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600+

Applications for BNEF's Pioneers competition in 2026

$25 billion

The cumulative fundraising amount of all BNEF's Pioneers alumni

12

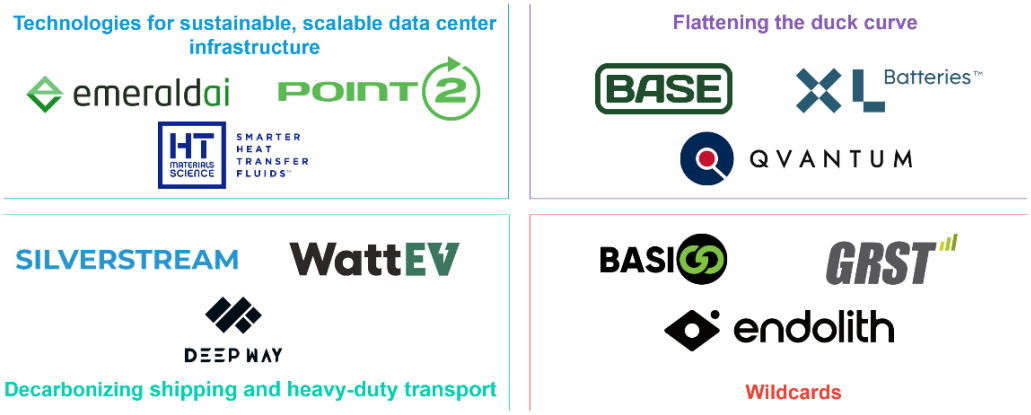
BNEF Pioneers winners in 2026

Climate-Tech Companies to Watch in 2026: BNEF Pioneers

BloombergNEF announced the 2026 winners of its Pioneers program on April 20, the culmination of an annual competition that identifies game-changing climate technologies. The 12 winners this year are helping to develop sustainable, scalable data center infrastructure, flatten the duck curve, and decarbonize shipping and heavy-duty transport.

- This year's competition is the 17th edition of BNEF Pioneers. Including this year's laureates, the contest has now named 176 winners, which together have raised a cumulative $25 billion in funding. For this year's program, BNEF received more than 600 applications from 66 different markets.
- **Challenge 1: Technologies for sustainable, scalable data center infrastructure.** The winners of this challenge are shifting computational workloads to unlock grid capacity (**Emerald AI**), developing semiconductor interconnect technology for data centers (**Point2 Technology**) and making cooling systems more energy efficient (**HT Materials Science**).
- **Challenge 2: Flattening the duck curve.** The winners of this challenge are deploying battery storage assets (**Base Power**), developing flexible heat pumps (**Qvantum**), and designing organic flow batteries for long-duration energy storage applications (**XL Batteries**).
- **Challenge 3: Decarbonizing shipping and heavy-duty transport.** The winners of this challenge are developing intelligent electric trucks (**DeepWay**), equipping commercial vessels with hull air lubrication technologies (**Silverstream Technologies**), and advancing heavy-duty freight electrification (**WattEV**).
- **Wildcards:** This year's wildcards are operating electric buses in Africa (**BasiGo**), improving copper recovery from low-grade ores (**Endolith**), and commercializing a water-based polymer binder for lithium-ion batteries (**GRST**).

Figure 1: BNEF Pioneers 2026 winners



Source: BloombergNEF

1. BNEF Pioneers 2026

1.1. How does BNEF choose its Pioneers?

Each year, BNEF awards the Pioneers prize to innovators addressing three pre-selected challenges. It also recognizes a few 'wildcard' winners outside of these categories.

The Pioneers are selected via a four-step process:

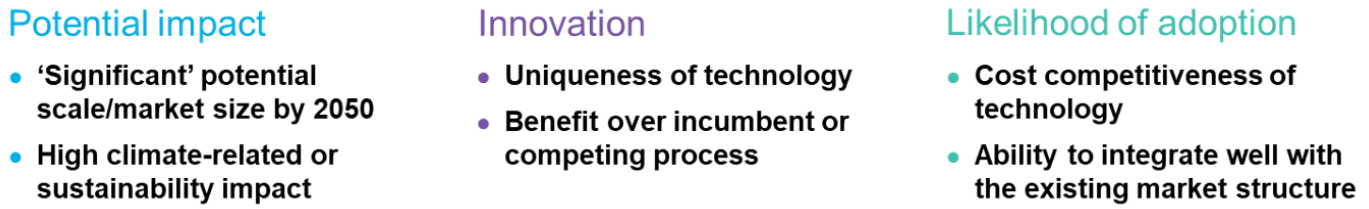
1. **Choosing the challenges:** BNEF chooses its challenge areas in collaboration with each of our sector teams, with a particular eye toward identifying topics where an urgent climate or energy challenge still lacks a clear technological solution. BNEF's long-term outlooks on energy, industry and transport, including the New Energy Outlook (web | terminal) and the Electric Vehicle Outlook (web | terminal), help identify these areas.

2. **Finding the applicants:** BNEF searches for potential applicants using its own startup databases and published research, as well as analyst knowledge. We solicit applications from our analysts, network of clients, research contacts, and open application portal.

3. **Choosing the finalists:** Each application is read and scored by a relevant sector analyst based on potential impact, innovation and likelihood of adoption (Figure 2). BNEF balances both quantitative and qualitative scoring data to select finalists that represent a diversity of technological solutions.

4. **Choosing the winners:** BNEF conducts a full day of finalist judging, where BNEF analysts present each finalist to a panel of judges. The judging panel, which includes members of BNEF's management committee and Bloomberg Green journalists, uses a voting and discussion process to determine the winners of the competition.

Figure 2: Scoring dimensions for BNEF Pioneers applications



Source: BloombergNEF

1.2. Who are this year's Pioneers?

This year's Pioneers have raised a cumulative $2.4 billion across 53 deals, according to CB Insights (Table 1). Six of the Pioneers are based in the US, three are in Europe, two are in China, and one is in Kenya. This global spread represents growing innovation ecosystems across diverse markets. Eight of the winners raised funding in the past two years, with Emerald AI raising the most recent round in March 2026.

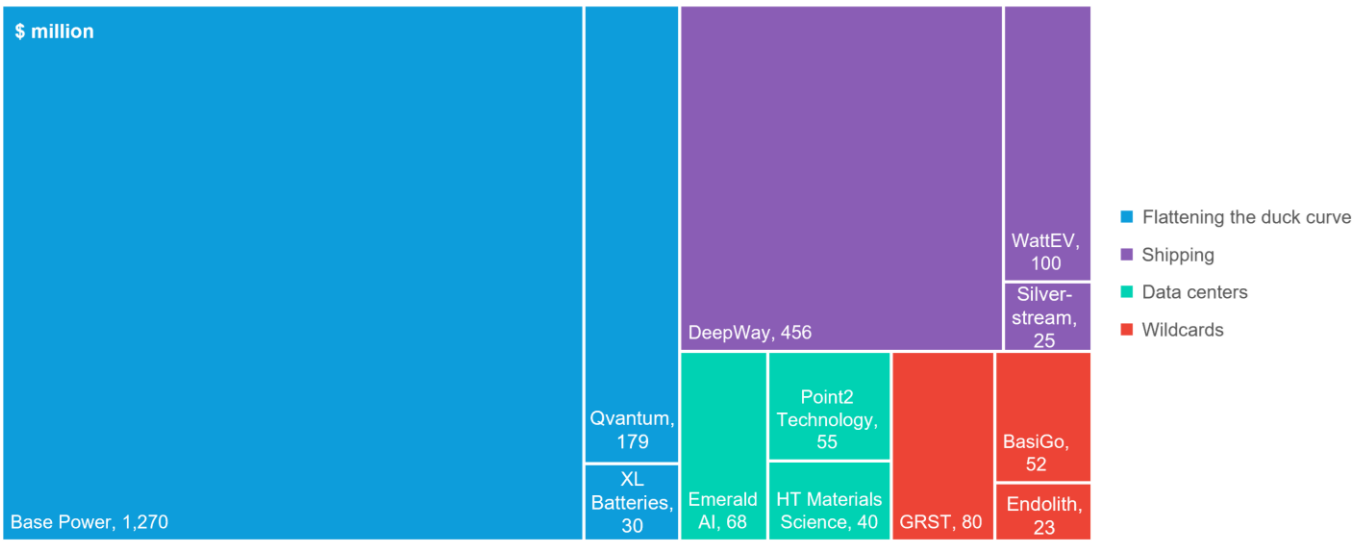
Table 1: BNEF Pioneers 2026

Challenge	Company name	Region	Latest funding round	Latest funding date	Cumulative funding ($ million)
Data centers	Emerald AI	US	Strategic expansion	March 2026	68
	HT Materials Science	Ireland	Series A	December 2024	40
	Point2 Technology	US	Series B – II	February 2024	55
Duck curve	Base Power	US	Series C	October 2025	1,270
	Qvantum	Sweden	Series C	January 2025	179
	XL Batteries	US	Seed	January 2026	30
Shipping	DeepWay	China	Unattributed VC	January 2026	456
	Silverstream Technologies	UK	Not disclosed	Not disclosed	25
	WattEV	US	Grant – V	January 2024	100
Wildcards	BasiGo	Kenya	Debt & Series A	October 2024	52
	Endolith	US	Series A	November 2025	23
	GRST	China	Not disclosed	Not disclosed	80

Source: BloombergNEF, CB Insights. Note: Colors indicate region and stage of deal maturity.

