 4 states to increase capacity and provide grid stability
- **India:** Developing 7 key grid scale battery projects to help store power during low demand periods
- **South Africa:** Developing 5 new storage batteries in the Northern Cape; building battery storage to improve grid reliability

## Growth drivers

**Government regulation** - Governments, such as the US, are incentivising investment in battery energy storage projects. In the US, the Inflation Reduction Act provides Investment Tax Credits for energy storage systems

**National renewable energy policy –** In the UK, Ofgem has funded several projects to support energy storage and China's "National Demonstration Power Project Management Measures", included support for Energy Storage in demonstration projects

**Technology advances -** Improvements to battery technology are seeing cheaper, more durable and lightweight solutions enter the market, including NIB and Redox batteries, alongside Graphene in Li-ion batteries

## Headwinds

**High cost of production** - Prices have been declining, primarily due to technological advancements, but the cost remains high relative to traditional energy storage options. The upfront investment required can often act as a deterrent to investment and adoption

**Geopolitical uncertainty –** The conflict in Ukraine has pushed up the price of rare Earth materials. Continued or new conflicts may pose further challenges to the industry

**Infrastructure costs -** Integrating battery storage into existing energy systems and infrastructure is costly and requires significant investment to ensure safety and compatibility

**Supply chain dependencies -** Existing supply chains are highly vulnerable. Countries including the US are seeking to establish more resilient supply chains and reduce its reliance on China, which currently provides the majority of mineral required

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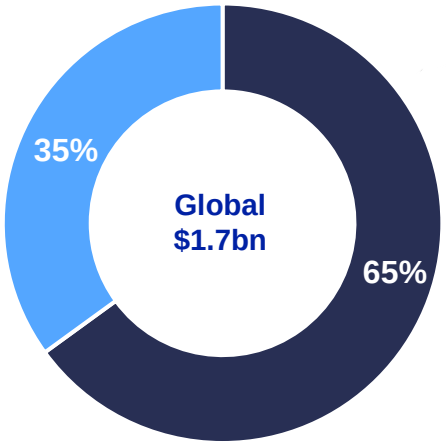
# Globally $1.7bn is expected to be invested in grid infrastructure between 2021-2025, with most investment focused on new lines in Europe and APAC

