# McKinsey Sustainability

## How incumbents can succeed in climate-driven growth investments

As incumbents navigate through cycles, early movers-and our hyperscaling formula-offer insight into how to approach and successfully build climate technology businesses.

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While there has been a recent, notable shift in sentiment toward investing in climate solutions, it is important for companies to maintain a long-term, through-cycle view, as action to mitigate emissions is needed more than ever. Corporate investments in building new climate technology businesses have been rising consistently from 2019 to 2023, driving growth for those investing actively, but current deployment levels of low-emission technologies are at only 10 percent of the levels required to reach net zero by 2050.<sup>1</sup>

Incumbent companies, particularly in capital-intensive industries, can play a role in bridging these gaps. As some of the most well-established companies across the globe, these incumbents have inherent advantages including balance sheet size, organizational scale, experience in capital project delivery, and strategic and R&D capabilities. There has been recent turmoil—including announcements of delayed investment, abandoned projects, and watered-down corporate decarbonization commitments—but looking at the historical development from 2019 to 2023, there has also been a clear ramping up in investment. In the midst of recent headwinds, it is imperative for incumbents to also focus on profitability to ensure sustainable growth, as they navigate through cycles in climate technology businesses.

This report looks at the incumbent companies that have invested in new climate tech-driven businesses in the recent past to identify what can be learned from their experiences. We explore how incumbents can use our hyperscaling formula—based on our work on climate technology since 2022—to scale climate tech businesses. The report then analyzes some early movers to distill lessons learned, with a distinct set of questions for incumbents to assess their current position on and approach to climate-driven growth investments.

#### Incumbents' investment in climate-driven growth businesses

Our analysis found that investment into climate-driven growth businesses—made by 377 of the largest capital-intensive incumbents by market capitalization—increased sixfold between 2019 and 2023, to a cumulative total of \$683 billion (Exhibit 1). The outlays included capital expenditure into climate tech—driven growth, R&D spending, equity investments, venture capital (VC) stakes, shifts in core portfolios toward climate technology, and spin-offs of climate tech—focused businesses (see sidebar "Our methodology"). These investments were centered on the 12 categories of climate technologies that could potentially reduce as much as 90 percent of total man-made greenhouse gas emissions.<sup>2</sup>

Incumbents in the power, automotive, and oil and gas sectors invested the most in climate-driven businesses over this five-year period. Two of those three sectors—oil and gas and automotive— also had the highest growth rates.

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<sup>&</sup>lt;sup>1</sup> "The hard stuff: Navigating the physical realities of the energy transition," McKinsey, August 14, 2024. <sup>2</sup> "What would it take to scale critical climate technologies?," McKinsey, December 1, 2023.

#### Exhibit1

#### Climate-driven growth investments surged sixfold between 2019 and 2023.



#### Increase in climate-driven investments, 2019–231 \$ billion (multiples)



<sup>1</sup>Investments in technology verticals as defined by McKinsey Platform for Climate Technologies, including capital expenditures, equity, R&D, spin-offs, venture capital arm investments, and significant portfolio-shifting investments, for 3 primary geographies.
<sup>2</sup>Top 377 companies by market capitalization as of Apr 2024, in capital-intensive sectors (namely aerospace and defense, automotive, chemicals, conglomerates, industrials, logistics, metals and minerals, oil and gas, power, and semiconductors). Primary geographies are Asia–Pacific (including 52 Chinese public

companies and partially state-owned enterprises), Europe, and North America. <sup>3</sup>Of the 377 companies we analyzed, 140 invested >\$300 million annually in chemicals, oil and gas, metals and minerals, and power (>\$100 million for other

sectors such as aerospace and defense, automotive, high tech, industrials, logistics, and semiconductors). Amounts below these thresholds were considered negligible and not included in the total investment.

<sup>4</sup>Other sectors include aerospace and defense, conglomerates, high tech, logistics, and semiconductors.

Source: Environmental, social, and governance and corporate social responsibility reports; McKinsey Value Intelligence platform

#### Our methodology

**In our research,** incumbent companies were established before 2015 in industrial sectors that emit high levels of carbon or produce products that use fossil fuels. These companies did not initially focus on climate technology businesses. We based our research on the largest 1,000 companies by market capitalization in the McKinsey Value Intelligence Platform as of April 2024.

The 377 incumbents identified spanned the aerospace and defense, automotive, chemicals, conglomerates, industrials and electronics, logistics, metals and minerals, oil and gas, power, and semiconductors sectors across North America, Europe, and Asia–Pacific, including 52 Chinese public companies and partially state-owned enterprises. We believe this is a representative sample for all geographies, except China (which was likely underrepresented).

We applied a minimum climate-driven investment threshold, which reduced the sample to 140 of the 377 companies. The threshold was at least \$300 million annual climate-driven investment in the chemicals, oil and gas, metals and minerals, and power sectors, and at least \$100 million for the other sectors. We added 15 additional incumbents or large scale-ups that were not listed in our original top 1,000 companies because of their aspiring investments in climate technologies.

We evaluated investments made between 2019 and 2023. Total investments and climate tech investments were identified from companies' financial statements, corporate social responsibility reports, and environmental, social, and governance reports. For European companies, we relied on the European Union's taxonomy for sustainable activity data—an environmental disclosure framework that requires companies to report revenues, operating expenditures, and capital expenditures associated with activities aligned to six environmental objectives—where available. Forward-looking investment was identified from the same company reports, as well as press searches, to identify announcements of future climatedriven investments up to 2030.

Climate-driven investments were defined by the McKinsey Platform for Climate Technologies, which includes alternative proteins, sustainable agriculture, batteries, carbon removals, circular technologies, energy storage, heat pumps, hydrogen, natural climate solutions, nuclear power, renewables, sustainable fuels and chemicals, and carbon capture, utilization, and storage.

We included investments in capital expenditures, equity, R&D, significant portfolio-shifting investments, spin-offs, and venture capital arm investments and excluded those in decarbonization plans and emission reduction (Scope 1, 2, and 3). We mapped annual climatedriven investments to technologies that fall under the McKinsey Platform for Climate Technologies verticals and subverticals to identify the percentage of climate-driven investments in "horizon three" and "horizon two" businesses.<sup>1</sup>

For revenue, we analyzed the 17 EU companies out of our 377 incumbents that report revenue from climate-driven investments under the EU taxonomy. Very few companies in our sample voluntarily disclosed the revenues of their climate technology businesses.

<sup>1</sup> "Enduring Ideas: The three horizons of growth," *McKinsey Quarterly*, December 1, 2009.

The automotive, oil and gas, and power sectors have been investing mostly in absolute dollars, although the proportion of these investments relative to the companies' total investment varies widely. The power sector spent on average 24 percent of its total investment on climate tech, the automotive sector spent 19 percent, and oil and gas, 8 percent (Exhibit 2).

A minority of the incumbents is leading these investments: 140 of the large companies we researched were responsible for a \$683 billion investment, while the rest made minimal investments.

There is also a geographic concentration of incumbents investing in climate tech businesses. While spending has been accelerating across geographies, companies in Europe and Asia are driving approximately 80 percent of the incumbent investment in climate tech businesses.<sup>3</sup>

For some sectors, geography can also influence which technologies incumbents prioritize for investment, possibly reflecting differences in local industry, policy incentives, and regulatory mandates. For example, oil and gas incumbents in Europe have focused investment on renewable energy sources (RES) and sustainable fuels, while US incumbents have focused on investment in carbon capture, utilization, and storage (CCUS).