The winners in the duck curve challenge are responsible for more than half of the fundraising of this year's Pioneers cohort. This is largely because 56% was raised by one company, Base Power (Figure 3). Two companies in this challenge raised the latest-stage funding of the cohort, with Base Power and Qvantum being the only winners to raise Series C. This represents growing interest in grid-responsive technologies in response to rising power demand and renewable penetration.

Figure 3: Total funding raised by 2026 Pioneers, by challenge



Source: BloombergNEF, CB Insights

2. Challenge 1: Technologies for sustainable, scalable data centers

Explosive data center growth is straining power grids, water systems, and materials supply chains.

The surge of interest in artificial intelligence (AI) is turning data centers into significant energy users. BNEF expects that electricity demand from data centers is set to quadruple within a decade, making the industry one of the fastest-growing electricity users on the planet. Data centers could consume 1,600 terawatt-hours of electricity by 2035, or around 4.4% of global demand. For more, see *AI Data Centers Fuel Quicker Growth in Power Demand* (web | terminal).

This explosive growth is straining power grids, water systems, and materials supply chains. Technologies that provide flexibility services without degrading performance, boost IT hardware efficiency, and improve heat rejection could help data centers maximize compute power while reducing their energy consumption and impact on resources.

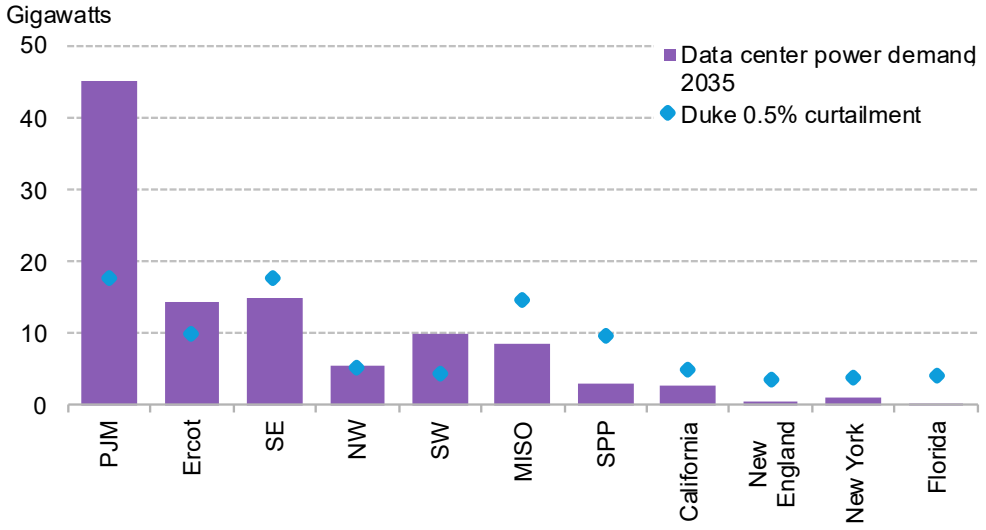
2.1. Emerald AI

Why is innovation needed to make data centers more flexible?

If new data centers were able to curtail 0.5% of their total possible annual energy consumption, 98 gigawatts (GW) of their load could be served with the existing power grid.

Data centers are hungry for access to power and in response, grid operators and data center providers are exploring methods to reduce demand at peak times. Data centers have not typically acted as flexible sources of demand, but a small amount of flexibility in their operation could dramatically reduce the need for new power generation capacity. If new data centers were able to curtail 0.5% of their total possible annual energy consumption, 98 gigawatts (GW) of their load could be served with the existing power grid, according to a Duke University study. At this curtailment level, many regions of the US could meet the load from new data centers by 2035 with no new generation capacity (Figure 4). For more, see *Data Center Giants and Power Grids Seek Flexible Demand* (web | terminal).

Figure 4: New load that could be served if data centers agreed to 0.5% curtailment, versus forecast data center capacity



Source: BloombergNEF, Duke University, Data Center Giants and Power Grids Seek Flexible Demand (web | terminal). Note: Ercot stands for the Electric Reliability Council of Texas, MISO is the Midcontinent Independent System Operator, SW is the Southwest, SE is the Southeast, NW is the Northwest.

What is Emerald AI's technology?

Emerald AI has developed software that data center operators can employ to shift computational workloads in response to power market signals. This enables higher data center energy usage at times when there is grid capacity, and lower at times when there is grid stress. It does this by moving delay-tolerant workloads to times of lower grid stress (time delay) or moving workloads from a data center in a grid-stressed area to one in a non-grid-stressed area (geographic load shifting). Emerald's software is able to cut power demand by up to 40% during peak grid events without significantly impacting critical workloads, based on the results of its 2025 UK trial.

A more traditional way to provide flexibility to the grid is to use power from onsite diesel generators, which data centers can use to curtail the amount of power they pull from the grid during peak events. Diesel generators are emissions-intensive and expensive to operate, and there are regulatory barriers to using them in non-emergency situations. Emerald AI's software offers an alternative demand-response pathway that is less emissions-intensive.

Why is Emerald AI a Pioneer?

Emerald AI has partnerships with major players in the data center space, including NVIDIA.

Emerald AI is a Pioneer because it is one of the few applications BNEF saw in this year's competition that demonstrated a clear commercial path towards helping data centers engage in demand response. This matters because developers care about speed to power and, in many markets, data centers that can act flexibly may be able to connect to the grid more quickly. For more, see *Sharing the Load: How the US Pays for Power in the AI Era* (web | terminal).

Emerald AI has partnerships with major players in the data center space, including NVIDIA, which invested in Emerald, collaborated with it on a project in Virginia, and included it as part of its reference design. Emerald AI has also partnered with Oracle, National Grid and PJM on recent demonstrations.

What's next for Emerald AI?

Emerald raised $25 million in March 2026, bringing its total funding to $68 million.

Emerald AI has grown quickly. It was founded in November 2024, completed its first commercial demonstration in Arizona in May 2025, and established a strategic partnership with National Grid in September 2025. Emerald raised $25 million in March 2026, bringing its total funding to $68 million. Its investors include NVentures (NVIDIA's venture capital arm), GE Vernova, Lowercarbon Capital, Energy Impact Partners, National Grid Partners, Salesforce Ventures and Siemens.

Emerald AI is currently working on implementing its flexibility software into the reference design of a 96 megawatt (MW) data center in Virginia, which is a grid-constrained US data center hub. The "Aurora AI Factory" is being constructed by Digital Realty, and it is expected to energize in the first half of 2026. Project partners include NVIDIA, EPRI, Digital Realty, and PJM. Emerald AI is also expanding its operations in the UK, where it recently concluded a trial with the Neocloud operator Nebius using NVIDIA Blackwell Ultra GPUs.

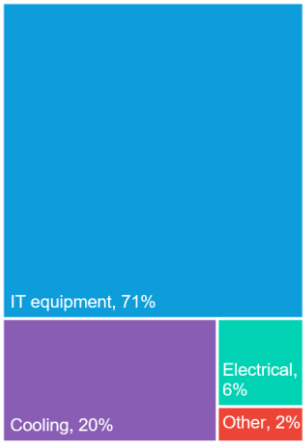
2.2. HT Materials Science

Why is innovation needed to make data center cooling more efficient?

Mechanical chillers, which are used to cool data centers and other industrial facilities, are energy-intensive. In data centers, cooling the IT infrastructure accounts for roughly 20% of total electricity demand (Figure 5). Improving chiller efficiency can reduce the energy intensity of cooling,

lowering overall data center energy demand. For more, see *From Grid to Chip: Electrical Equipment in Data Centers* (web | terminal).

Figure 5: Share of data center power consumption by equipment

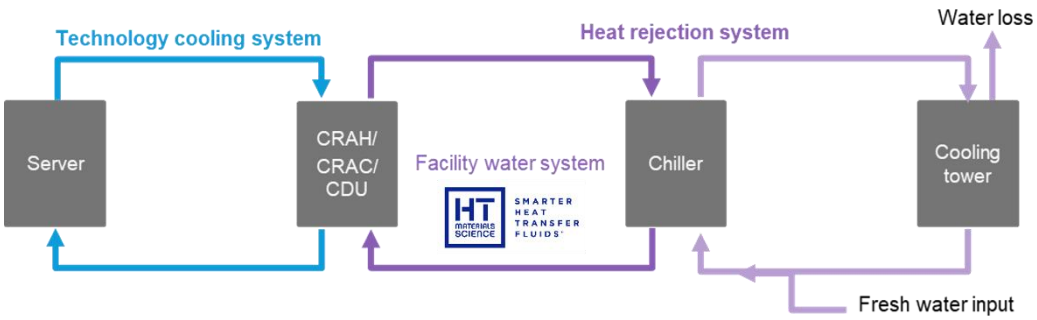


Source: BloombergNEF, SemiAnalysis. Note: assumes a power usage effectiveness of 1.4.

What is HT Materials Science's technology?

Data centers use mechanical chillers – which are effectively large-scale heat pumps run in reverse – to cool the water in a loop called the facility water system (FWS) in a data center. The FWS intersects with a separate loop called the technology cooling system (TCS). The TCS is responsible for circulating fluid that removes heat from the servers and transfers it into the FWS. The TCS can consist of air- or liquid-based systems (Figure 6).