## Global investment 2021-2025

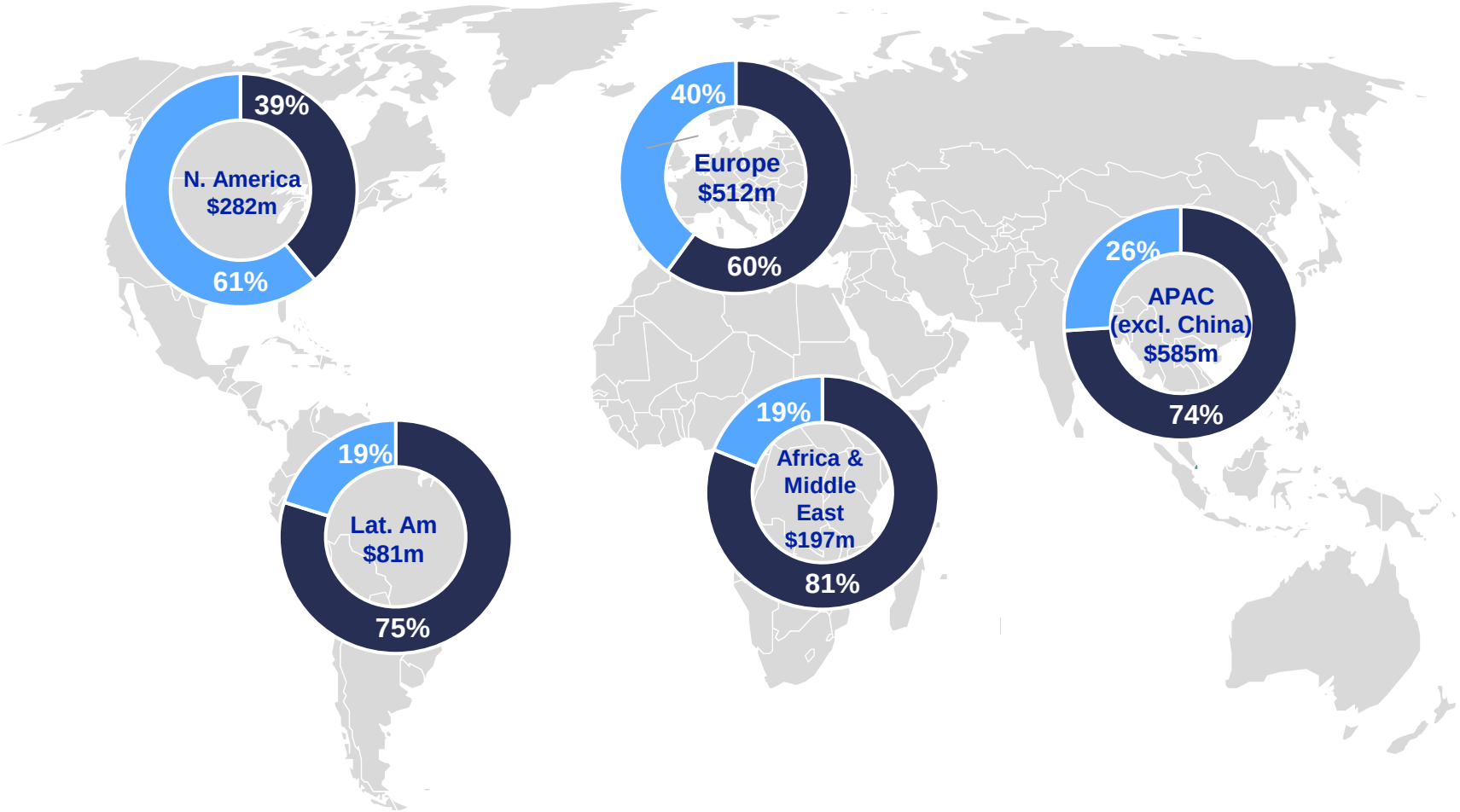
Total grid infrastructure investment (Capex on new lines and replacement), 2021-2025 ($bn)[1]





## Regional investment breakdown 2021-2025

Regional breakdown of total grid infrastructure (Capex on new lines and replacement), $m 2021-2025



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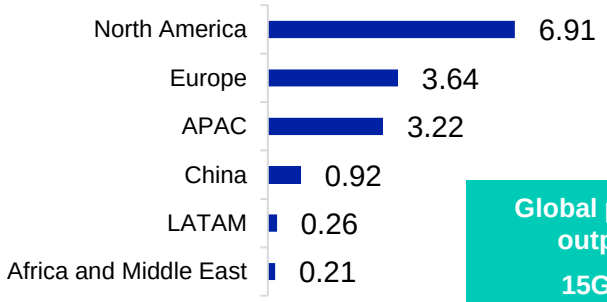
# Planned electrochemical BESS plants will more than double those currently active across all geographies

## Global electrochemical BESS operational capacity

**Global electrochemical battery storage power output (GW), operational 2023**




**Global power output**
**15GW**
*(electrochemical)*

## Regional considerations

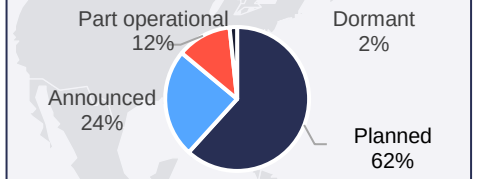
- **US:** The Inflation reduction act has allowed for battery developer to claim investment tax credits easier as they plan to install 22GW more capacity by 2026
- **UK:** Has more than 16GW of battery storage (all types) currently operating, under construction or in the pipeline across 496 projects
- **Australia:** Are constructing 8 large batteries and 58 community batteries across four states to increase capacity and provide grid stability
- **India:** Developing 7 key grid scale battery projects to help store power during low demand periods. India aims to have 140-200GW storage capacity by 2040
- **South Africa:** Are developing 5 new storage batteries in the Northern Cape, they are not able to build new generation capacity so are building battery storage to improve grid reliability