#### Exhibit 2

## Climate technology growth investments by incumbents leading the charge are four to nine times the sector average.



<sup>1</sup>Sector average ratio of climate-driven investments as percent of total investments. Only includes incumbents investing in new green businesses above threshold of \$300 million between 2019–23 for energy sectors and \$100 million for other sectors. Source: Environmental, social, and governance and corporate social responsibility reports

<sup>&</sup>lt;sup>3</sup> Higher investment in Europe may be influenced by the EU Taxonomy reporting requirements.

In other sectors, there is less variation across geographies. For example, investments by power sector incumbents around the globe have been focused on RES, while those in the automotive sector have focused on electric vehicles (EVs) and battery manufacturing.

For some companies in our sample, we see that climate tech capital expenditure is already being converted into businesses with tangible revenues. The 17 European Union–headquartered incumbents (as referenced in the above sidebar) that have reported revenues for their climate tech businesses also reported an increased share of capital expenditures dedicated to climate tech from 2020 to 2023, as well as a rise in their average share of revenues from climate-driven businesses (Exhibit 3).<sup>4</sup>

Looking ahead to 2030, we expect a small subset of incumbents to continue driving investment in climate tech businesses. Fewer than 10 percent of the companies are responsible for 50 percent of the \$1.3 trillion in announced investments in climate tech businesses between now and 2030. This subset of companies has also been responsible for 20 percent of climate-driven business investment over the past five years.

#### Exhibit 3



#### Climate technology investments are generating revenue.

<sup>11</sup>7 out 40 companies based in the EU that separately report revenues from climate technology businesses in line with EU taxonomy requirements. Source: Environmental, social, and governance and corporate social responsibility reports

<sup>&</sup>lt;sup>4</sup> Calculated by taking the average of the climate technology revenues over total revenues ratio for the 17 companies.

#### What is driving incumbents' investments in climate tech businesses?

Even before the volatility of the past few months, difficult macroeconomic conditions, policy uncertainty, and geopolitical shifts have had an impact on climate tech investments. Still, many companies have stayed on course to find attractive investment opportunities. To date, incumbents have typically prioritized investment in climate tech businesses for one of three reasons: a unique business opportunity for growth, a potential decline in their core business, or regulatory requirements.

Wind and solar-power investments are an example of investment driven by a unique business opportunity. European and US companies in various sectors have accelerated investments in these technologies as costs have become more competitive with conventional power alternatives driven by scale, technology development, and partially increased regulatory and public support. Within the Global South, similar incentives have started to accelerate, and companies are moving early to diversify into RES technology businesses to capitalize on the growing momentum.

With an expected long-term decline in the demand for fossil fuels,<sup>5</sup> many oil and gas companies have started investing to diversify their portfolios. Some companies are shifting toward technologies closely aligned to their core business such as liquified natural gas and sustainable fuels. Others are looking into more novel technologies such as hydrogen and direct air capture (DAC) for future value creation.

Regulatory requirements are also having an impact. Investments in battery-electric-vehicle (BEV) businesses, and in some instances, battery manufacturing, have been primarily driven by stricter emission limits for internal combustion engine vehicles in various regions. Regulatory incentives also have a part to play. For example, blending mandates in Europe, such as ReFuelEU Aviation, are driving increased adoption of sustainable fuels in aviation.

Incumbents have typically prioritized investment in climate tech businesses for one of three reasons: a unique business opportunity for growth, a potential decline in their core business, or regulatory requirements.

<sup>5</sup> "Global Energy Perspective 2023: Oil outlook," McKinsey, January 24, 2024.

#### Incumbents' climate tech investments across different maturities

McKinsey's three horizons of growth framework<sup>6</sup> provides a structure for companies to assess and prioritize their growth opportunities and investments. Horizon one is the existing, core (often fossil fuel-based) businesses that currently generate cash flow. Horizon two is emerging opportunities—the growth businesses to invest in now that will scale to generate profit. Horizon three businesses are the growth options for the future, such as research projects or pilot programs (Exhibit 4). Climate tech businesses can fit into all three horizons, although they skew toward horizons two and three.

The maturity of a business is determined by the technology's relative cost competitiveness, market readiness, technology readiness level (TRL), and stability of possible regulatory support if needed, which can vary by region. For example, investments in solar-power businesses are horizon two in Europe, where the economics make sense and the levelized cost of energy (LCOE) is competitive with fossil alternatives. In other parts of the world where the economics are still evolving, investments in power generation based on solar photovoltaics (PV) would be a horizon three businesss. The solar PV example shows that the line between horizon two and horizon three businesses is not razor sharp. For example, while a technology such as precision fermentation of alternative proteins still requires additional measures<sup>7</sup>—for example, innovation in bioreactor technologies, alternative-protein market development, and regulatory approval of alternative proteins as food—to cross the horizon two boundary at scale, there are individual players that are already close to cost competitiveness and scaling readiness.

#### Exhibit 4

#### Across climate technology businesses, we see two horizons of momentum.

Strategic horizons for climate technology<sup>1</sup> (nonexhaustive)



<sup>1</sup>Horizon classification of climate technology businesses can vary between regions depending on local resources, regulations, and economics. <sup>2</sup>Solar and onshore wind in Europe, large nuclear, plant-based dairy, and heat pumps. Certain climate technology businesses (eg, solar and onshore wind businesses) are horizon 3 in certain geographies where the business model is still maturing. <sup>3</sup>Carbon removals, lithium air batteries, small modular reactors, plant-based beef. Source: McKinsey Platform for Climate Technologies; McKinsey analysis

<sup>&</sup>lt;sup>6</sup> "Enduring Ideas: The three horizons of growth," *McKinsey Quarterly*, December 1, 2009.

<sup>&</sup>lt;sup>7</sup> Kimberly Stover, Kate Toews, and Roberto Uchoa, "Novel proteins: Consumer appetite for sustainably made ingredients," McKinsey, March 21, 2024.

Some climate-driven tech businesses such as sustainable fuels are currently on the boundary between horizon three and horizon two. Production pathways are at various levels of technology readiness and maturity, and although regulations support investments, technologies are not yet fully cost competitive with fossil alternatives.

### To date, over 80 percent of incumbents' climate tech business investment has been in four mature technologies

Our research shows that in the past five years, over 80 percent of incumbents' climate tech investments have been in businesses focused on solar, onshore wind, EVs, and batteries.<sup>8</sup> These four technologies are horizon two businesses that have been commercially viable in large parts of the world.

The other 20 percent of investment has been spread across businesses in multiple earlier-stage climate technologies, including CCUS, sustainable fuels, small modular reactors, and hydrogen, with a focus on horizon three businesses that are on the boundary of becoming horizon two in the short to medium term.

Market conditions and public support have driven the early deployment of climate technologies by helping to lower costs and facilitating funding to further refine the technologies. Renewables, for example, have been supported by a combination of government policies and incentives (such as feed-in tariffs and tax credits) that have fostered technological advancement and cost reduction, driving the cost competitiveness of renewables with carbon-intensive alternatives. The LCOE for onshore-wind and utility-scale solar PV plants decreased by around 70 percent and 90 percent, respectively, between 2010 and 2023.<sup>9</sup> Emission restrictions currently in place for automotive companies across Europe are also fostering long-term demand for EVs and battery manufacturing.

While most incumbents focus on adjacent businesses to leverage their core expertise and existing customer base, others are diversifying away from their main business. For example, some metals and minerals producers have invested in renewables and low-carbon fuels to diversify their portfolios and explore alternative ways to create value.