Figure 6: The cooling loops in a data center



Source: BloombergNEF, HT Materials Science. Note: CRAH is computer room air handler, CRAC is computer room air conditioner, CDU is coolant distribution unit.

HT Materials Science has developed a technology to make data center cooling more efficient. Its product is a fluid – called Maxwell nanofluid – that can be added to a data center's FWS. It is made of aluminum-oxide nanoparticles. Maxwell increases the thermal capacity of the water or glycol in the FWS, reducing the work required by the chiller's compressors to maintain the same design temperatures in the server rooms of the data center. This in turn reduces the electrical energy required to produce the same cooling effect. HT Materials said that Maxwell typically increases heat transfer in the chiller evaporator by 12.5 to 15%.

HT Materials Science sells its concentrated fluid additive on a per liter basis to the operators of chillers. The technology is compatible with incumbent FWS cooling methods, which means that it can be added to the cooling system after it has been installed.

Why is HT Materials Science a Pioneer?

Maxwell nanofluid could improve thermal performance in many types of data centers.

HT Materials Science is a Pioneer because its technology is a drop-in additive to improve the cooling systems of all kinds of data centers and industrial facilities. Many companies are developing advanced cooling technologies that can reduce chiller run hours or the number of chiller compression/expansion cycles. Such approaches are only likely to be deployed in AI data centers. HT Materials Science's technology does not compete with those newer approaches, rather it is complementary. The product could improve thermal performance in many types of data centers, regardless of whether the data centers have also adopted other innovations such as direct-to-chip liquid cooling.

What's next for HT Materials Science?

HT Materials Science has raised $40 million since its founding in Ireland in 2018. Its investors include Aramco Ventures, Ecolab, Barclays, CDP Venture Capital and Progress Tech Transfer. It

was selected for the Amazon Sustainability Accelerator in 2025, which led to pilots across three Amazon fulfillment centers in the UK.

HT Materials Science's pilot at a district cooling facility in Abu Dhabi resulted in a chiller plant efficiency improvement of 13.6%.

HT Materials Science has run several large-scale pilots at industrial facilities. Its pilot at a district cooling facility in Abu Dhabi resulted in a chiller plant efficiency improvement of 13.6% compared to previous operation of the chiller plant under the same load conditions. Maxwell fluid was also used in two chillers operated by Aramco in Saudi Arabia and at a pharmaceutical cold storage facility in Malaysia.

HT Materials Science is currently developing pilots at data centers in Europe, Asia and North America. The company is working with chiller manufacturers to validate the performance improvements and material compatibility of Maxwell fluid with their equipment. This will be essential to gain the confidence of facility managers at data centers.

2.3. Point2 Technology

Why is innovation needed in data interconnection systems?

Copper cables face physical limitations that could constrain the scale of AI infrastructure.

Interconnect cables are central components for transmitting data between AI servers. Active electric cables (AECs) are used for short-distance connections, such as between chips, servers and switches. These cables are typically made of copper, which faces physical limitations that could constrain the scale of AI infrastructure.

Above distances of three meters, AECs suffer from losses that reduce energy efficiency and signal quality. To counter this, the cables can be made thicker, which limits flexibility, or fitted with energy-consuming controls. The result is that there is a physical limitation on how long the cables between chips can be and therefore on how big server racks can be. These limitations force servers to be packed more densely, which increases the costs of operating and cooling them. Additionally, the cost to procure copper AECs is likely to climb as the copper supply deficit widens. For more, see *Tracking Copper in Data Centers 2025-2035* (web | terminal).

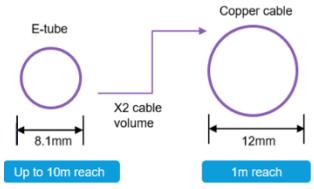
Large incumbents are looking for alternatives to copper AECs for short distances, which includes using co-packaged optical cables that include electrical to optical converter systems. It is an open debate whether optical cable conversion can improve their costs and energy efficiency to be used for rack-scale distances, which opens the door to alternative interconnect technologies.

What is Point2's technology?

Point2 has developed a new kind of interconnect cable for data centers that allows for faster and more energy-efficient communication between AI servers. Point2's technology is a radio frequency (RF) interconnect cable, called an e-tube. Point2's e-tube transmits rack-scale data using high-frequency radio waves in the gigahertz range, guided through a plastic dielectric waveguide. At each end of the plastic 'cable' a radio frequency transmitter/receiver system-on-chip (SoC) converts the signal to and from radio frequency.

Point2 says that its e-tube is roughly half the volume of copper cables, which makes them more flexible for short interconnects between servers (Figure 7). It can also reach up to ten times as far. In combination, this means servers do not need to be packed together so closely, which enables more efficient energy consumption in the data center.

Figure 7: Size and reach of Point2 e-tube compared to a conventional copper interconnect cable



Source: BloombergNEF, Point2.

Point2 says that its e-tube is roughly half the volume of copper cables, which makes them more flexible for short interconnects.

Why is Point2 a Pioneer?

AECs and optical cables have some fundamental physical limits that constrain their operation, so alternatives could allow for more energy-efficient rack designs. Point2's radio frequency semiconductor interconnect technology provides a non-traditional alternative to these incumbent technologies. If Point2 can integrate its e-tube into standard server designs, the technology could help decrease the power density of servers and therefore ease associated energy requirements in data centers. Additionally, large incumbent semiconductor companies are exploring novel ways to scale emerging interconnect technologies, which could benefit Point2 as the market develops.

What's next for Point2?

Point2 raised $22.6 million in Series B funding in 2022, with investors including Molex and Bosch Ventures. Point2's executive team has industry experience at large Silicon Valley companies such as Marvell, NVIDIA and Texas Instruments.

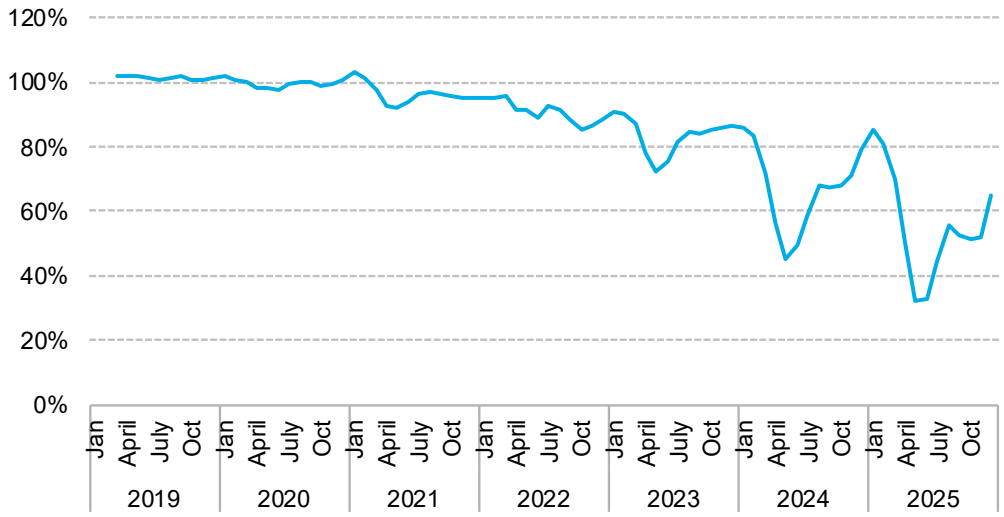
Point2 does not currently have a commercial deployment, but it is working to test its technology with large partners. Point2 is collaborating with Molex, a manufacturer of electrical and fiber-optic cabling, to explore ways to integrate its e-Tube into Molex's interconnect cables. Point2 is also developing its technology with Foxconn Interconnect Technology, a contract electronics manufacturer, and Keysight Technologies, an engineering testing company. Point2 is targeting deployment in data centers in 2027.

3. Challenge 2: Flattening the duck curve

In regions with high renewable deployment, the duck curve phenomenon is already reducing project financial returns and slowing investment.

As solar and wind installations have grown, many grids have come to face steep midday net-load dips and evening ramps, known as the "duck curve." In regions with high renewable deployment, this is already reducing renewable project financial returns and slowing clean energy investment. In Spain, a market where renewables account for 59% of the electricity mix, solar assets captured just 38% of the average power price in July 2025, a strong departure from the 102% premium in July 2020 (Figure 8). For more, see *European Power Merchant Tool* (web | terminal).

Figure 8: Solar scalars in Spain



Source: BloombergNEF, European Power Merchant Tool (web | terminal). Note: Scalars are the ratio of the revenue of solar in the day-ahead market versus baseload power prices.

Innovations in battery storage deployment business models, long-duration energy storage technologies, and demand-response technologies can help balance the grid and increase the revenue that developers can earn for building renewable energy assets.

3.1. Base Power

Why is innovation needed to scale battery deployment?

Batteries can help flatten the duck curve by charging when power prices are low and discharging when power prices are high. This helps shift load based on demand and price signals. The cost of energy storage systems (ESS) is dropping rapidly, and installations are rising in markets with significant intraday power price spreads. Turnkey energy storage system prices fell sharply in 2025 to a global average of $117 per kilowatt-hour (kWh), down 31% from 2024. Expanding the potential for energy storage behind-the-meter through innovative financing models will help scale installations even more quickly and absorb wholesale price pressure from renewable energy generation. For more, see *Energy Storage Systems Cost Survey 2025* (web | terminal).