## Regional electrochemical BESS plant size and status

Regional breakdown of current and planned electrochemical battery storage plants and current status of known plants

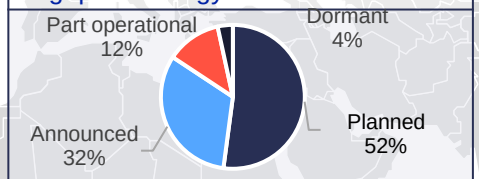
### North America

| | |
|---|---|
| # **active** plants: | **922** |
| Avg. plant power:[1] | **7.5 mw** |
| Avg. plant energy:[2] | **29.6 mw/h** |
| # **planned** plants: | **854** |
| Avg. plant power:[1] | **66.6 mw** |
| Avg. plant energy:[2] | **187.3 mw/h** |



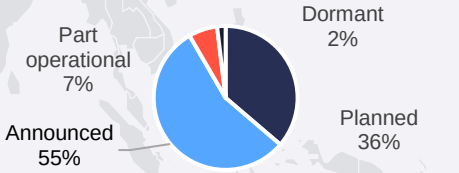

### Europe

| | |
|---|---|
| # **active** plants: | **482** |
| Avg. plant power:[1] | **7.6 mw** |
| Avg. plant energy:[2] | **7.3 mw/h** |
| # **planned** plants: | **585** |
| Avg. plant power:[1] | **60.9 mw** |
| Avg. plant energy:[2] | **131.9 mw/h** |



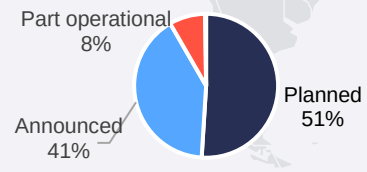

### APAC (exc. China)

| | |
|---|---|
| # **active** plants: | **362** |
| Avg. plant power:[1] | **8.9 mw** |
| Avg. plant energy:[2] | **12.5 mw** |
| # **planned** plants: | **398** |
| Avg. plant power:[1] | **197.9 mw** |
| Avg. plant energy:[2] | **524.7 mw/h** |



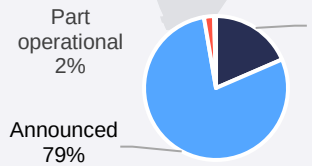

### LATAM and Caribbean

| | |
|---|---|
| # **active** plants: | **58** |
| Avg. plant power:[1] | **4.4 mw** |
| Avg. plant energy:[2] | **3.3 mw/h** |
| # **planned** plants: | **60** |
| Avg. plant power:[1] | **78.9 mw** |
| Avg. plant energy:[2] | **213.4 mw/h** |




### Africa and Middle East

| | |
|---|---|
| # **active** plants: | **97** |
| Avg. plant power:[1] | **2.1 mw** |
| Avg. plant energy:[2] | **5.1 mw/h** |
| # **planned** plants: | **112** |
| Avg. plant power:[1] | **46.5 mw** |
| Avg. plant energy:[2] | **131.1 mw/h** |



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# There is a mature global value chain for BESS for end-user self-generation and self-storage, while large-scale installations are dependent on upgrade and evolution of power grids

Energy storage system manufacture | Generation | Electricity transmission, distribution & storage | Uses/markets | Second life/recycling

Material mining & processing → Battery cell manufacturing → Battery cell assembly

**Electrochemical**

**73% of global storage power output**

1. Lead acid
2. Li-ion
3. NaS
4. Flow

**Mechanical**

**9% of global storage power output**

1. Flywheel
2. Compressed Air Storage
3. Hydro – pumped storage

**Thermal**

**18% of global storage power output**

1. Molten salt
2. Ice thermal storage
3. Chilled water storage

## Applications

Utilities use electric storage technologies (for power generated from fossil fuels and renewables) in a range of applications such as time-shifts and supply capacity to meet the demand-supply gap efficiently