Across climate tech businesses, most of the incumbents' investment has been through direct capital expenditure (Exhibit 5), often into operating assets for horizon two businesses, or on pilot or first industrial-scale plants for horizon three businesses. Smaller investments have been made into R&D and equity stakes in early-stage technology companies or acquisitions.

<sup>&</sup>lt;sup>8</sup>Climate technologies with technology readiness levels (TRLs) between TRL 9 and TRL 11. <sup>9</sup>*Renewable power generation costs in 2023*, IRENA, September 2024.

#### Exhibit 5

#### Investments have been focused on capital expenditure.







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#### Incumbents' recipe for climate tech success

Although investing in a climate tech business comes with risk, and not all incumbents have been successful, it can create future value for shareholders. Emerging success stories include NextEra Energy growing into a top RES producer, LG Chem rising to the forefront of EV battery manufacturing, and MAN Energy Solutions accelerating the hydrogen value chain.

#### The approach depends on the maturity of the business

Across horizon two and horizon three businesses, successful incumbents understand the business case and take decisive action to improve it. They also drive execution excellence and judge the right time to invest and scale. We identified two archetypes for successful climate-driven business investments by incumbents: pioneer scalers and fast followers.

*Pioneer scalers* invest early in demonstrated but early-stage technology businesses (horizon three). They innovate to reduce cost and capital intensity, enable performance improvements that make climate technologies viable, shape supportive regulatory environments, find profitable niches, and often seek customers who are initially willing to pay a premium. They also inject substantial capital when the time is right—for example, when the business is ready to start shifting to horizon two. These incumbents benefit from early-mover advantages.

*Fast followers* invest in climate tech businesses that are ready for scaling with proven demand and business model (horizon two). The incumbents rely on their execution capabilities to build scale on an accelerated timeline to establish a strong market position. Although fast followers have the advantage of reduced technology risk, they need to build scale quickly.

Incumbents can win with either approach, depending on their risk appetite and ability to lead disruption and execute at pace.

Our research also identified two timing-related failure modes. The first is investing too early in horizon three businesses, before they are ready to scale (see sidebar "Investing too early in horizon three businesses: Green methanol"). The second is investing too slowly and too little in horizon two businesses and falling behind competitors who have accelerated ahead (see sidebar "Investing too slowly and too little in horizon two businesses: EV battery manufacturing").

#### Investing too early in horizon three businesses: Green methanol

Since the late 2010s, companies across sectors, including chemicals, energy, and oil and gas, started investing in earlystage green- and e-methanol projects to develop low-emission fuel as early market demand signals started to emerge in maritime and aviation. However, over the past few years, e-methanol has become more expensive than fossil-based and other transition fuels because of changes in current macroeconomic conditions, geopolitics, and slower than expected market growth in the short term with delays in decarbonization timelines. These changes in the global investment climate meant the time and conditions were not right for some to scale their businesses, leading several companies to delay or cancel their green-methanol projects.

#### Investing too slowly and too little in horizon two businesses: EV battery manufacturing

The electric vehicle (EV) market began to expand in the 2010s, with several companies starting to invest in EV battery manufacturing across regions.<sup>1</sup> This investment coincided with China beginning to offer highly competitive subsidies to its domestic EV battery makers, which created a significant cost advantage that increased price pressure on rivals.<sup>2</sup> Some fast followers in other regions undertook M&A to scale and build technical expertise while others increased R&D investment to improve their battery efficiency and production processes.

Those investments have proved to be too little or too late to bridge the gap. Chinese manufacturers continue to lead the market with over 70 percent share of global EV lithium-ion battery manufacturing capacity in 2023.<sup>3</sup> Other regions are currently unable to match China's low costs—for example, battery manufacturing costs in China are on average 20 percent lower than in the United States.<sup>4</sup> As rivals—particularly new entrants struggle, some chemicals and automotive companies have divested their EV battery businesses.

<sup>4</sup> Ibid.

<sup>&</sup>lt;sup>1</sup> Global EV outlook 2024: Trends in electric vehicle batteries, International Energy Agency, April 2024.

<sup>&</sup>lt;sup>2</sup>Patrick Hertzke, Nicolai Müller, Stephanie Schenk, and Ting Wu, "The global electric-vehicle market is amped up and on the rise," McKinsey, May 4, 2018.

<sup>&</sup>lt;sup>3</sup> Global EV outlook 2024: Moving towards increased affordability, International Energy Agency, April 2024.

#### Learnings from climate tech hyperscalers

Looking more closely at incumbents that have successfully built climate tech businesses, we see that the hyperscaling formula we introduced in 2022 applies to incumbents, with some nuances. All elements—such as leading with bold ambition, developing a cost and capital expenditure advantage, and proactively creating business ecosystems—are important. Incumbents also need to build on their inherent strengths, such as balance sheet size, organizational scale, strategic capabilities, existing customer base, and supplier relationships.

The formula provides a guide to help reduce risks and accelerate progress when investing in climate tech businesses, which can often go hand in hand if the business case is clear, the incumbent is ready, and the market timing is right. However, horizon two and horizon three businesses do require quite different approaches (Exhibit 6).

#### Exhibit 6

#### Horizon two and horizon three businesses require very different approaches.

#### Hyperscaling formula strategies for horizon 2 and horizon 3 businesses

		Fast followers for horizon 2 businesses	Pioneer scalers of horizon 3 businesses
1	Bold ambition in the right opportunity window	Industrialize and scale proven technologies, executing multiple projects in parallel	Get to scaling readiness across technology maturity, business model, market development, regulations, and business viability while stage-gating resources
2	Establish technology leadership	Commit to leading technology performance and drive toward full potential through continuous improvement	Within the chosen tech domain, work with multiple tech pathways in parallel to pick one with the best odds for successful scaling
3	Cost and capital expenditure advantage	Build leading project capabilities across design, sourcing, and execution benchmarked to best-in-class industry performance to ensure cost competitiveness	Target parity with gray alternatives in technology and manufacturing costs
4	Captive demand before scaling capital investments	Shape demand and capture leading share by leveraging customer relationships and propelling regulatory dialogue	Partner with customers to test products, derisk demand, and shape offtakes
5	Business ecosystems supply chain	Drive low cost and supply security, while maintaining quality, through partnerships or vertical integration	Collaborate with suppliers, customers, and downstream players that have a similar commercialization, cost-down, and scaling mission
6	Star executives and operating model to win	Establish dedicated entities to provide arms- length governance (such as spin-offs) powered by exceptionally strong execution leaders	Led by entrepreneurial leaders with broad networks and ability to deal with ambiguity; ring-fence team
7	Low-cost financing	Leverage external capital with different risk/ return expectations, such as project finance and infrastructure funding, to accelerate portfolio development	Source financing for innovation and first commercial scale facility including equity investment, joint ventures, grants, and partner co-investment

#### Hyperscaling horizon two businesses

Horizon two hyperscalers focus on high-quality execution and industrialization when building a climate tech business, with particular emphasis on the following elements.

Set a bold ambition in the right opportunity window: Industrialize and scale proven technologies, executing multiple projects in parallel. Incumbents building horizon two businesses should aim to "go big" by setting an explicit goal to be a leader and to scale fast. For example, Indian power company Tata Power Renewable Energy has set an ambitious target of 25 gigawatts (GW) of renewable-power generation by 2030, scaling in line with India's National Solar Mission. Launched in 2010, the original national mission targeted 20 GW by 2022 but has been revised up to around 500 GW by 2030.