What is Base Power's business model?

Base Power operates as a "gentailer," meaning that it is a vertically integrated company that is generating and selling electricity.

Base Power is a Texas-based power company that trades electricity in the region's deregulated market using residential ESS as energy assets while selling power to end residential customers. Base Power operates as a "gentailer," meaning that it is a vertically integrated company that generates and sells electricity.

Base Power installs 25-50kWh lithium-ion ESS at customers' homes. It typically charges customers a $695-995 installation fee, plus a monthly membership fee for battery maintenance and monitoring. In exchange, customers using Base's batteries pay energy rates that are below the local market average, and they can use a portion of their storage capacity for backup power during blackouts. Base Power manages the remaining capacity for energy arbitrage in the Electric Reliability Council of Texas (Ercot).

Why is Base Power a Pioneer?

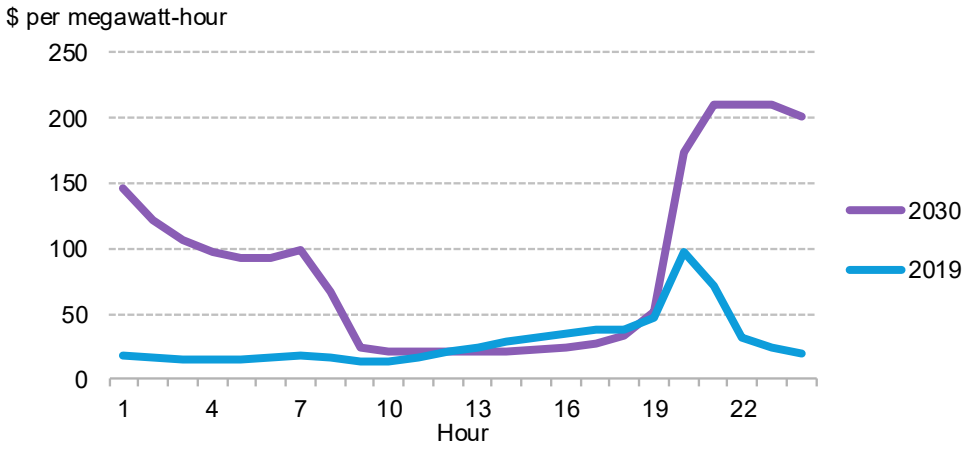
By 2030, the difference between electricity prices during Texas' four highest-priced hours and the lowest-price hours in summer is $186/MWh.

Base Power is a Pioneer because it has identified a good market to prove the business case for scaling residential batteries. Texas has a high risk of blackouts, which means that customers have a willingness to pay upfront for a battery, which is a cheaper option than traditional diesel-powered backup generators. Texas also has high intraday price volatility, which allows Base to generate revenues via energy arbitrage. By 2030, the difference between electricity prices during the four highest-priced hours (8pm-12am) and the lowest-price hours (9am-1pm) in summer will be $186/MWh, compared to a spread of $41/MWh in 2024 (Figure 9). For more, see *Ercot Power Market Outlook 2025: Across-the-Board Ascent* (web | terminal).

The company has raised a significant amount of capital that it can use to scale its operations. Base Power raised $1 billion in Series C funding in October 2025, following a $200 million fundraise six months earlier. It has raised the most capital out of this year's Pioneers cohort.

Base Power may also benefit from US tax credits because it is developing an onshore supply chain. The company is currently building its first energy storage and power electronics factory in Austin, Texas.

Figure 9: Average hourly power prices by hour in Ercot



Source: BloombergNEF. Note: Season is summer. Power price forecast is average across weather years for North Hub. Ercot is the Electric Reliability Council of Texas. MWh is megawatt-hour.

What's next for Base Power?

Base Power currently provides over 300MWhs of battery capacity to 10,000 Texas homeowners.

Base Power is scaling its battery deployments across Texas. It currently provides over 300MWhs of battery capacity to 10,000 Texas homeowners. To expand residential deployments, it partnered with Lennar, a large homebuilding company, to offer select Texas homeowners a discounted Base Power backup battery and registration for Base Power's monthly electricity service.

Going forward, Base Power is growing its utility partnerships and expanding into new markets. Base Power announced a 100MW residential storage program with CoServ in March 2026 and a pilot program with El Paso Electric (EPE) in February 2026. This builds on existing relationships with Texas utilities including Farmers Electric Cooperative and Guadalupe Valley Electric Cooperative.

Base Power is also planning to expand its services beyond Texas. It received a license to operate as an alternative retail electric supplier in Commonwealth Edison's (ComEd) service territory, an Illinois utility which is part of PJM, in March 2026. PJM is seeing an upward trend in capacity prices due to tightening supply-demand balances, which is expected to persist as load in the region continues to grow. Higher capacity prices could improve the economics for installing residential storage in the ComEd service territory. For more, see *PJM Power Market Outlook 2026: Brace for Impact* (web | terminal).

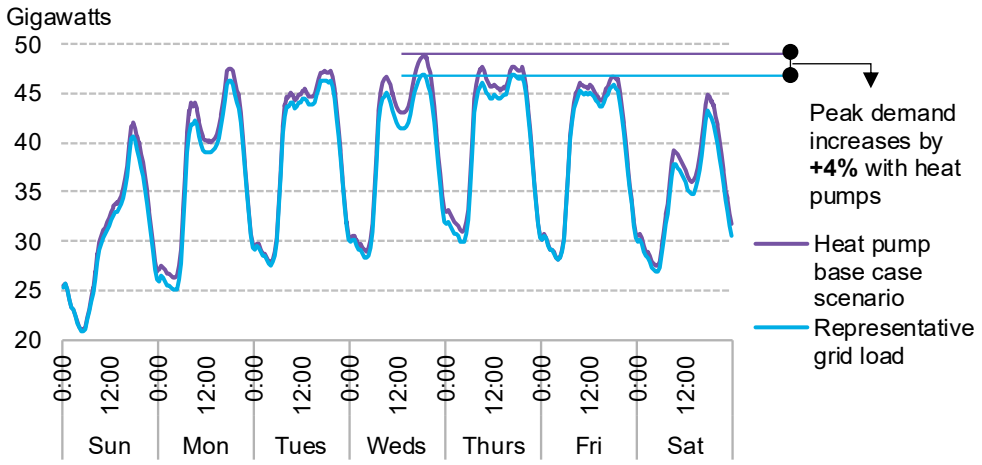
3.2. Qvantum

Why is innovation needed to make heat pumps more flexible?

In the UK, if 1.2 million heat pumps are installed by 2029 annual peak power demand could rise by 4%.

Electrifying heating with heat pumps will add to power demand in many European markets, especially on cold winter evenings when solar generation is at its lowest and heating spikes when people come home. This makes it harder for solar generation to meet this increase in demand and further exacerbates grid stress. In the UK for example, if 1.2 million heat pumps are installed by 2029 and heat all day, annual peak power demand could rise by around 4% (Figure 10). Meeting this increased demand through supply-side interventions would require additional grid and generation investment.

Figure 10: Impact of heat pumps on peak electricity demand, UK study



Source: BloombergNEF's HeatLoad model, National Energy Systems Operator. Note: Heat pump scenario is the load impact of 1.2 million heat pumps operating inflexibly. Typical year for grid data was 2019, which has a temperature profile that is most representative of the past 10 years. Chart is for week January 27-February 2.

Shifting electricity demand for residential heating into hours of high renewable production is an attractive opportunity for flattening the duck curve.

Flexibly operated heat pumps could help mitigate this problem. Demand-side flexibility of heat pumps would mean customers heat their homes when electricity prices are lower and renewable power generation is higher. In the UK, the increase in peak power demand as a result of electrified heating is halved if heat pumps are operated flexibly. For more, see *Heat Pumps Push Up Peak Power By 4% In The UK by 2029* (web | terminal).

What is Qvantum's technology?

Qvantum has developed flexible heat pumps that have larger integrated thermal storage, around 12kWh per unit, than a standard residential heat pump (2-4kWh) (Figure 11). This thermal storage allows the heat pumps to store excess energy when electricity prices are low and shift up to 10 kilowatts (kW) of load away from peak times. Qvantum's heat pumps shift load via software, which optimizes heat pump operations against day-ahead wholesale electricity prices. This allows the owners of the heat pumps to either earn an additional source of revenue if they are enrolled in a demand-response program or reduce their energy cost through time-of-use tariffs.

Figure 11: Qvantum QE exhaust air heat pump

Source: Qvantum

Qvantum has also developed a thermal loop system that connects these flexible heat pumps across multi-family housing units – and the idea would be they eventually connect across districts or cities. Qvantum's heat pumps can use low-temperature waste heat from sources such as data centers or industry, feeding that into the thermal loop, which improves the efficiency of the heat pump and decreases carbon emissions.

Why is Qvantum a Pioneer?

Qvantum is a Pioneer because shifting electricity demand for residential heating into hours of high renewable production is an attractive opportunity for flattening the duck curve, particularly in European markets with high renewable penetration. By combining thermal storage hardware with flexibility software, it offers an all-in-one solution for grid balancing that is simpler to deploy than some alternative flexibility mechanisms.

Qvantum's heat pumps allow for new deployment opportunities, particularly in cities.