1. **Fossil fuel**
2. **Renewable energy**
3. **Distributed generation**

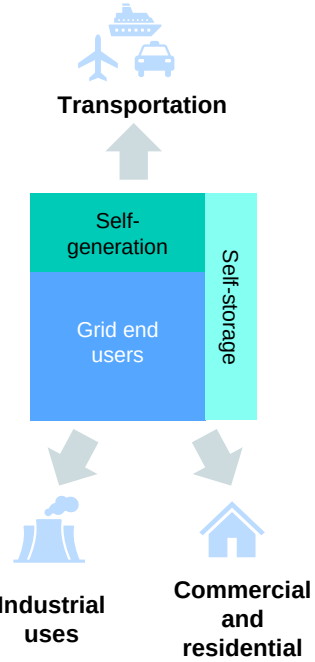
## Grid side applications

End-to-end solution providers for deployment and operations of BESS's could potentially disrupt the market and are accelerating future opportunities

- **Hardware**
- **Software**
- **Services**

## Applications

End-users benefit from the efficiencies energy storage systems offer in time-of-use energy tariff cost management, demand charge management, and uninterruptible power supplies




## Applications

Batteries used in storage systems have **more secondary life applications** than in EVs, as overall performance is more variable, resulting in longer lifetimes

How this could be used is still unclear, as the technology continues to develop, and most systems are **10-20 years away from expected degradation** – given the nascency of their application

## Recycling

The recycling market is **critical to reducing the environmental impacts** of producing battery material, using heavy mining processes and **toxic chemicals.** However**, fewer than 5%** of lithium-ion batteries are currently recycled

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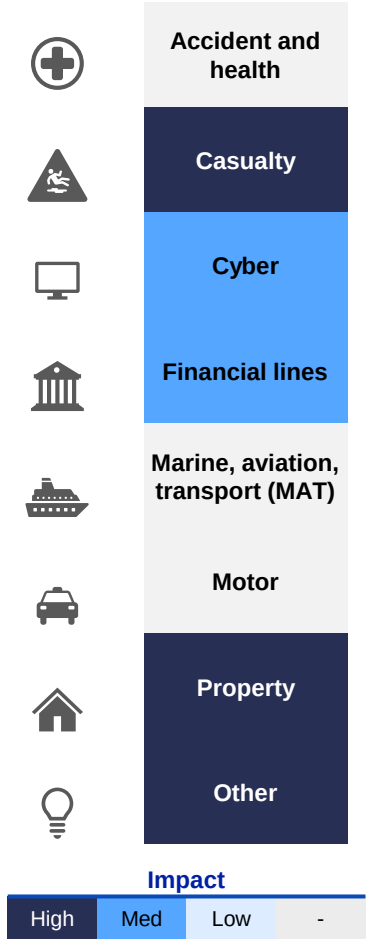
# Insurers have developed standalone products for energy storage or integrated them into existing power policies, but BESS operators will seek increased capacity as more projects commence

## (Re)insurance class of business impact




## Key coverage sought for projects

**Property/casualty (operational): operational all risks (OAR), public liability, employers liability** with biggest increased risk from fire including from:

- **Thermal runaway** – the result of a chain reaction where misused or damaged battery being to release heat energy, leading to further damage in a negative feedback loop which can cause build-up of explosive atmosphere and fire
- **Failure of BESS control systems** - If one or more control component fails, for instance a battery management system, it can lead to overheating and fire
- **BESS and hydrogen evolution** - In lead-acid batteries, excess hydrogen can create a risk of explosion unless proper ventilation methods are in place

**Other (construction):** construction all risks (CAR), delay in start up (DSU), supply chain insurance, terrorism, public liability, political and regulatory risks

**Other (extended warranties):** Warranty offered in addition to a standard warranty typically offered by the manufacturer, providing protection in case of battery failure