*Establish technology leadership:* Commit to leading technology performance and drive toward full potential through continuous improvement. Even with horizon two technology businesses, which are already somewhat mature, there often remains significant additional hard work to be done to develop the technology further. A good illustration is mobile telephony equipment companies, which, over 40 years, cycled through five generations of technology (from 1G to 5G), increasing data transfer speeds from 0 kilobits per second in the 1980s up to 20 gigabits per second with 5G.

An example in the climate tech space is LONGi, which over the past two decades has continuously invested to evolve its technology for solar panels to remain at the forefront of solar PV. In 2024, it surpassed its own records in silicon heterojunction back-contact (HBC) cell efficiency, offering a nearly 12 percent boost in power generation compared with the previous model.<sup>10</sup>

Create a cost and capital expenditure advantage: Build leading project capabilities across design, sourcing, and execution, benchmarked to best-in-class industry performance to ensure cost competitiveness. Our recent article describes how climate tech businesses are reducing costs by standardizing plant designs to remove complexity and reduce lead times, using long-term contracts as incentives for contractor performance, and optimizing schedules to accelerate construction timelines. The goal should be to "beat the world record" with every new build.

Tesla exemplified this approach with its gigafactories. When the company built its fifth gigafactory, in Texas, it reduced capital expenditures by 60 percent and time to market by more than half compared with its first gigafactory in Nevada.<sup>11</sup> Tesla's "challenge everything" culture enabled agile practices that were supported by a dedicated "SWAT team"; adapted engineering, procurement, and construction (EPC) strategies; and fostered cross-collaboration among senior management.

For technology solutions and products, a design-to-value (DtV) approach can help optimize materials, improve product performance, and expand supply chains. DtV is an established process in many industries, but it needs to be more widely adopted across emerging climate tech businesses.

<sup>&</sup>lt;sup>10</sup> "LONGi sets new standards in solar technology with world record efficiency and innovative module design," LONGi press release, February 24, 2024.

<sup>&</sup>lt;sup>11</sup> Vaibhav Dua and Rahul Gupta, "To meet climate goals, green tech needs to get bigger, faster. The 'plant as a product' approach could help," McKinsey, October 9, 2024.

Another important lever is improving product performance, for example by increasing energy efficiency or adopting AI to expedite the innovation process and scheduling. Incumbents should also consider overall total expenditure implications of their facilities and optimize operational expenditures from the start. Also important is prioritizing locations with optimal labor costs, proximity to specialized expertise, and access to low-cost raw materials and energy.

Secure captive demand before scaling capital investments: Shape demand and secure leading share by leveraging customer relationships and regulatory access. Incumbents have a unique ability to derisk demand through early customer partnerships and offtake arrangements. In some businesses, such as EV batteries, these agreements are a necessity, as the products must be designed to the customers' specifications. Likewise, most renewable-energy projects secure power purchase agreements (PPAs), government-backed feed-in tariffs, or contracts for difference early on. In the case of multibusiness incumbents, the customers may be found close to home. For example, Tata Power provides renewable energy to other Tata Group subsidiaries such as Tata Motors and Tata Steel.

*Build business ecosystems: Drive cost and supply security, while maintaining quality, through partnerships or vertical integration.* Scaling a new business rapidly and cost-efficiently typically requires collaboration beyond an incumbent. Collaboration with leading companies across each relevant value chain provides an opportunity to create a best-in-class supply chain, as well as drive costs down through partnerships. Incumbents can vertically integrate along the value chain, particularly as a way to seek differentiation, or when there are concerns about the depth, cost, or scale of supply. This is best exemplified by automakers investing in their own EV battery manufacturing capacity. For example, Toyota's first automotive battery plant is expected to come on line in 2025 in North Carolina.<sup>12</sup> Incumbents should carefully weigh which scope they are best positioned to take on. For example, the BMW Group announced a \$1.7 billion investment to build EVs in the United States, partnering with Envision to supply batteries specifically designed for BMW's next-generation EVs.<sup>13</sup> Another example is the several solar-energy developers in Asia, including Tata Power, that are integrating upstream to manufacture solar PV cells and modules.

*Build a star executive team and winning operating model:* Establish dedicated entities to provide arms-length governance (such as spin-offs) powered by exceptionally strong execution leaders. Leaders with strong execution credentials are crucial for successfully scaling a business. They should have a singular focus on executing the ambitious scale-up agenda. Some successful incumbents take structural actions—like establishing a dedicated entity or spin-off—to enable focus and arms-length governance away from "corporate distractions" associated with the core business. This operating model also enables quick decision-making, redeployment of capital, and flexibility to ramp-up resources. For example, Enel Group founded Enel Green Power in December 2008 to develop and operate its renewable-energy generation globally. It has an installed renewable capacity of 64.7 GW with a generation mix that includes solar and wind power.<sup>14</sup> Another example is Reliance Power's December 2024 announcement to set up Reliance NU Energies, its renewable-energy business arm, to "innovate and seize the opportunities in developing clean, affordable, and reliable energy solutions."<sup>15</sup>

<sup>&</sup>lt;sup>12</sup> "Toyota battery manufacturing North Carolina," Toyota press release, February 2025.

<sup>&</sup>lt;sup>13</sup> "BMW Group announces \$1.7 billion (USD) investment to build electric vehicles in the U.S. and signs agreement with Envision AESC for the supply of battery cells to Plant Spartanburg," BMW Group press release, October 19, 2022.

<sup>&</sup>lt;sup>14</sup> "Renewable energy for a sustainable future," Enel, accessed on March 18, 2025.

<sup>&</sup>lt;sup>15</sup> "Reliance Power forms new arm for renewable energy business; appoints CEO, COO," *Economic Times*, December 10, 2024.

To bring a horizon three business to scaling readiness, incumbents need a bold ambition to create disruption and a systematic approach to shaping the entire value chain, in collaboration with others.

Source low-cost financing: Leverage external capital with different risk/return expectations, such as project finance and infrastructure funding, to accelerate portfolio development. Incumbents can access increasingly popular financing instruments including infrastructure funding, capital rotation project financing, and green loans. For example, Tata Power has obtained external financing (including \$525 million equity fundraising from BlackRock and Mubadala<sup>16</sup>), a \$4.25 billion memorandum of understanding with Asian Development Bank to finance key clean-energy power projects.<sup>17</sup>

#### Hyperscaling horizon three businesses: Focus on reaching scaling readiness

Horizon three hyperscalers focus on accelerating toward scaling readiness—in collaboration with others—across commercial viability and technology maturity, with particular emphasis on the following elements.

Set a bold ambition in the right opportunity window: Get to scaling readiness across technology maturity, business model, market development, regulations, and business viability while stagegating resources. To bring a horizon three business to scaling readiness, incumbents need a bold ambition to create disruption and a systematic approach to shaping the entire value chain, in collaboration with others. A disciplined stage-gated process and defined metrics ensure that investment and resources are appropriately managed and prioritized if certain milestones are met.

Using a design-for-scale mindset—designing for the "end state" all the way from demonstration to industrial scale—can also help businesses develop an actionable plan and the discipline to only scale capacity when the conditions are right.

In addition to developing an actionable plan for scaling, incumbents should ensure that the right conditions are met before executing. For example, Raízen, a Latin American energy company, spent a decade perfecting its first commercial-scale cellulosic-ethanol plant<sup>18</sup> before announcing a pipeline of 20 additional plants with a combined annual production capacity of 1.6 million cubic meters.<sup>19</sup>

<sup>&</sup>lt;sup>16</sup> "Mubadala & BlackRock invest in India's Tata Power Renewables," Mubadala Investment press release, 2022.