Qvantum's apartment-friendly heat pump models also expand the housing types that can use flexible heat pumps. Most heat pump deployments today remain concentrated in single-family homes, but Qvantum's heat pumps allow for new deployment opportunities, particularly in cities. It has installed thousands of its heat pumps in multi-family buildings throughout European cities including London, Dublin and Amsterdam.

Qvantum is already making significant progress to scale its heat pump technology. It has a strong presence in the European heat pump market and decades of experience in heat pump manufacturing. The company builds on the legacy of Qvantum Energi, which was founded in 1993 as a heat pump manufacturer. It merged with the current company in 2021 through a management buyout and has since expanded into seven European markets. Its manufacturing capabilities in Europe are expanding to support this growth. Qvantum acquired a large-scale manufacturing facility in Hungary from Electrolux in 2023, and it operates a manufacturing facility in Sweden. Qvantum is aiming for the combined production from these facilities to reach roughly 300,000 heat pumps per year in 2027.

What's next for Qvantum?

Qvantum is growing its commercial relationships with wholesalers, distributors, and home builders in Europe. Qvantum entered into a strategic partnership with Heinz von Heiden GmbH (HvH), a German housing services company, in March 2026. It signed a multi-year agreement with Bad & Värme, one of Sweden's largest HVAC installation chains, in January 2026. It also announced a partnership with a UK-based electric heating company called Fischer Electric in June 2025. Qvantum raised $111 million in Series C capital in 2025, bringing its total funding to $179 million.

3.3. XL Batteries

Why is innovation needed in long-duration storage?

High capital costs and elevated development risks continue to constrain LDES near-term deployment.

The need for long-duration energy storage (LDES) is rising, as renewable energy generation grows. This increases the need for storing energy for longer periods of time to address intermittency. LDES deployment has grown rapidly, reaching 8.1GW in 2025, a fourfold increase from the year prior. However, cost and technological barriers remain to scaling LDES technology. Most novel LDES technologies remain at an early stage of commercialization, with high capital costs and elevated development risks continuing to constrain near-term deployment. For more, see *2026 Long-Duration Energy Storage Outlook* (web | terminal).

What is XL Batteries' technology?

XL Batteries designs and manufactures an organic flow battery for utility-scale LDES applications. Flow batteries are a type of rechargeable battery that store energy in liquid electrolytes kept in large tanks. During charging and discharging, the electrolytes release electricity by circulating the liquid through a battery stack. Flow batteries typically rely on vanadium-based electrolytes that are costly and corrosive. XL Batteries' technology uses a patented water-based, organic electrolyte that is non-toxic and non-flammable, within the same flow battery architecture. Its electrolyte is derived from widely available petrochemical feedstocks.

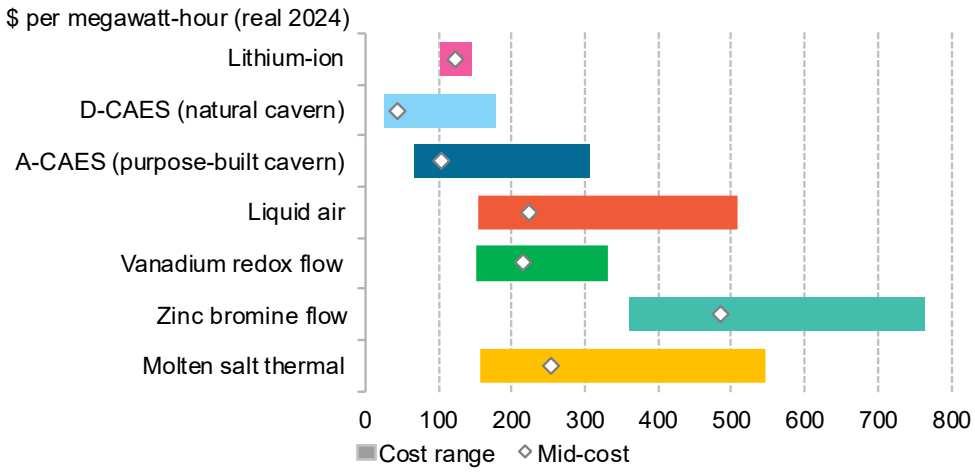
Why is XL Batteries a Pioneer?

XL Batteries is a Pioneer because its technology addresses some of the main limitations of vanadium redox flow batteries – namely material cost. Vanadium redox flow batteries are currently pricier than lithium-ion alternatives, though the cost gap is narrowing. BNEF estimates that the levelized cost of storage for vanadium redox flow batteries outside of China in 2024 was

XL Batteries says it could achieve a levelized cost of $50/MWh for over ten-hour durations.

$214/MWh, compared to $122/MWh for lithium-ion batteries, assuming durations from 6-120 hours (Figure 12). XL Batteries says it could achieve a levelized cost of $50/MWh for over 10-hour durations. For more, see *Levelized Cost for Long-Duration Storage Nears Parity* (web | terminal).

Figure 12: Levelized cost range for fully installed storage systems in non-Chinese markets in 2024



Source: BloombergNEF. Note: Storage technologies shown here span durations from six to 120 hours. We assume one cycle per day (365 cycles annually). For storage durations beyond 12 hours, only 12 hours will be stored and dispatched. Only LDES technologies with adequate cost data from our survey are included here. D-CAES = diabatic compressed air energy storage, A-CAES = adiabatic compressed air energy storage. For non-Chinese markets, US lithium-ion battery costs are used as the benchmark.

XL Batteries can be deployed in population-dense areas without the permitting, safety or siting constraints of lithium-ion or vanadium redox flow systems.

XL Batteries' organic flow batteries have additional benefits. Unlike vanadium redox flow batteries which are corrosive and toxic, XL Batteries' organic electrolyte is non-toxic. This means that XL Batteries can be deployed in population-dense areas without the permitting, safety or siting constraints of lithium-ion or vanadium redox flow systems. XL Batteries also says its batteries can safely store energy from short durations to up to 250 hours, which is on the upper end of battery life for LDES. These cost, safety, and storage duration claims will need to be validated in future large-scale commercial deployments.

XL Batteries is positioned to benefit from US domestic manufacturing incentives and the storage investment tax credit, as it plans to build US installations with domestically sourced materials.

What's next for XL Batteries?

The company has raised $30 million since its founding in 2019 and is now developing early commercial pilots. The company commissioned its first fully integrated commercial pilot with Stolthaven Terminals in 2025, which is a provider of storage services for chemicals and gases. XL Batteries announced a multi-year agreement with Prometheus Hyperscale in May 2025 to begin demonstrating its systems at US data centers. This matters because data center developers and utilities are beginning to look toward novel LDES applications as a source of demand-side flexibility and backup power. The 333kW demonstration-scale battery project is scheduled for completion in 2027. For more, see *Data Centers' Energy Storage Ramp Up: AI Drives New Uses* (web | terminal).

4. Challenge 3: Decarbonizing shipping and heavy-duty transport

Significant technological innovation is needed for the shipping and transport sectors to achieve net-zero emissions.

Shipping and heavy-duty road transport are challenging sectors to decarbonize because they face steep technical and economic barriers, including long duty cycles, energy-dense fuel needs and fragmented infrastructure. BNEF expects carbon emissions from these sectors to fall by roughly a quarter by 2050 thanks to fuel switching and electrification. However, significant technological innovation is needed for the sector to achieve net-zero emissions.

4.1. DeepWay

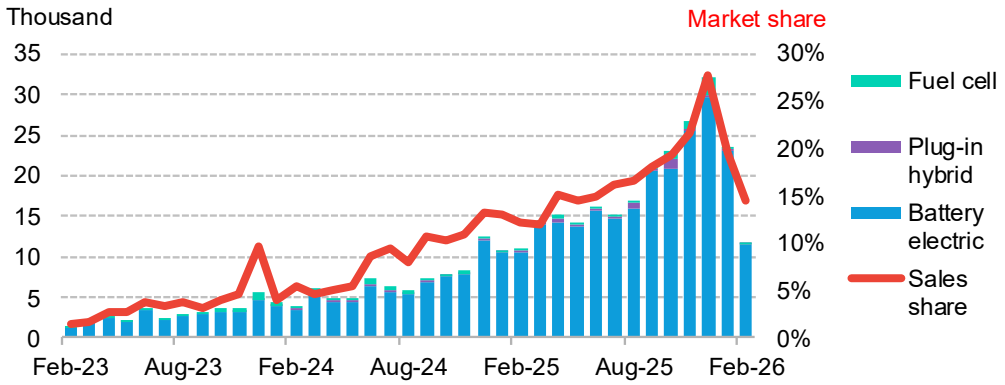
Why is innovation needed in electric trucking?

The electrification of trucking is a critical transport decarbonization route. Today the commercial-vehicle sector is far from a trajectory leading to net-zero CO_2 emissions. The global heavy-duty electric truck fleet grows to 53 million vehicles by 2050 to achieve net zero in BNEF's Net Zero Scenario, up from less than 400,000 such vehicles on the road as of 2025. Policy uncertainty and the relaxation of CO_2 emission rules in the US and EU are major barriers to achieving that level of growth. These pressures have already weighed on some electric trucking companies, with several going bankrupt in recent years. For more, see *Electric Vehicle Outlook 2025* (web | terminal).

Even in China, the world's most advanced electric-vehicle market, further electrification is still needed to align with net-zero pathways.