**Other (performance guarantee cover):** Cover purchased in conjunction with an extended warranty product that guarantees at least 70% retention of battery capacity for a given period

## Gaps in coverage currently offered

- Coverage is mostly provided under pre-existing power policies as a **property and liability component**, if the plant building an energy storage is already in operation however high-profile fire incidents in the BESS sector, have impacted insurer's appetite to provide energy storage cover
- The current **construction** market has been hesitant in establishing risk profiles given the diversity of technologies employed within the battery storage space. Minimum global standards on construction and increased loss data is needed to assist the industry in pricing
- For standalone energy storage industrial scale developments, standalone **warranty and liability products** have been developed however the market is currently immature
- Reasons for this include potential insurability challenges, losses associated with the unproven nature of the technology and the limited availability of battery performance data from original equipment manufacturer (OEMs)

# The insurance industry is adapting existing warranty and business interruption offerings to BESS solutions

## Example market offerings

| Provider | Product description |
|---|---|
| AIG | – AIG offers coverage for "**traditional renewable energy**" which includes coverage for onshore wind, solar, hydro, battery storage<br>– These coverages span property, casualty, D&O, and other lines of business |
| AXIS | – **BESS CAR and OAR solutions** provide specialised P&C coverage for every stage of a battery energy storage project from development through operation<br>– Axis work with independent power producers, project developers, operators EPCs and utility companies |
| Munich RE | – **E-mobility insurance** means manufacturers and fleet owners are shielded from excessive costs resulting from warranty claims for their long-term battery warranties by Munich Rr's coverage for e-mobility applications |
| Munich RE | – **Stationary energy storage solution** provides strong protection against excessive repair and replacement expenses brought on by component failure or unanticipated capacity deterioration<br>– Directed at participants along the entire value chain |
| Munich RE | – Munich Re uses monitoring by TWAICE software to offer performance warranty insurance for Li-ion batteries<br>– Munich Re's **performance warranty** insurance policy covers repair and maintenance of battery storage systems and can be extended to cover lost revenue from downtime. The customer is also protected against insolvency and non-payment on the battery supplier's side |
| AXA XL Insurance Reinsurance | – AXA XL support Paragon Insurance Holdings, a **specialist MGA**, in offering technology performance and battery revenue insurance |
| Altelium MS amlin | – Initially launched in 2022, **MS Amlin** partnered with **Altelium** to offer a BESS construction all risk and operational all risk solution, which has subsequently closed |

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# Notes & Sources (1)

| Page number | Source | Notes |
|---|---|---|
| 3 | IEA; International Council on Clean Transportation; IEA; UN PRI; GlobalData | 1. Batteries includes grid, EV charging and EV battery manufacturing; 2. Grid includes replacement only and excludes new lines |
| 4 | IEA | |
| 5 | IEA; Energypost; S&P Global; Financial Times; U.S Department of Energy; Reuters | |
| 6 | IEA; International Council on Clean Transportation; GlobalData | 1. According to the Base Case – Forecast Policy Scenario (UN PRI) with battery here including grid, EV charging and EV battery manufacturing |
| 7 | IEA; GlobalData | 1. Expected Capex investment is based on the Net Zero Scenario (IEA). Excludes China. |
| 8 | GlobalData | 1. Power rating (measured in megawatts) indicates how much power can flow into or out of the battery in any given instant; 2. The energy rating (measured in kilowatt-hours) is the amount of energy that can be delivered or absorbed over the course of an hour |
| 9 | IEA; International Council on Clean Transportation; S&P Global; EVGO; Manufacturer websites | 1. The Group Rating Panel, administered by Thatcham Research, assigns new car models to an insurance group from 1 (cheapest to insure) to 50 (the most expensive). |
| 10 | Aon analysis | |
| 11 | SMI ITF 2022 products and services showcase; Carrier websites | 1. Percentage split according to the Base Case – Forecast Policy Scenario (UN PRI) |

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