<sup>&</sup>lt;sup>17</sup> "Tata Power signs MoU with Asian development bank for US\$4.25 billion to finance key clean energy power projects," Tata Power press release, November 21, 2024.

<sup>&</sup>lt;sup>18</sup> Mateus Schreiner Garcez Lopes, "Webinar on biorefineries efficiency improvement," Raízen, 2023.

<sup>&</sup>lt;sup>19</sup> Thomas Washington and Harry Clyne, "Interview: Brazil's Raízen sees ethanol producers unable to meet demand," S&P Global, November 2, 2023.

*Establish technology leadership:* Within the chosen tech domain, work with multiple tech pathways in parallel to pick one with the best odds for successful scaling. Incumbents can work with multiple technologies initially, with the option to partner with or even acquire technology developers to secure access to competitive solutions. For example, as NextEra Energy began expanding into solar power, the company started with solar thermal technology and transitioned to solar PV as it became more prominent, eventually deciding to scale this technology.<sup>20</sup> MAN Energy Solutions is another example, leveraging M&A to develop technology leadership for a defined technology in the hydrogen value. The company acquired a 40 percent stake in proton electrolysis technology company Quest One (previously H-TEC SYSTEMS), prior to a full acquisition in 2021, to build its footprint in the hydrogen value chain and advance industrial-scale electrolyzer technology.<sup>21</sup>

**Create a cost and capital expenditure advantage:** Target parity with fossil-based alternatives in technology and manufacturing costs. Targeting cost parity<sup>22</sup> requires a radical approach to cost reduction starting with understanding the theoretical minimum cost of the technology when it is at scale. The most successful incumbents use approaches such as DtV to drive toward their target of cost parity.

For example, in 2008, Ørsted set out to make offshore wind an at-scale power generation technology. In 2013, it set a goal to reduce its electricity costs by 35 to 40 percent. To make this happen, it worked systematically on all aspects of the value chain, and also pushed for design standardization of wind substations and components, to optimize costs for future wind farms.<sup>23</sup> In 2016, Ørsted succeeded in making its wind power competitive with electricity produced from coal- and gas-fired power stations.<sup>24</sup> This achievement paved the way for Ørsted to become a global leader in renewable energy, set a new benchmark for the industry, and demonstrated that sustainable energy solutions could be both economically viable and scalable.

Iberdrola, in a joint venture (JV) with Spanish fertilizer producer Fertiberia, recently launched a green-hydrogen production pilot plant with a target to achieve cost parity with gray hydrogen by leveraging the low cost of solar energy and the declining capital cost of electrolyzers.<sup>25</sup> This initiative is part of a broader strategy to develop over 2 GW of green-hydrogen capacity in Spain by 2030. The project includes a phased approach, starting with a 20-megawatt pilot production plant, and expanding to 780 megawatts in subsequent phases.

Secure captive demand before scaling capital investments: Partner with customers to test products, derisk demand, and shape offtakes. Incumbents' established networks can help secure early customers to help prove technology feasibility and establish market readiness, which are both crucial to accelerate the development of a horizon three climate technology business. For example, SSAB has confirmed anchor demand for its fossil-free steel with letters

<sup>&</sup>lt;sup>20</sup> "Technology and Innovation," NextEra Energy, accessed on March 18, 2025.

<sup>&</sup>lt;sup>21</sup> "MAN Energy Solutions continues to invest in hydrogen: Acquisition of H-TEC SYSTEMS," Man Energy Solutions press release, January 15, 2021.

<sup>&</sup>lt;sup>22</sup> "A radical approach to cost reduction at climate tech companies," McKinsey, June 18, 2024.

<sup>&</sup>lt;sup>23</sup> "DONG Energy awards substation design contract to Atkins as it continues to drive down offshore wind," Ørsted, March 18, 2015.

<sup>&</sup>lt;sup>24</sup> "Could our green transformation inspire yours?," Ørsted, accessed on March 18, 2025.

 $<sup>^{\</sup>rm 25}$  "Laying the foundations for green hydrogen," Iberdrola, accessed on March 18, 2025.

of intent and supply partnerships signed with various industry customers. Another example is Occidental Petroleum's DAC subsidiary 1PointFive. Its Stratos facility<sup>26</sup> is expected to become operational in 2025,<sup>27</sup> but it has already finalized several prepurchase agreements, including Microsoft's agreement to purchase 500,000 tons of DAC credits.

There may also be opportunities for incumbents to become the first customers. For example, shipping company Maersk and ferry operator DFDS are working in partnership with other companies in the value chain to develop a power-to-ammonia project.<sup>28</sup> It will produce e-ammonia, a green shipping fuel, for use in their operations and will help reach the target reduction of carbon emissions set by the International Maritime Organization.

**Build business ecosystems:** Collaborate with suppliers, customers, and downstream players that have a similar commercialization, cost-down, and scaling mission. An incumbent can help find partners across its value chain with a similar commercialization mission and aspiration to help reduce costs. This may also involve engaging new stakeholders, suppliers, and customers. For example, Airbus is joining forces with energy providers, technology specialists, airlines, airports, and industry partners to investigate the feasibility of hydrogen-powered aviation as part of the Airbus Hydrogen Hubs at Airports network.<sup>29</sup> This network is also partnering with fuel providers and technology companies to lead the development of sustainable-fuel production.

Build a star executive team and winning operating model: Led by entrepreneurial leaders with broad networks and the ability to deal with ambiguity. Building horizon three businesses requires entrepreneurial leaders with broad networks, an agile mindset, and the ability to deal with ambiguity to bring their business-building experience into a corporate context, sometimes for the first time. These executives often need to be recruited from outside the typical incumbent search pools. Entrepreneurs help navigate the sometimes complex technology and regulatory landscapes with a diverse tool kit, such as by building ecosystem partnerships and accessing alternative financing options.

These leaders typically need a ring-fenced team aligned on the bold ambition, as developing a horizon three business within a regular corporate structure can be difficult given differences in timelines, success metrics, priorities, and culture. Setting up an entity to focus its talent and investment was Tata Power's approach when it established the Tata Power Solar JV in 1989. Likewise, Mitsubishi Corporation established its Next-Generation Energy Business Group in 2023, consolidating next-generation energy businesses across different groups and pooling together key people and know-how to advance its climate technology businesses.

**Source low-cost financing:** Source financing for innovation and first commercial-scale facility including equity investment, JVs, grants, and partner co-investment. Incumbents can access multiple financing options to derisk investments in innovative businesses and pilots. Options include post-VC and pre-private-equity funding, special-purpose vehicles with customers, JVs, and government innovation funding. For example, 1PointFive has secured funding from the US Department of Energy under Phase III of the Carbon Storage Assurance Facility Enterprise to support the development of its CO<sub>2</sub> sequestration hubs.<sup>30</sup>

<sup>&</sup>lt;sup>26</sup> "Microsoft agrees to purchase 500,000 tonnes of DAC carbon removal credits," 1PointFive, July 9, 2024.
<sup>27</sup> "Stratos," 1PointFive, accessed on March 18, 2025.

<sup>&</sup>lt;sup>28</sup> "DFDS aims for greener ferries from alternative fuel project," DFDS, February 22, 2021.

<sup>&</sup>lt;sup>29</sup> "Developing a global ecosystem to support hydrogen-powered flight," Airbus, September 2, 2024.

<sup>&</sup>lt;sup>30</sup>"1PointFive sequestration hubs awarded Department of Energy funding," Occidental Petroleum Corporation press release, October 3, 2024.