Even in China, the world's most advanced electric-vehicle market, further electrification is still needed to align with net-zero pathways. Electric medium- and heavy-duty commercial vehicles made up roughly 20% of total truck sales in China, with 211,000 sold in 2025 (Figure 13). This growth is driven by legacy Chinese machinery makers and electric truck manufacturers. Electric trucking startups could help grow the market share of electric vehicles by offering differentiated products, including drivetrain and battery innovations, as well as driver assistance technology.

Figure 13: Electric medium- and heavy-duty commercial vehicles sales in China



Source: BloombergNEF, China Automotive Technology and Research Center.

What is DeepWay's technology?

DeepWay is a Chinese company that manufactures and sells technology for heavy-duty electric trucking and intelligent road freight. It currently sells two electric truck models: DeepWay Star (2021) and DeepWay Xingtu (2025). The trucks have three design features that differentiate them from legacy e-truck designs:

1. They are aerodynamically designed with wedge-shaped cabs to decrease wind resistance and drag (Figure 14). This design lowers battery consumption per mile, allowing for a longer driving range.

Figure 14: DeepWay Star Model

Source: DeepWay

2. They have large, 600kwh battery packs located at the bottom of the truck and integrated into the chassis, which is the steel frame that runs under the truck. This design frees up space in the back of the truck and can increase cargo volume by roughly 10%, compared to traditional battery-swapping heavy-duty trucks.
3. They are mounted on a platform that is specifically designed for electric trucks, rather than being mounted on legacy diesel platforms. This can improve the weight distribution, aerodynamics, and range of electric trucks, making them more suited to regional and long-haul use cases.

Additionally, DeepWay models are equipped with driver assistance software, which is powered by technology from Chinese tech giant Baidu. Current models are designed with Level 2 Advanced Driver Assistance Systems (ADAS), which helps drivers detect obstacles and reduce accidents. DeepWay plans to use operational data gathered from Xingtu trucks to develop Level 4 ADAS trucks, which could be operated without a driver. It plans to deploy these trucks in 2027.

Why is DeepWay a Pioneer?

DeepWay has scaled quickly, selling 6,400 heavy-duty electric trucks as of 1H 2025.

DeepWay is a Pioneer because electric trucking in China is growing quickly, and DeepWay has the partnerships and technological innovations to capture a share of the market. DeepWay was founded in 2020 as a joint venture between Lionbridge, a major vehicle logistics company, and Baidu. This backing gives it a technical edge in the growing autonomous electric truck market in China. Additionally, DeepWay's design features make the trucks more energy efficient. The company has scaled quickly, selling 6,400 heavy-duty electric trucks as of 1H 2025.

What's next for DeepWay?

DeepWay raised $173 million in pre-IPO funding in January 2026, ahead of a planned Hong Kong initial public offering. The company's revenue was roughly $200 million in 1H 2025, but it hadn't yet made a profit, according to its prospectus. It expects to continue incurring net losses in the near term as it increases investments in R&D, sales and production.

Going forward, DeepWay is expanding its deliveries in markets beyond China. It delivered trucks to the UAE and Oman in September 2024 and New Zealand in March 2026. It remains to be seen how quickly DeepWay will scale in these markets, where electric transport infrastructure is less mature than in China.

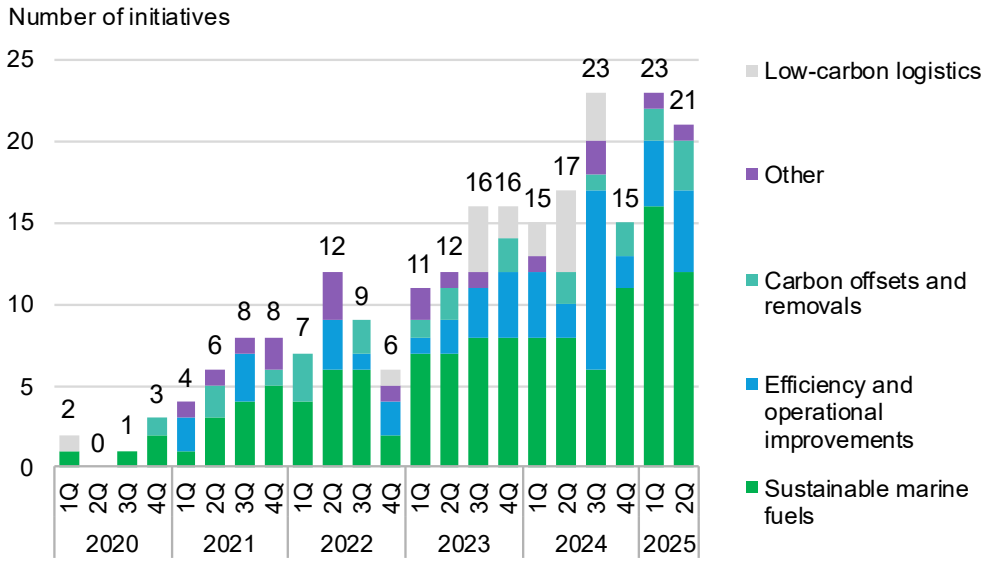
4.2. Silverstream Technologies

Why is innovation needed in shipping efficiency?

Efficiency gains enhance both cost competitiveness and decarbonization compliance readiness.

Efficiency and operational improvements are emerging as critical strategies for shipping decarbonization, particularly in light of the high cost and limited supply of sustainable marine fuels. Efficiency and operational improvements made up 21% of all shipping operator decarbonization strategies from 2020 to 2025 (Figure 15). These improvements are not a substitute for switching to sustainable marine fuels, but a complementary pathway that enhances both cost competitiveness and decarbonization compliance readiness. For more, see *Low Carbon Strategy Playbook for Clean Shipping* (web | terminal).

Figure 15: Shipping operator decarbonization strategy trends



Source: BloombergNEF, company disclosures. Note: January 1, 2020 – June 30, 2025.

What is Silverstream's technology?

Silverstream makes an air lubrication system (ALS) for commercial ships that reduces the drag between a vessel's hull and the surrounding water. It installs air compressors along the flat bottom of large vessels which release a uniform layer of microbubbles (Figure 16). These microbubbles help decrease frictional resistance, which results in lower fuel consumption and emissions. Silverstream sells its product to shipyards or shipowners and provides maintenance support throughout installation and operations.

Why is Silverstream a Pioneer?

Silverstream is a Pioneer because it offers a straightforward path to shipping decarbonization: using less fuel. The company says that its efficiency gains save 5-10% on net fuel, which will bring shipping companies significantly closer to meeting regulatory decarbonization requirements. The technology can be used in conjunction with other decarbonization strategies, including fuel switching, carbon offsets and supply chain management.

Silverstream's technology is also notable for its versatility. The ALS can be installed onto a wide range of vessels that have large, flat bottoms, including passenger cruise ships, LNG carriers and container ships. It can be added as a retrofit to existing ships in under 10 days, or it can be installed on newbuilds. Because of this versatility, Silverstream has scaled quickly. Its technology is now installed on over 150 vessels, including those owned by BP, Chevron, ExxonMobil, Maersk, MSC, Carnival, Princess and Vale.

Figure 16: Illustration of Silverstream's air lubrication system beneath a vessel

Source: Silverstream Technologies

Silverstream will supply its ALS to nine newbuild ships, contracted by the Grimaldi Group at China Merchants Industry Weihai Shipyard Co.

What's next for Silverstream?

Silverstream was one of the first movers in the air lubrication space in 2010, and it has since demonstrated its technology at scale. It signed an agreement for its first full-scale installation with Shell in 2013 and completed its first pilot installation on a 40,000-deadweight tonnage tanker in 2014. Silverstream began cruise ship installations in 2016, with Carnival Cruise Line as its first cruise customer.

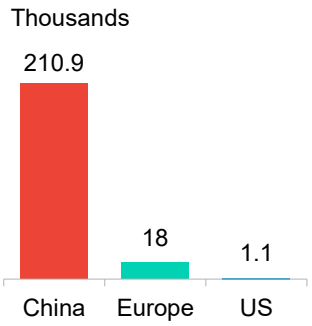
Silverstream's presence in APAC is growing. It signed its first APAC order in 2021, where it's adding the ALS to 12 liquefied natural gas carrier (LNGC) newbuilds at Hyundai Heavy Industries Shipyard. In December 2025, Silverstream signed a deal to supply its ALS to nine newbuild ships, contracted by the Grimaldi Group at China Merchants Industry Weihai Shipyard Co.

4.3. WattEV

Why is innovation needed in the business of truck charging?

The pace of adoption of electric commercial vehicles is a limiting factor for charging companies, particularly in the US. Although many charging companies have emerged to serve this segment, adoption is currently extremely low in the US compared to other regions. Sales in China and Europe are roughly 188 and 16 times higher than in the US, respectively (Figure 17). This creates a self-reinforcing cycle: charging infrastructure will struggle to scale without more electric commercial vehicles on the road, and fleet operators may be reluctant to shift to electric vehicles without more readily available charging infrastructure. Companies that can address both sides of this equation have the potential to bring more electric medium- and heavy-duty commercial vehicles to American roads.

Figure 17: Electric medium- and heavy-duty commercial vehicle sales by region in 2025



Source: BloombergNEF, European Alternative Fuels Observatory, ACEA, EV-Volumes, Marklines, China Automotive Technology and Research Center.