#### Lessons from early movers' successes

Incumbents that have decided to build climate-driven growth businesses can choose between being a fast follower or a pioneer scaler, depending on their risk appetite, endowments, path to profitability, and long-term value creation opportunity. Investments in climate tech businesses can be uncertain in the current environment of shifting policy, geopolitics, and macroeconomic conditions. Below are four case studies of successful investments in climate-driven businesses by incumbents. They may not be directly transferable but do offer some guidance.

#### NextEra Energy

NextEra Energy<sup>31</sup> is a leading energy company that combines one of America's largest electric utilities (Florida Power & Light Company)<sup>32</sup> and NextEra Energy Resources, one of the world's largest producers of wind and solar energy.

A pioneer scaler in wind and solar-energy production, NextEra Energy (then FPL Group) started exploring alternative fuels in 1979. In 1997, it established NextEra Energy Resources to focus on clean energy and to invest early in solar power and onshore wind. In the following decade, NextEra Energy developed and executed an ambitious program to expand renewable capacity at pace, including its first wind site in 1998 and constructing and acquiring 17 wind farms in various states. NextEra Energy became the leading producer of solar power in the United States in 2009, a position that the company continues to hold. In 2015, it launched Desert Sunlight Solar Farm, one of the nation's largest solar PV projects at the time.

NextEra Energy secured supply chain capacity and fostered innovation through business ecosystems, signing supply agreements with SunPower for its high-efficiency solar panels and collaborating to develop the DeSoto and Space Coast Next Generation Solar Energy Centers to bring commercial-scale solar PV to Florida.<sup>33</sup> NextEra Energy Resources has developed renewable generation and storage capacity of around 30 GW with a backlog of around 22 GW and a project pipeline of 300 GW.34

NextEra began investing in renewable energy with a focus on ensuring profitability on a project-by-project basis, with early conviction that renewables could become the low-cost generation source of choice.

<sup>&</sup>lt;sup>31</sup> FPL Energy was renamed NextEra Energy in 2010. <sup>32</sup>As of 2024.

<sup>&</sup>lt;sup>33</sup> "FPL Group signs solar power supply agreement with SunPower Corp.," NextEra Energy, April 23, 2009. <sup>34</sup> "Europe investor presentation June 2024," NextEra Energy, June 2024.

The following are key takeaways from NextEra's approach:

- began investing in renewable energy with a focus on ensuring profitability on a project-byproject basis, with early conviction that renewables could become the low-cost generation source of choice
- applied early learnings from wind power to expand and scale solar power
- deployed substantial capital in wind power to drive economic viability on a project-by-project basis, focusing on locations with supportive policies and regulatory frameworks in place—adding 15 GW of generation capacity through acquisitions and new projects between 1999 and 2019, with an initial focus on locations with favorable regulation and policy incentives (for example, Texas in the early 2000s)
- built a strong balance sheet, reputation as a top power generation company, and customer relationships to secure captive demand through PPAs
- focused on capital and execution discipline, with development of a fit-for-purpose capital management process
- built on its existing reputation and portfolio—including Florida Power & Light—to access lowcost capital

These actions are closely aligned with four aspects of our hyperscaling formula: set a bold ambition in the right opportunity window, secure captive demand before scaling capital investments, create a cost and capital expenditure advantage, and source low-cost financing.

#### **MAN Energy Solutions**

Founded in 1758, MAN Energy Solutions (MAN ES) invented the diesel engine and established itself as a leader in two- and four-stroke engines for marine and power applications, compressors, and turbines over the next two centuries. Acquired by Volkswagen in 2011, MAN ES made a bold commitment in 2017 to "dedicating itself to being a pioneer of decarbonization in shipping, energy, and industrial production," with the goal of 70 percent of its solutions being "green" by 2030.<sup>35</sup>

A pioneer scaler in hydrogen production, MAN ES has been scaling climate investments over the past four years, primarily positioning itself to decarbonize hard-to-abate sectors. It has focused on five technologies: carbon capture, alternative/future fuel engines, hydrogen production, industrial heat pumps, and retrofit solutions for alternative fuels in shipping. MAN ES made organic investments, selectively partnered, and in 2021 acquired Quest One, a proton exchange membrane (PEM) electrolyzer producer. MAN ES committed to invest about €500 million to scale Quest One. It has tapped existing industrial customer relationships to develop a strong order pipeline, and over the past three years, MAN ES has tripled the number of employees in its main PEM factory. In 2024, it opened a new "Gigahub" to produce five GW of PEM stacks per year. MAN ES has also been collaborating with other maritime ecosystem partners to develop a at its research center in Copenhagen. Over the past three years, its revenue has grown over 10 percent annually, and it has had an all-time-high order intake.

<sup>&</sup>lt;sup>35</sup> Corporate responsibility report 2019, MAN Energy Solutions, May 15, 2020.

The following are key takeaways from MAN ES's approach:

- defined an ambition for 70 percent of its solutions to be green by 2030, with early investment in climate technologies such as hydrogen- and ammonia-fueled engines
- prioritized climate technologies based on the potential impact on core businesses such as marine-emission-reduction targets, future market potential, and existing capabilities such as expertise in engine manufacturing to establish a "right to win"
- assessed technical capability and leveraged acquisition to bridge skill gaps, for example by acquiring Quest One with its capabilities in hydrogen production
- leveraged customer relationships and leading market position to secure captive demand for climate tech businesses such as CO<sub>2</sub> compression technology for carbon capture in the process industries and green engines/retrofit solutions for shipping
- brought together value chain participants to advance technology development and commercialization, such as maritime leaders to develop engine concepts for hydrogen- and ammonia-fueled engines, as well as working with Helen Oy (the City of Helsinki energy company) on a large-scale hydrogen production pilot plant

These actions are closely aligned with four aspects of our hyperscaling formula: set a bold ambition in the right opportunity window, establish technology leadership, secure captive demand before scaling capital investments, and build business ecosystems.

#### LG Chem

LG Chem was established in 1947 as a cosmetic chemicals company and subsequently expanded into petrochemicals. For more than two decades, LG Chem has been building climate tech businesses with a broad technology portfolio including e-mobility, circular technologies, and hydrogen and energy storage.

*A pioneer scaler in EV batteries*, LG Chem first expanded into batteries for consumer electronics in 1992 and two decades later entered the EV battery market.<sup>36</sup> In 2015, the company partnered with Tesla to provide lithium-ion batteries for the Roadster. LG Chem has continued to invest in and grow its battery business, with an ambition to lead "the widespread distribution of electric vehicles by creating batteries with the most advanced technology in the world." In December 2020, the company spun off LG Energy Solution (LGES). In 2020 LGES became part of the group of Asian companies that supply over 70 percent of the global EV battery market. LGES has constructed more than seven plants, with a production capacity of more than 250 gigawatt-hours in 2023. LG Chem also announced a joint investment in a battery precursor plant to further reinforce its vertical integration of the cathode materials supply chain in the same year. LG's xEV batteries have been installed in more than 11 million vehicles<sup>37</sup> in the field, making LGES one of the world's top EV battery manufacturers.

 <sup>&</sup>lt;sup>36</sup> "The start of Korea's battery history," LG Energy Solution.
 <sup>37</sup> "Advanced automotive battery," LG Energy Solution.

LG Chem started to invest in batteries early on and expanded to EV batteries when the market was growing, leveraging existing capabilities and synergies with the traditional business.

The following are key takeaways from LG Chem's approach:

- started to invest in batteries early on and expanded to EV batteries when the market was growing, leveraging existing capabilities and synergies with the traditional business
- prioritized capital expenditure into strategic locations with promising growth prospects, leveraging support from US incentives
- committed to best-in-class technology for batteries, with average investment of around 4 percent of annual revenue that prioritized R&D and innovation, including materials and chemistry specialization
- worked with automotive customers primarily through JVs (such as with GM and Hyundai in the United States) to create early captive demand for EV batteries
- secured supply of critical materials through vertical integration

These actions are closely aligned with four aspects of our hyperscaling formula: set a bold ambition in the right opportunity window, establish technology leadership, secure captive demand before scaling capital investments, and build business ecosystems.

#### Tata Power

With a history that spans more than a century, Tata Power is one of the largest integrated power companies in India.

*Both a pioneer scaler and fast follower in solar power*, Tata Power began investing in climate technologies in the early 1990s. It established Tata Power Solar Systems (previously Tata BP Solar),<sup>38</sup> a JV with BP Solar, with the ambition to "enable solar everywhere." The company began manufacturing solar modules and cells and offering engineering, procurement, and construction (EPC) solutions for solar-power plants. It set up its first solar plant in 1996, and over the next few years, continued operating primarily at its Bangalore manufacturing facility.

<sup>&</sup>lt;sup>38</sup> "Tata BP Solar India Limited renamed as Tata Power Solar Systems Limited – a new beginning for India's pioneering solar company," Tata Power Solar Systems press release, August 30, 2012.

As renewable energy became more competitive in the 2010s, Tata Power established its Tata Power Renewable Energy division to scale solar and wind power in India. The company scaled its renewable portfolio, and in 2016 it acquired Welspun Renewables Energy, which brought over 1 GW of renewable-energy capacity.<sup>39</sup> In the following years, its renewables-generation development slowed while it scaled its solar EPC business. It also promoted decentralization of power by venturing into EV charging, rural microgrids, solar pumps, and solar rooftops. In the past few years, it has renewed its focus on scaling the renewable-power-generation business, dramatically expanding in operating solar and wind capacity from 2.2 GW<sup>40</sup> in 2018 to 5.0 GW<sup>41</sup> in October 2024. Since 2018, almost 60 percent of its capital expenditure investment, amounting to over \$4 billion, has been spent in the renewables business. The company has commissioned nearly 11.5 GW of solar projects across India with many first-of-its-kind projects such as floating solar, vertical solar, and solar carport. As of October 2024, it had a project pipeline of 5.9 GW.<sup>42</sup>

In 2023, Tata Power spun off its renewable businesses into Tata Power Renewable Energy Limited. The subsidiary of Tata Power has attracted a half-billion-dollar investment from BlackRock and Mubadala. In the past few years, Tata Power has also expanded its backward integration in solar manufacturing, setting up a new 4.3 GW solar cell and module manufacturing facility. Since 2018, Tata Power has seen fivefold growth in its market value. It is recognized as a top renewable-energy company and India's largest solar-rooftop company with over 2 GW of installations today.

The following are key takeaways from Tata Power's approach:

- started investing early in climate technologies across multiple areas with stage-gated investment into solar components, EPC services, distributed rural generation, and rooftop solar
- selectively scaled investment when market or regulatory conditions were right, for example, in utility-scale solar and components manufacturing, and It reevaluated investment if the conditions were not right, for example, minimizing investment in solar-equipment businesses over two decades
- deemphasized investing in businesses that did not scale, such as solar pumps
- vertically integrated to create an in-house ecosystem to get to a low-cost position across generation, equipment, and EPC
- partnered with multiple research institutions, academia, and start-ups to codevelop and deploy pilots for future energy solutions and services, including first-of-its-kind projects
- set up dedicated JVs (Tata BP Solar) and conducted spin-offs (Tata Power Renewable Energy) to drive its scaling agenda

<sup>&</sup>lt;sup>39</sup> "India's Tata Power to acquire Welspun Renewables," *Infrastructure Investor*, June 14, 2016.

<sup>&</sup>lt;sup>40</sup> "Tata Power expands '#GharGharSolar' initiative to Chhattisgarh, aims to unlock state's solar potential," Tata Power Solar Systems press release, September 10, 2024.

<sup>&</sup>lt;sup>41</sup> "Tata Power Renewable Energy Limited partners with IndusInd Bank to empower MSEs with solar energy financing solutions in India." Tata Power press release. October 29, 2024.

<sup>&</sup>lt;sup>42</sup> "India's Tata Power to acquire Welspun Renewables," 2016.

- built and nurtured project execution capabilities with a focus on serving preexisting demand through its third-party solar EPC business
- deployed deep homegrown talent—with at least 25 years of tenure and rotations around the business—supplemented with external hiring at senior levels to bring execution heft
- leveraged its established brand and credibility to secure low-cost financing, for example, from BlackRock and Mubadala

These actions are closely aligned with four aspects of our hyperscaling formula: set a bold ambition in the right opportunity window, build business ecosystems, build a star executive team and winning operating model, and source low-cost financing.

#### Incumbents have numerous opportunities to invest

Horizon two businesses are far from saturated. Even across commercially mature climate tech businesses—such as solar, wind, EVs, and lithium-ion batteries—there is still significant opportunity for incumbents to invest, primarily as fast followers. Electrification is expected to accelerate across industry, buildings, and mobility, creating opportunities both in renewables and across the electrification value chain.

Within the power sector, the pipeline for wind and solar projects announced in the United States is about 150 GW short of the installed-capacity target for 2030, according to McKinsey analysis. The same gap in the European Union, Norway, Switzerland, and the United Kingdom is nearly 300 GW.<sup>43</sup>

Further down the electrification value chain, McKinsey analysis projected that heat pump revenue could grow by up to 16 percent annually by 2030.<sup>44</sup> There are also opportunities in the EV value chain including battery materials, charging infrastructure, software for electrified fleets, and battery recycling. For example, to meet the International Energy Agency's "net-zero emissions by 2050" scenario<sup>45</sup> forecast of two-thirds EV market share by 2030, annual EV battery supply would need to increase from 0.8 terawatt-hours to 5.5 terawatt-hours, and a cumulative investment of around \$1 trillion in EV charging is needed between now and the beginning of the next decade.

#### Horizon three businesses are getting closer to scaling readiness

There are also early signs that some front-runner projects of a horizon three nature are getting closer to a point where scaling is viable, starting to pull some horizon three businesses toward horizon two. This indicates opportunities for able and willing incumbents to lead as pioneer scalers in these domains. Investments in many horizon three businesses are not as sizable as expected just a few years ago, and there have been project delays and cancellations. However, overall investment in key horizon three technologies has been growing, with early-stage investment accelerating technology readiness and cost competitiveness (Exhibit 7).

<sup>43</sup> "The energy transition: Where are we, really?," McKinsey, August 27, 2024.

<sup>44</sup> "Global Energy Perspective 2023: Industrial electrification outlook," McKinsey, January 16, 2024.

<sup>&</sup>lt;sup>45</sup> World Energy Outlook 2024, International Energy Agency, 2024.

#### Exhibit 7

## Looking ahead, there are early indicators that momentum is building in the next wave of climate technologies.



Source: Hydrogen Council and McKinsey Project and Investment Tracker, as of Dec 2020, May 2022, and May 2024; McKinsey CDR 360 Tracker; McKinsey sustainable fuels database

#### McKinsey & Company

Despite project delays and cancellations, investments into hydrogen businesses are rising, mostly led by incumbents.<sup>46</sup> Final investment decisions (FIDs) in hydrogen projects have significantly increased, with the number of committed projects quadrupling between December 2020 and May 2024.