What is WattEV's technology?

WattEV is a US-based vertically integrated electric trucking and charging provider. The company operates six large, high-power charging depots near ports and freight corridors in California (Figure 17). Through its "charging-as-a-service" model, fleets and carriers pay for access to WattEV's charging network, along with associated electricity use and operational support. WattEV says that its charging depots can charge a heavy-duty truck in under 30 minutes for a 300-mile range. Some of these charging sites have on-site solar and storage for backup power.

WattEV also leases Class 8 battery-electric trucks to trucking companies through its "trucking-as-a-service" model. The leases include truck access, maintenance support, insurance, charging access and telematics. It currently has 75 heavy-duty trucks in its fleet, with an additional 100 coming this year. Half of its fleet is leased to outside companies, and the other half is driven by WattEV truck drivers.

In addition to providing charging and leasing services, WattEV runs route optimization software for truck drivers. The proprietary software plans routes based on battery range, charger availability, energy use and uptime. WattEV assigns these routes to its drivers or brokers them to its truck customers.

Why is WattEV a Pioneer?

WattEV is accelerating electric truck adoption in the US and providing a pathway for future adoption. The company's vertically integrated model makes the business more scalable and helps overcome the fragmentation that limits other players in the sector. WattEV has built one of the state's largest heavy-duty public access electric truck charging networks by capacity and operates one of the largest electric trucking fleets in the US (Figure 18). Its route optimization software

helps manage charging schedules for large fleets to avoid peak charging hours, which is important in California due to the state's high electricity costs.

The company has received strong public and private backing that has helped it scale. Apollo-managed funds and Vitol provided structured debt and equity financing to WattEV in 2023. It also received a $75.6 million grant from the US Federal Highway Administration in 2024 and $33.6 million from the Transport Corridor Enhancement Program in 2023.

WattEV is also positioned to benefit from California's electric trucking incentive programs, including vouchers that reduce the upfront cost of purchasing electric trucks, funding for setting up charging infrastructure, and credits for low-carbon fuel alternatives. These incentives help lower the upfront costs that WattEV incurs for purchasing trucks and building its charging depots, which allows it to charge rates that are more competitive with the cost of operating diesel trucks.

Figure 18: WattEV's California charging hubs

Source: WattEV. Note: Green fill indicates open locations. White fill indicates sites under development.

WattEV is also developing innovations to build high-speed charging infrastructure using its own modular solid-state transformer technology.

What's next for WattEV?

WattEV is working to grow its charging infrastructure and fleet operations. It aims to place 12,000 heavy-duty electric trucks on California roads by 2030 and have 100 charging stations in operation by 2035. It doubled the capacity of its San Bernardino truck charging depot in January 2026, which will now be able to charge 200 electric trucks per day and offer megawatt charging capability. It broke ground on its sixth California charging depot at the Port of Oakland in June 2025, which it says will be capable of charging 25 medium- and heavy-duty electric trucks concurrently at up to 240KW each. In February 2025, it announced an agreement with Tesla to deliver 40 Tesla Semi trucks to the Port of Long Beach in 2026.

WattEV is also developing innovations to build high-speed charging infrastructure in California. It designed modular solid-state transformer (SST) technology in 2025, which could provide direct current power to EV charging hubs**.** This allows for more efficient use of power and lower charging costs. The technology is also applicable to data centers.

WattEV faces some uncertainties due to federal policy shifts. Congress rolled back California's Advanced Clean Trucks rule in June 2025, which would have required manufacturers to increase the number of zero-emission cars and trucks sold over the next decade. With uncertainty around the future of these policies, electric truck adoption will need to be driven by improved economics and charging infrastructure.

5. Wildcards

5.1. BasiGo

Why is innovation needed in the financing of e-bus deployment?

Electric bus deployment is growing in many markets, including China, India, Europe and parts of Latin America. However, in many African markets, fossil-fuel powered transport remains dominant. In Kenya, for example, petrol and diesel-engine vehicles comprised over 95% of vehicle registrations from 2018 to 2023. This matters because fossil-fuel powered vehicles are emissions-intensive and environmentally hazardous. In Kenya, 57% of total energy-related CO_2 emissions came from the transport sector in 2023, according to the IEA.

One of the major barriers to scaling e-bus deployment is the high upfront cost compared to diesel-powered vehicles. Innovative financing mechanisms that lower the cost of operating e-buses will help scale e-bus deployment in Kenya.

What is BasiGo's technology?

BasiGo is a vertically integrated company operating e-buses and charging infrastructure in Kenya and Rwanda. BasiGo imports bus parts from China and then assembles them locally at the Kenya Vehicle Manufacturers' plant. This helps reduce import duties and accelerates their capability to bring production online, with output expected to rise to 20 buses per month in 2026. In Rwanda, the company imports fully built buses and deploys them in partnership with operators.

BasiGo's primary innovation is in its financing model, called "pay-as-you-drive" (PAYD). After BasiGo assembles its e-buses, local operators pay the company a small initial deposit for the bus, plus a daily fee based on how many kilometers they drive. The PAYD fee includes the cost of battery leasing, charging, and routine maintenance. This leasing model lowers the upfront cost that operators incur for acquiring e-buses, which is one of the primary barriers to adoption in Kenya. It also provides a source of monthly recurring revenue to BasiGo.

In addition to its leasing service, the company manages a DC fast charging network in Kenya and Rwanda (Figure 19). It currently operates eleven charging sites along city and intercity bus routes. The charging sites double as service centers at night and are open to passenger EVs during the day, which is an additional source of revenue for BasiGo.

Figure 19: BasiGo bus at charging depot

Source: BasiGo

Why is BasiGo a Pioneer?

BasiGo has developed a leasing model that lowers the upfront cost of adopting e-buses in Kenya and Rwanda.

BasiGo is a Pioneer because it has developed an innovative leasing model that lowers the upfront cost of adopting e-buses in Kenya and Rwanda, as well as financing, service, and charging infrastructure. BasiGo's subscription-based model can help increase demand for e-buses in Kenya and Rwanda, where fleet operators may otherwise find the upfront costs of these vehicles too high to bear themselves. Its accompanying charging infrastructure helps scale deployment of e-buses in a region where such infrastructure is otherwise limited. Charging e-buses in Kenya also has a low carbon intensity because 91% of Kenya's electricity generation comes from renewables.

Policy shifts in Kenya are signifying a growing interest in scaling e-bus deployment in the region. Kenya announced incentives for charging infrastructure, e-buses and EV parts under its new National Electric Mobility Policy in February 2026. These incentives include zero-rated value-added tax on e-buses. Together, these measures are expected to reduce the cost of acquiring and assembling e-buses, improving the overall economics for operators such as BasiGo.

What's next for BasiGo?

Since its founding in 2021, BasiGo has become a major player in the African e-bus market. BasiGo has deployed over 130 e-buses in Kenya and Rwanda, and it aims to expand to 1,000 buses in the next few years. This includes new bus deployments at schools. BasiGo sold 11 vehicles to the School of the Nations in March 2026. It also plans on installing its charging infrastructure on the school's grounds.

To scale up local assembly, BasiGo has a partnership with King Long Bus Company and Kenya Vehicle Manufacturers.

The company has developed strong partnerships to scale its e-bus deployment and charging infrastructure. It sources its buses from major vehicle manufacturers in China such as BYD, CHTC, and King Long. To scale up local assembly, BasiGo began a partnership with King Long Bus Company and Kenya Vehicle Manufacturers in September 2025. On the charging side, it partnered with Vivo Energies (Shell) to deploy its charging infrastructure at three Shell service stations in Kenya. It plans to build more inter-city charging infrastructure outside of the Nairobi metropolitan area in the coming years.

BasiGo has raised funding from infrastructure and development-finance investors to help grow its fleet. The company has raised $52 million in combined equity and debt since its founding, with funders including Africa50, British International Investment, and the US International Development Finance Corporation.

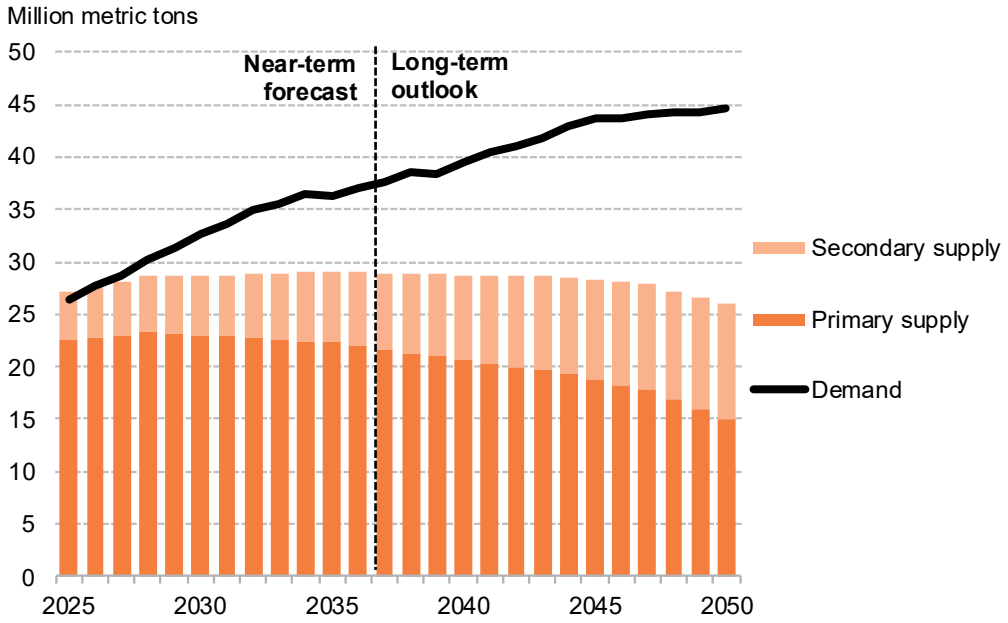
5.2. Endolith

Why is innovation needed in copper mining?