The long-term pipeline for sustainable fuels is also growing (up 22 percent in two years with about 150 projects reaching FID as of September 2024). Clean-fuel mandates are encouraging long-term demand for biofuels in the European Union and South Korea. Seoul's biofuel development measures set an 8 percent biofuels-blending mandate by 2030, with a minimum requirement for the use of hydrotreated vegetable oil.<sup>47</sup>

Between 2022 and November 2024, there was a threefold increase in the number of deals for durable carbon dioxide removal (CDR). Demand growth is expected to continue, likely driven by the increasing pace of voluntary corporate net-zero commitments, and expectations of broader eligibility criteria for durable CDRs in compliance markets such as the EU Emissions Trading

<sup>46</sup> Hydrogen insights 2024, Hydrogen Council in collaboration with McKinsey, September 2024.

<sup>&</sup>lt;sup>47</sup> "South Korea to boost domestic biofuels use," Argus Media, October 14, 2022.

System.<sup>48</sup> Regulation can open windows of opportunity for incumbents to invest in horizon three businesses for those who are ready to go, have a strong conviction in their capabilities to execute now, and can see a path to eventually developing a subsidy-free business model. In Europe, the EU Carbon Border Adjustment Mechanism, which was due to come into effect in 2026 but could potentially be delayed, could level the playing field by setting a price on emitted carbon for selected carbon-intensive imports. Horizon three businesses remain a small proportion of incumbents' climate tech businesses, but spending has increased on those that are approaching the horizon two boundary (Exhibit 8).

We can also see that VCs have started shifting their focus to horizon three businesses. Between 2019 and 2023, VC<sup>49</sup> investment in horizon three businesses increased eightfold to 41 percent, from 5 percent, with considerable growth in green materials. During the same period, investments

#### Exhibit 8

#### Venture capitalists have started shifting their investments toward horizon three technology businesses.



#### Climate-driven investments, 2019–23, % share

1 Incumbent investments in technology verticals defined by McKinsey Platform for Climate Technologies, including capital expenditures, equity, R&D, spin-offs, VC arm investments, and significant portfolio-shifting investments. Top 377 companies by market capitalization as of Apr 2024, in capital-inten aerospace and defense, automotive, chemicals, conglomerates, industrials, logistics, metals and minerals, oil and gas, power, and semiconductors). Primary geog-raphies are Asia–Pacific (including 52 Chinese public companies and partially state-owned enterprises), Europe, and North America. <sup>2</sup>66 out of top 100 VCs that have at least 1 investment in energy tech sectors out of top 100 VCs (with assets under management >\$1 billion; 208 transactions out of 403 transactions in clean tech.

<sup>3</sup>Includes \$1.8 billion venture funding in Commonwealth Fusion Systems. Source: Cleantech Group; Crunchbase; PitchBook; McKinsey analysis

<sup>&</sup>lt;sup>48</sup>The European Union's Carbon Removals Certification Framework (CRCF) is currently being drafted and may influence the EU Emissions Trading System (ETS).

<sup>&</sup>lt;sup>49</sup>The analysis focuses on the top 100 VCs by assets under management (AUM) from a data set of VCs with AUM greater than \$1 billion and at least one investment in energy technology sectors; the sample size is 66 VCs with investments in green businesses; the total deal size is 208 transactions out of 229 in the clean technology sector.

in climate technology businesses at the boundary of horizon three and two increased fivefold to 16 percent, from 3 percent, primarily driven by circular technologies. VC investment continues to be a driver for step-change innovation and acceleration of early-stage technologies, such as plant-based food and EV batteries. They have also played a part in building the approximately 175<sup>50</sup> climate tech unicorns that have been created since 2015.

These horizon three investments represent over 20 percent of the cumulative \$139 billion VC investment in climate tech start-ups over the five-year period from 2019 to 2023.<sup>51</sup>

Like cars in the early 19th century or mobile phones in the late 20th century, climate tech businesses will go through boom-and-bust cycles of proliferating entry and consolidation. But along with risk, cycles provide incumbents with the opportunity to time their entry with the cycle and then use their assets to execute at speed while riding out the storms.

#### How incumbents can position for success

Many large companies are dealing with both known and completely new uncertainties and economic pressures. Balancing the short-term agenda with investments in long-term growth and resilience is not easy, but the quality of decisions made in difficult times often makes winners stand out from the rest. Therefore, this is a timely moment for incumbents to take stock of their stance toward the growth opportunities in climate tech businesses. Based on our research, we have identified a few diagnostic questions that incumbents should ask themselves:

- 1. Are the current climate tech businesses growing rapidly enough, creating value or getting ready to create value?
- 2. If the focus is on horizon two businesses, is the scaling ambition of the businesses adequate across capital expenditures and M&A? Are these investments backed up with the necessary capabilities—project execution, supply, demand capture, et cetera?
- 3. If the focus is on horizon three businesses, are the businesses being treated as such, that is, being developed and readied for scaling across *all* aspects—technology, regulations, demand, supply chain? Are there enough opportunities across R&D and relationships with or stakes in technologies?
- 4. Is the timing to move a business from horizon three to horizon two being judged explicitly and carefully, particularly by pioneer scalers? Are all the conditions in place—market readiness, technology maturity, regulatory support, and competitive landscape—before making substantial investments?
- 5. Is the overall aspiration bold enough, and capital allocation between legacy and new businesses commensurate? Are each of these new businesses being governed and staffed in the manner that is right for them?

<sup>&</sup>lt;sup>50</sup>As of June 2024.

<sup>&</sup>lt;sup>51</sup> Rosie Bradbury, "Startups: Climate-tech VC deals fell for 3rd straight year," PitchBook, January 14, 2025.

Companies that are contemplating stepping up their growth investments would benefit from asking the following questions:

- 1. How are our core businesses impacted by the energy and materials transition—compliance requirements, regulatory frameworks, customer expectations, and supply shifts?
- 2. What are real opportunities for us? What are the adjacencies to consider from among the 12 major climate tech groups? Given current capabilities (technologies, customers, supply base, et cetera) and the license from stakeholders, what are realistic opportunities to pursue?
- 3. What is the right approach for scaling—acquisition or organic build? Should we focus on being a fast follower or play the long game as a pioneer scaler?
- 4. What are the capability gaps for building the new business? How should these capabilities be built?
- 5. What governance, capital allocation approaches, and other conditions are needed for us to stay the course, given the long gestation, huge capital intensity, uncertainty, and regulatory dependence of these businesses? How different are they from our current approaches?

With deployment levels of low-emission technologies at only 10 percent of the levels required by 2050 to reach net-zero emissions, there is space to explore climate tech-focused business building.<sup>52</sup> Climate technologies have the potential to create significant value over the next decade—McKinsey has estimated the climate tech market could offer \$9 trillion to \$12 trillion in annual sales by 2030. Even with some delays, the market opportunity remains significant for technologies that reach economic and technical scaling readiness, through cycles. Building on momentum over the past five years, incumbents can take a leading role in accelerating these climate tech businesses in the large white space that remains for horizon two businesses and the next wave of horizon three businesses.

While we recognize that incumbents are at different stages in their climate journey, this report shows examples of how some have built successful climate tech businesses. Looking across industries and geographies, the time is right for all incumbents to ask themselves if there are climate-driven opportunities that they should explore to secure healthy growth for the future. And for those companies that decide to pursue these opportunities, there are lessons to learn from those that went before.

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<sup>&</sup>lt;sup>52</sup> "The hard stuff," McKinsey, 2024.

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