Copper is projected to move into a structural deficit starting this year, which widens to 28 million metric tons in 2050 under BNEF's Economic Transition Scenario (Figure 20). An extended supply crunch could elevate prices over a long period, leading to a slowdown in the deployment and adoption of clean technologies due to higher infrastructure costs and scarcity of raw materials. For more information, see BNEF Theme: *Copper Supply Squeeze Haunts Energy Transition* (web | terminal).

Copper is projected to move into a structural deficit starting this year, which widens to 28 million metric tons in 2050.

Figure 20: Global copper supply and demand balance



Source: BloombergNEF. Note: Supply is based on BNEF's announced asset-level supply analysis and benchmarking, and represents risk-adjusted capacity. Secondary supply includes collected scrap and battery recycling material availability. Demand is under BNEF's Economic Transition Scenario.

Declining ore grades are also a massive problem in the copper mining industry that increases the energy requirements and production costs of mining. Innovation is needed to find more efficient and economical methods for extracting copper from low-grade ore.

Innovation is needed to find more efficient and economical methods for extracting copper from low-grade ore.

What is Endolith's technology?

Typically, after extracting copper ore from the earth, mining companies recover target metals either through high-temperature smelting (pyrometallurgy) or by leaching sulfuric acid over large "heaps" of rock (hydrometallurgy). Interest in heap leaching is growing as an effective way to extract metals from the lower grade, yet more abundant, oxide ores.

Endolith's technology is a microbial catalyst that means more copper can be recovered from the ore.

Endolith's technology introduces tailored microbial consortia into the hydrometallurgical process. Endolith deploys a modular "bio-hatchery" next to a heap of low-grade ore, where it uses adaptive laboratory evolution to select microbes that are suited to that specific ore body's chemistry and conditions, including acidity, temperature, salinity, and metal concentrations. These microbes are then added to the circulating leach solution. Through enzymatic activity, the microbes accelerate iron and sulfur oxidation reactions within the heap, increasing reaction rates and helping raise temperatures above ambient. This allows for more efficient leaching and increased copper recovery from existing ore.

Why is Endolith a Pioneer?

Endolith's technology, which can be implemented as a drop-in solution, is one of few innovations that exist in the market to help boost the capacity of existing copper mines. This is important because the incoming supply crunch for copper could limit the roll out of key technologies that use large amounts of copper, such as EVs, wind turbines and electric grids. Copper mines can take over a decade to come online, which means that the high prices induced by the supply crunch are unlikely to be quickly resolved solely by new mining capacity. Boosting capacity of existing facilities can provide some short-term relief while new capacity is brought online.

Endolith's microbes, in early testing, can help recover up to 1.7-1.9x more copper from low-grade ore.

In addition, Endolith's technology has proven technologically successful in early testing. Endolith found that its microbes can help recover up to 1.7-1.9x more copper from low-grade ore under validated test conditions, compared to incumbent hydrometallurgy processes.

What's next for Endolith?

Endolith is working with some of the world's largest mining companies to begin field testing its product. It is part of the Founders Factory Mining Tech Accelerator, operated in partnership with Rio Tinto, which provides access to testing environments representative of operating mines. It was also part of BHP's Think and Act Differently program, where it conducted column tests to trial its technology under simulated operating conditions. These early research partnerships helped Endolith raise its initial round of capital, closing a $16.5 million Series A round in 2025.

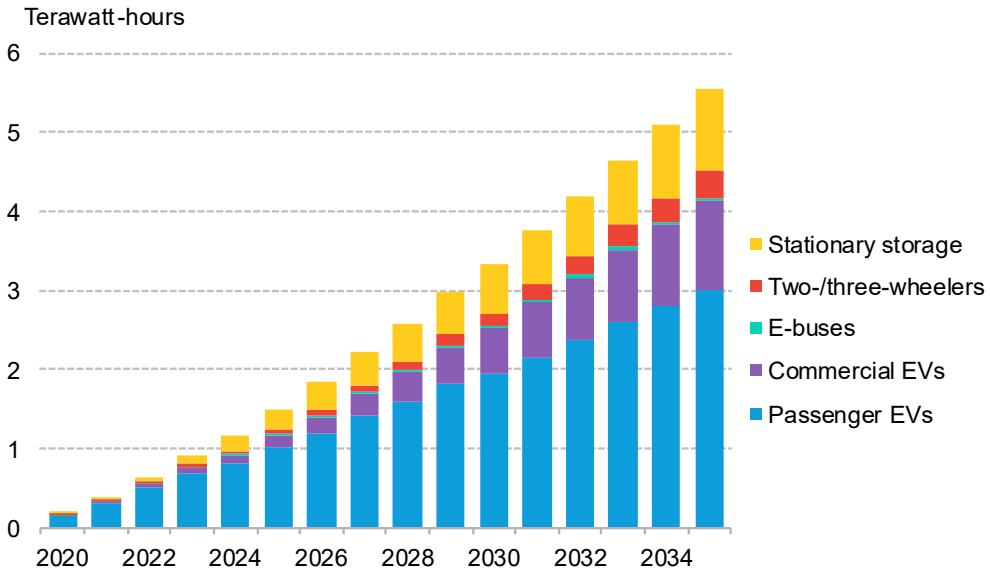
Endolith eventually aims to sell subscription-based, multi-year service agreements to large copper producers. It is targeting early deployments in North America and key Latin American markets, including Chile and Peru. Together, these markets made up 40% of copper mine production in 2024, according to the US Geological Survey.

5.3. GRST

Why is innovation needed in lithium-ion battery design?

Lithium-ion batteries are central to the energy transition, and demand for them across various applications is rising. Global battery demand for electric vehicles and stationary energy storage is set to grow to 5.5TWh in 2035, from 1.5TWh in 2025 (Figure 21). For more, see *Lithium-Ion Batteries: State of the Industry 2025 (1.2)* (web | terminal).

Figure 21: Global battery demand for stationary storage and electric vehicles



Source: BloombergNEF. Note: Transport-related battery demand is based on the Economic Transition Scenario in BNEF's Long-Term Electric Vehicle Outlook 2025. Base-case battery demand for energy storage systems is based on the 2H 2025 Energy Storage Market Outlook, while Net Zero Scenario values are from the New Energy Outlook 2024.

There will likely be a growing interest in batteries that are designed with PFAS-free alternatives.

Lithium-ion batteries are typically designed with chemicals called per- and polyfluoroalkyl substances (PFAS) to make them resistant to heat, water and stains. PFAS can be found in lithium-ion battery cells as binders, in electrodes and separator coatings, and in additives as electrolytes. Because of their strong carbon-fluorine bonds, PFAS do not break down easily. When the batteries are recycled or disposed of, these "forever chemicals" linger in the environment and can contaminate groundwater and cause risks to human health. In response to these risks, the EU Chemicals Agency is moving toward restricting the use of PFAS in battery manufacturing. This means there will likely be a growing interest in batteries that are designed with PFAS-free alternatives.

What is GRST's technology?

Figure 22: GRST's water-soluble binder technology

Source: The Earthshot Prize, GRST

GRST is developing a new type of PFAS-free binder for lithium-ion batteries. Binders function as the "glue" in a battery, adhering the active materials, such as electrodes, to the current collector. When batteries are charged and discharged, the binders ensure that the electrode materials stay in place while the ions move freely. Lithium-ion battery binders are commonly made from polyvinylidene fluoride (PVdF), a PFAS with high electrochemical stability and adhesive strength. GRST's binder material is a drop-in replacement for PVdF that is made of a non-fluorinated, water-soluble polymer. This means that when batteries with GRST's binders are recycled, the metals inside can be recovered in water without emitting toxic PFAS chemicals into the environment (Figure 22).

Why is GRST a Pioneer?

GRST is a Pioneer because it offers a drop-in solution that improves battery recycling and disposal, which is a key bottleneck in deploying clean energy technology. GRST says that its

binder matches the performance and cost of conventional PVdF binders and is compatible with existing production equipment. It has been proven at scale, with over 200 MWh of cells in the market using GRST's binder.

GRST says that its binder matches the performance and cost of conventional PVdF binders and is compatible with existing production equipment.

GRST also has commercial relationships and a factory in China, where a large share of lithium-ion cells are manufactured and recycled. This allows it to integrate its binder into existing battery supply chains in China. It can then export it to markets like the EU, where there is growing demand for PFAS-free binder alternatives.

What's next for GRST?

GRST has scaled up its manufacturing capabilities since its founding in Hong Kong in 2015. It operates a 1GWh battery binder factory and a 0.5GWh cell factory in China, and its binder is being integrated by third-party cell manufacturers in China and Europe. It aims to reach 10GWh of binder production by the end of 2026.

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